

CALCULATION TITLE PAGE

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CLIENT & PROJECT <i>Private Fuel Storage Limited Liability Corp/Private Fuel Storage Facility</i>				PAGE 1 OF 16 + <i>Attachments (40 pgs)</i>	
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CALCULATION OBJECTIVE

The objective of this calculation is to determine doses to individuals at the Private Fuel Storage Facility (PFSF) Owner Controlled Area (OCA) boundary and at the nearest residence to the PFSF from a hypothetical loss of canister confinement accident, for both a PWR canister containing 24 PWR fuel assemblies and a BWR canister containing 68 (worst case) BWR fuel assemblies.

CALCULATION METHOD / ASSUMPTIONS

The spent fuel in the canisters postulated to be leaking is assumed to be B&W 15X15 fuel assemblies with a conservative burnup of 45,000 MWd/MTU and 5-year cooling time for the canister containing PWR fuel and GE 8X8R fuel assemblies with a burnup of 45,000 MWd/MTU and 5-year cooling time for the canister containing BWR fuel. Holtec determined that the source term from canisters containing these fuel assemblies bounds that for other PWR and BWR fuel assembly types which can be loaded into the HI-STORM system (Reference 1). The source term from the HI-STORM SAR also bounds the radionuclide release modeled in the TranStor SAR (Reference 2) for this hypothetical accident condition. The total inventory of radionuclides of interest was derived from ORIGEN-S code runs by Holtec, and presented in the HI-STORM SAR. The fuel cladding of all fuel rods in the canister is assumed to have failed, and release fractions of various radionuclides from the spent fuel are specified in NUREG-1536 (Reference 3). Reference 4 presents information regarding the fractions of particulate and volatile radionuclides that escape from the canister. The dispersion factor (χ/Q) was previously calculated in Reference 5 (in accordance with Reg. Guide 1.145 - Reference 6), based on the nearest distance from the Canister Transfer Building to the OCA boundary (500 meters).

Factors from Reference 4 are applied to account for inability to inhale particles greater than an established diameter. Inhalation doses are calculated to an individual based on dose conversion factors from EPA's Federal Guidance Report No. 11 (Reference 7). In addition to inhalation doses, doses from exposure to radionuclides contained in the plumes (submersion doses) were calculated by means of the PERC2 computer code (Reference 8). Doses at the nearest residence, 2.0 miles from the PFSF, are calculated by multiplying doses at the OCA boundary by the ratio of dispersion factors for 500 meters and 3,219 meters (2.0 miles).

REFERENCES

1. Topical Safety Analysis Report for the Holtec International Storage and Transfer Operation Reinforced Module Cask System (HI-STORM 100 Cask System), Holtec Report HI-951312, Docket 72-1014, Revision 1, January 1997.
2. Safety Analysis Report for the TranStor Storage Cask System, SNC-96-72SAR, Sierra Nuclear Corporation, Docket 72-1023, Revision B, March

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- 1997.
3. NUREG-1536, Standard Review Plan for Dry Cask Storage Systems, Final Report, January 1997.
4. SAND80-2124, "Transportation Accident Scenarios for Commercial Spent Fuel, Sandia National Laboratories, February 1981.
5. SWEC Calculation No. 0599601- UR-1, Accident Dispersion Factors (χ/Q) for the PFSF, prepared by J.R. Johns, dated June 4, 1997.
6. Regulatory Guide 1.145, Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants, Revision 1, U.S. NRC, 1983.
7. Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, DE89-011065, U.S. Environmental Protection Agency, 1988.
8. Computer Code Designator NU-226, "Passive/Evolutionary Regulatory Consequence Code" (PERC2), Version 0, Level 1; Executable File Creation Date 6/22/94 at 3:45 p.m.

CONCLUSION

The following table summarizes the total doses to postulated individuals positioned in the wind plume at 500 meters (the closest point on the OCA boundary) and 3,219 meters (the nearest residence, 2.0 miles from the PFSF) from the hypothetical canister breach accident. Doses are calculated for canisters assumed to contain both PWR and BWR spent fuel assemblies.

Distance From Release	Calculated Doses From Postulated PWR Canister Breach (mrem)		Calculated Doses From Postulated BWR Canister Breach (mrem)	
	500 meters	3,219 meters (2.0 miles)	500 meters	3,219 meters (2.0 miles)
CEDE	547	26.8	752	36.8
CDE - Lungs	2,473	121	3,475	170
CDE - Thyroid	296	14.5	379	18.6
CDE - Skin	3,297	162	3,360	165

The CEDE and CDEs to organs, based on a hypothetical accident with extremely conservative assumptions, are within the 5 Rem limit to the whole body or any organ from any design basis accident specified in 10 CFR 72.106(b).

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CALCULATIONSource Terms

Section 7.V.3 of the NRC's Standard Review Plan for Dry Cask Storage Systems (NUREG-1536, Reference 3) provides a list of the nuclides that the NRC considers should be analyzed for the effects of potential release in the event of a hypothetical loss of canister confinement accident, along with the fraction of each nuclide assumed to be released from fuel rods whose cladding has failed. This list is Table 7.1 of NUREG-1536, and stipulates the following release fractions:

Table 1 Radionuclide Fractions Available for Release

RADIONUCLIDE	Fractions Available for Release *
H-3	0.30
Co-60 **	0.15
Kr-85	0.30
Sr-90	2.3 E-5
Ru-106	1.5 E-5
I-129	0.10
Cs-134	2.3 E-5
Cs-137	2.3 E-5

* Except for Co-60, only failed fuel rods contribute significantly to the release. Total fraction of radionuclides available for release must be multiplied by the fraction of fuel rods assumed to have failed.

** Source of Co-60 is crud on fuel rods, estimated to be 140 $\mu\text{Ci}/\text{cm}^2$ for PWRs and 600 $\mu\text{Ci}/\text{cm}^2$ for BWRs. Total Co-60 activity is this estimate times the total surface area of all rods in the cask.

For conservatism, it is assumed that the cladding of all fuel rods in a canister ruptures, releasing the above fractions of the fission product inventory of each fuel rod into the canister internal atmosphere. 15% of all the Co-60, assumed to be deposited as crud on the outer surfaces of all fuel rods in a canister, is assumed to be released from the surfaces of the fuel rods and into the canister internal atmosphere.

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The following radionuclide inventories were derived from ORIGEN-S calculations by Holtec for HI-STORM design fuel, as described in Section 7 of the HI-STORM SAR (Reference 1). The PWR values are based on the B&W 15X15 fuel assembly with a conservative burnup of 45,000 MWd/MTU and 5-year cooling time. Holtec determined that this bounds PWR fuel assembly types which will be loaded into the HI-STORM system. Similarly, bounding values for BWR fuel types are based on the GE 8X8R fuel assembly with a burnup of 45,000 MWd/MTU and 5-year cooling time. The Co-60 value presented in the following table is a factor of 600/140 greater than that in the HI-STORM SAR, since Holtec assumed a Co-60 concentration of 140 $\mu\text{Ci}/100\text{ cm}^2$ on both PWR and BWR fuel assemblies, whereas the guidance in Reference 3 specifies an assumed Co-60 concentration of 600 $\mu\text{Ci}/100\text{ cm}^2$ for BWR fuel assemblies. The following radionuclide inventories bound those modeled in the TranStor SAR (Reference 2) for this hypothetical accident condition.

Table 2 Radionuclide Inventories in Spent Fuel in Canisters

Radionuclide	Inventory Associated with 24 PWR Design Fuel Assemblies (μCi)	Inventory Associated with 68 BWR Design Fuel Assemblies (μCi)
H-3	5.74 E9	5.84 E9
Co-60	5.66 E8	2.33 E9
Kr-85	9.70 E10	9.79 E10
Sr-90	1.02 E12	1.05 E12
Ru-106	2.93 E11	2.55 E11
I-129	5.04 E5	5.19 E5
Cs-134	5.23 E11	4.85 E11
Cs-137	1.51E12	1.56 E12

Based on Table XIX of Reference 4, it is assumed that 90% of the volatile fission products (I-129, Ru-106, Cs-134, and Cs-137) and 90% of the particulates (Co-60 and Sr-90) are held up within the breached cask following release from the fuel assemblies, and do not escape to the atmosphere. 10% of these radionuclides and 100% of the H-3 and Kr-85 are assumed to escape from the canister breach to the atmosphere.

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The following Table 3 multiplies the radionuclide inventories presented in Table 2 by the NRC release fractions presented in Table 1 (which represents the activity released from the fuel rods), and then by 10% (for all radionuclides except for H-3 and Kr-85) to determine the quantities of each radionuclide calculated to be released to atmosphere from the postulated breach in the canister.

Table 3 Quantities of Radionuclides Assumed to be Released From Canisters

Radio-nuclide	Quantity of Radionuclides Released from Canister Containing 24 PWR Design Fuel Assemblies (μCi)	Quantity of Radionuclides Released from Canister Containing 68 BWR Design Fuel Assemblies (μCi)
H-3	$(5.74 \text{ E}9)(0.30)(1.0) = 1.72 \text{ E}9$	$(5.84 \text{ E}9)(0.30)(1.0) = 1.75 \text{ E}9$
Co-60	$(5.66 \text{ E}8)(0.15)(0.10) = 8.49 \text{ E}6$	$(2.33 \text{ E}9)(0.15)(0.10) = 3.50 \text{ E}7$
Kr-85	$(9.70 \text{ E}10)(0.30)(1.0) = 2.91 \text{ E}10$	$(9.79 \text{ E}10)(0.30)(1.0) = 2.94 \text{ E}10$
Sr-90	$(1.02 \text{ E}12)(2.3 \text{ E}-5)(0.10) = 2.35 \text{ E}6$	$(1.05 \text{ E}12)(2.3 \text{ E}-5)(0.10) = 2.42 \text{ E}6$
Ru-106	$(2.93 \text{ E}11)(1.5 \text{ E}-5)(0.10) = 4.40 \text{ E}5$	$(2.55 \text{ E}11)(1.5 \text{ E}-5)(0.10) = 3.83 \text{ E}5$
I-129	$(5.04 \text{ E}5)(0.10)(0.10) = 5.04 \text{ E}3$	$(5.19 \text{ E}5)(0.10)(0.10) = 5.19 \text{ E}3$
Cs-134	$(5.23 \text{ E}11)(2.3 \text{ E}-5)(0.10) = 1.20 \text{ E}6$	$(4.85 \text{ E}11)(2.3 \text{ E}-5)(0.10) = 1.12 \text{ E}6$
Cs-137	$(1.51 \text{ E}12)(2.3 \text{ E}-5)(0.10) = 3.47 \text{ E}6$	$(1.56 \text{ E}12)(2.3 \text{ E}-5)(0.10) = 3.59 \text{ E}6$

Dispersion

The radionuclides postulated to be released from the hypothetical breached canister are dispersed in the atmosphere, reaching the downwind dose point and resulting in a dose to a hypothetical individual standing at the OCA fence for the duration of the release. Reference 5 is the calculation which determines the dispersion factor (χ/Q) for the minimum distance from the Canister Transfer Building to the OCA boundary. This distance was determined to be as 500 meters, based on SWEC dwg entitled Site Access Road Location Plan (Dwg. No. 0599601-EY-1-D). A dispersion factor of $1.94 \text{ E}-3 \text{ sec/cubic meter}$ was calculated in accordance with Regulatory Guide 1.145 (Reference 6), for a distance of 500 meters from the release source, conservatively assuming a wind speed of 1 meter/sec, and atmospheric stability class F, with no consideration for plume meander.

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Uptake by Inhalation

An adult breathing rate of 3.3 E-4 cubic meters per second is assumed in accordance with Reference 7. Based on Table XX of Reference 4, 95% of Co-60 and Sr-90 particulates are greater than 10 microns aerodynamic diameter and are non-respirable. Therefore, a respirable factor of 0.05 was applied to these particulates to account for inhalation of only those particulates having an aerodynamic diameter less than 10 microns.

The following Table 4 calculates the quantity of each radionuclide assumed to be released from the canister that is considered to be inhaled by an adult standing 500 meters from the release source for the duration of the release, with the exception of Kr-85. For Kr-85, the activity released from the canister is multiplied by the dispersion factor, resulting in values with units of $\mu\text{Ci-sec/m}^3$ at the OCA boundary, which are not meaningful until multiplied by the dose conversion factors for submersion (which have units of $\text{mrem/sec per } \mu\text{Ci/m}^3$, equal to $\text{mrem-m}^3/\mu\text{Ci-sec}$). The Kr-85 dose comes from submersion in a cloud or plume of Kr-85 activity, rather than from inhalation since Kr-85 is not absorbed into the body. Quantities of radionuclides inhaled are calculated by multiplying the activity of each radionuclide released from the canister by the dispersion factor (1.94 E-3 cubic meters/sec), by the adult breathing rate (3.3 E-4 cubic meters/sec), and then multiplying by the fraction of activity inhaled for each radionuclide (100%, except for the particulates Co-60 and Sr-90, for which 5% is inhaled). The factor of 6.40 E-7 in the following table is the dispersion factor times the breathing rate ($1.94 \text{ E-3 sec/m}^3 \times 3.3 \text{ E-4 m}^3/\text{sec} = 6.40 \text{ E-7}$).

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Table 4 Quantities of Radionuclides Inhaled into Respiratory System

Radio-nuclide	Quantity of Radionuclides Inhaled into Respiratory System by Individual at OCA Boundary from Breached Canister Containing 24 PWR Design Fuel Assemblies (μCi)*	Quantity of Radionuclides Inhaled into Respiratory System by Individual at OCA Boundary from Breached Canister Containing 68 BWR Design Fuel Assemblies (μCi)*
H-3	$(1.72 \text{ E}9)(6.40 \text{ E-}7)(1.0) = 1.10 \text{ E}3$	$(1.75 \text{ E}9)(6.40 \text{ E-}7)(1.0) = 1.12 \text{ E}3$
Co-60	$(8.49 \text{ E}6)(6.40 \text{ E-}7)(0.05) = 2.72 \text{ E-}1$	$(3.50 \text{ E}7)(6.40 \text{ E-}7)(0.05) = 1.12 \text{ E}0$
Kr-85*	$(2.91 \text{ E}10)(1.94 \text{ E-}3) = 5.65 \text{ E}7$	$(2.94 \text{ E}10)(1.94 \text{ E-}3) = 5.70 \text{ E}7$
Sr-90	$(2.35 \text{ E}6)(6.40 \text{ E-}7)(0.05) = 7.51 \text{ E-}2$	$(2.42 \text{ E}6)(6.40 \text{ E-}7)(0.05) = 7.73 \text{ E-}2$
Ru-106	$(4.40 \text{ E}5)(6.40 \text{ E-}7)(1.0) = 2.81 \text{ E-}1$	$(3.83 \text{ E}5)(6.40 \text{ E-}7)(1.0) = 2.45 \text{ E-}1$
I-129	$(5.04 \text{ E}3)(6.40 \text{ E-}7)(1.0) = 3.23 \text{ E-}3$	$(5.19 \text{ E}3)(6.40 \text{ E-}7)(1.0) = 3.32 \text{ E-}3$
Cs-134	$(1.20 \text{ E}6)(6.40 \text{ E-}7)(1.0) = 7.70 \text{ E-}1$	$(1.12 \text{ E}6)(6.40 \text{ E-}7)(1.0) = 7.14 \text{ E-}1$
Cs-137	$(3.47 \text{ E}6)(6.40 \text{ E-}7)(1.0) = 2.22 \text{ E}0$	$(3.59 \text{ E}6)(6.40 \text{ E-}7)(1.0) = 2.30 \text{ E}0$

* For Kr-85, the value calculated has units of $\mu\text{Ci-sec/m}^3$, representative of the concentration of Kr-85 in the air at the OBA boundary and not the quantity inhaled.

Dose Conversion Factors

The last step in determining the dose to an individual is application of dose conversion factors (DCFs) to the quantity of each radionuclide inhaled, and in the case of Kr-85, to the value associated with concentration of Kr-85 in the cloud of radioactivity at the OCA boundary. DCFs are extracted from Reference 7 for organs (e.g. lungs and thyroid) to calculate the committed dose equivalent (CDE) and for the effective dose to calculate the committed effective dose equivalent (CEDE). DCFs in Reference 7 are stated in terms of Sievert per Becquerel (Sv/Bq). 100 Rem is equal to one Sv, and one μCi ($1 \text{ E-}6 \text{ Ci}$) is equal to $3.7 \text{ E}4 \text{ Bq}$ (or $3.7 \text{ E}4$ decays per second). A factor of $3.7 \text{ E}9$ is used to convert from Sv/Bq to mrem/ μCi . The inhalation DCFs for CEDE and for CDE to the lungs and thyroid are given in Table 5. Table 6 gives the DCFs for an individual located inside a cloud of Kr-85 and H-3 gases. These submersion DCFs are presented in Reference 7 in units of Sv/hr per Bq/ m^3 . A factor of $3.7 \text{ E}9$ is used to convert from Sv/hr per Bq/ m^3 to units of mrem/hr per $\mu\text{Ci}/\text{m}^3$. This value is then divided by 3,600 sec/hr to obtain units of mrem/sec per $\mu\text{Ci}/\text{m}^3$, as presented in Table 6.

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**Table 5 Inhalation Dose Conversion Factors from Federal Guidance
Report No. 11 (Reference 7)**

Radionuclide	Effective DCF (mrem/ μ Ci)	Lung DCF (mrem/ μ Ci)	Thyroid DCF (mrem/ μ Ci)
H-3	6.40 E-2	6.40 E-2	6.40 E-2
Co-60	2.19 E2	1.28 E3	5.99 E1
Sr-90	1.30 E3	1.06 E4	9.77 E0
Ru-106	4.77 E2	3.85 E3	5.07 E1
I-129	1.74 E2	1.16 E0	5.77 E3
Cs-134	4.63 E1	4.37 E1	4.11 E1
Cs-137	3.19 E1	3.26 E1	2.93 E1

**Table 6 Submersion Dose Conversion Factors from Federal Guidance
Report No. 11 (Reference 7)**

Radio- nuclide	Effective DCF (mrem/sec per μ Ci/ m^3)	Lung DCF (mrem/sec per μ Ci/ m^3)	Thyroid DCF (mrem/sec per μ Ci/ m^3)	Skin DCF (mrem/sec per μ Ci/ m^3)
Kr-85	4.83 E-7	4.43 E-7	2.57 E-7	4.79 E-5
H-3	1.22 E-9	1.02 E-8	N.A.	N.A.

Dose Calculations for Inhalation

The following Tables 7 and 8 present the CEDEs, and CDEs to the lungs and thyroid, calculated to result from inhalation of radionuclides released from postulated breach of a PWR and BWR canister, respectively. The dose equivalents are calculated by multiplying the quantity of each radionuclide inhaled (Table 4) by the inhalation dose conversion factor (from Table 5). Consistent with the Derived Air Concentrations (DAC) in Reference 7, calculated inhalation doses from H-3 include a factor of 1.5 to account for absorption through the skin.

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**Table 7 - Inhalation Doses From Postulated
PWR Canister Breach**

Radio-nuclide	CEDE (mrem)	CDE to the Lungs (mrem)	CDE to the Thyroid (mrem)
H-3	$(1.10 \text{ E}3)(6.40 \text{ E-}2)(1.5) = 1.06 \text{ E}2$	$(1.10 \text{ E}3)(6.40 \text{ E-}2)(1.5) = 1.06 \text{ E}2$	$(1.10 \text{ E}3)(6.40 \text{ E-}2)(1.5) = 1.06 \text{ E}2$
Co-60	$(2.72 \text{ E-}1)(2.19 \text{ E}2) = 5.94 \text{ E}1$	$(2.72 \text{ E-}1)(1.28 \text{ E}3) = 3.47 \text{ E}2$	$(2.72 \text{ E-}1)(5.99 \text{ E}1) = 1.63 \text{ E}1$
Sr-90	$(7.51 \text{ E-}2)(1.30 \text{ E}3) = 9.75 \text{ E}1$	$(7.51 \text{ E-}2)(1.06 \text{ E}4) = 7.95 \text{ E}2$	$(7.51 \text{ E-}2)(9.77 \text{ E}0) = 7.34 \text{ E-}1$
Ru-106	$(2.81 \text{ E-}1)(4.77 \text{ E}2) = 1.34 \text{ E}2$	$(2.81 \text{ E-}1)(3.85 \text{ E}3) = 1.08 \text{ E}3$	$(2.81 \text{ E-}1)(5.07 \text{ E}1) = 1.43 \text{ E}1$
I-129	$(3.23 \text{ E-}3)(1.74 \text{ E}2) = 5.60 \text{ E-}1$	$(3.23 \text{ E-}3)(1.16 \text{ E}0) = 3.75 \text{ E-}3$	$(3.23 \text{ E-}3)(5.77 \text{ E}3) = 1.86 \text{ E}1$
Cs-134	$(7.70 \text{ E-}1)(4.63 \text{ E}1) = 3.56 \text{ E}1$	$(7.70 \text{ E-}1)(4.37 \text{ E}1) = 3.36 \text{ E}1$	$(7.70 \text{ E-}1)(4.11 \text{ E}1) = 3.16 \text{ E}1$
Cs-137	$(2.22 \text{ E}0)(3.19 \text{ E}1) = 7.10 \text{ E}1$	$(2.22 \text{ E}0)(3.26 \text{ E}1) = 7.26 \text{ E}1$	$(2.22 \text{ E}0)(2.93 \text{ E}1) = 6.52 \text{ E}1$
TOTAL	5.04 E2	2.43 E3	2.53 E2

**Table 8 - Inhalation Doses From Postulated
BWR Canister Breach**

Radio-nuclide	CEDE (mrem)	CDE to the Lungs (mrem)	CDE to the Thyroid (mrem)
H-3	$(1.12 \text{ E}3)(6.40 \text{ E-}2)(1.5) = 1.08 \text{ E}2$	$(1.12 \text{ E}3)(6.40 \text{ E-}2)(1.5) = 1.08 \text{ E}2$	$(1.12 \text{ E}3)(6.40 \text{ E-}2)(1.5) = 1.08 \text{ E}2$
Co-60	$(1.12 \text{ E}0)(2.19 \text{ E}2) = 2.45 \text{ E}2$	$(1.12 \text{ E}0)(1.28 \text{ E}3) = 1.43 \text{ E}3$	$(1.12 \text{ E}0)(5.99 \text{ E}1) = 6.71 \text{ E}1$
Sr-90	$(7.73 \text{ E-}2)(1.30 \text{ E}3) = 1.00 \text{ E}2$	$(7.73 \text{ E-}2)(1.06 \text{ E}4) = 8.18 \text{ E}2$	$(7.73 \text{ E-}2)(9.77 \text{ E}0) = 7.55 \text{ E-}1$
Ru-106	$(2.45 \text{ E-}1)(4.77 \text{ E}2) = 1.17 \text{ E}2$	$(2.45 \text{ E-}1)(3.85 \text{ E}3) = 9.42 \text{ E}2$	$(2.45 \text{ E-}1)(5.07 \text{ E}1) = 1.24 \text{ E}1$
I-129	$(3.32 \text{ E-}3)(1.74 \text{ E}2) = 5.77 \text{ E-}1$	$(3.32 \text{ E-}3)(1.16 \text{ E}0) = 3.86 \text{ E-}3$	$(3.32 \text{ E-}3)(5.77 \text{ E}3) = 1.92 \text{ E}1$
Cs-134	$(7.14 \text{ E-}1)(4.63 \text{ E}1) = 3.30 \text{ E}1$	$(7.14 \text{ E-}1)(4.37 \text{ E}1) = 3.12 \text{ E}1$	$(7.14 \text{ E-}1)(4.11 \text{ E}1) = 2.93 \text{ E}1$
Cs-137	$(2.30 \text{ E}0)(3.19 \text{ E}1) = 7.33 \text{ E}1$	$(2.30 \text{ E}0)(3.26 \text{ E}1) = 7.50 \text{ E}1$	$(2.30 \text{ E}0)(2.93 \text{ E}1) = 6.74 \text{ E}1$
TOTAL	6.77 E2	3.40 E3	3.04 E2

These inhalation doses are verified by runs of the PERC2 Code (Reference 8), which is a SWEC Category I code that can be used for important-to-safety applications. PERC2 runs were performed on 5/16/97 by Joe Baron of SWEC-Boston, and output is included as Attachment 1 (PWR case) and Attachment 2 (BWR case). The last page of each attachment, entitled "Total Site Boundary Activity (Curies) and Dose (Rem) from 0.0000 To 2.0000 Hours", summarizes the doses, and it is seen that the above totals are within 1% of the totals calculated by PERC2. Based on the PERC2 Code output, it is clear that the lung is the maximally exposed (critical) organ.

CALCULATION SHEET

CALCULATION IDENTIFICATION NUMBER				PAGE <u>12</u>
J.O. OR W.O. NO. 05996.01	DIVISION & GROUP Rad. Protection	CALCULATION NO. UR-2	OPTIONAL TASK CODE N.A.	

Dose Calculations From Submersion in Plume Containing Radioactivity

In addition to doses calculated to result from inhalation of radioactive materials, doses resulting from submersion in a cloud or plume containing radioactivity are also evaluated. Out of the radionuclides assumed to be released from the canister, Reference 7 provides submersion DCFs for H-3 and Kr-85, and these are listed above in Table 6. In order to obtain submersion doses, the representative value calculated at the OCA boundary (Table 4, having units of $\mu\text{Ci-sec/m}^3$) is multiplied by the dose conversion factor (Table 6, with units of $\text{mrem-m}^3/\mu\text{Ci-sec}$).

Table 9 Submersion Doses From Postulated PWR Canister Breach, Using Dose Conversion Factors From Federal Guidance Report No. 11 (Reference 7)

Radio-nuclide	CEDE (mrem)	CDE to the Lungs (mrem)	CDE to the Thyroid (mrem)	CDE to the Skin
H-3	(1.72 E9)(1.94 E-3) (1.22 E-9) = 4.07 E-3	(1.72 E9)(1.94 E-3) (1.02 E-8) = 3.40 E-2	N.A.	N.A.
Kr-85	(2.91 E10)(1.94 E-3) (4.83 E-7) = 27.3	(5.65 E7)(1.94 E-3) (4.43 E-7) = 25.0	(5.65 E7)(1.94 E-3) (2.57 E-7) = 14.5	(2.91 E10)(1.94E-3) (4.79 E-5) = 2,700

Table 10 Submersion Doses From Postulated BWR Canister Breach, Using Dose Conversion Factors From Federal Guidance Report No. 11 (Reference 7)

Radio-nuclide	CEDE (mrem)	CDE to the Lungs (mrem)	CDE to the Thyroid (mrem)	CDE to the Skin
H-3	(1.75 E9)(1.94 E-3) (1.22 E-9) = 4.14 E-3	(1.75 E9)(1.94 E-3) (1.02 E-8) = 3.46 E-2	N.A.	N.A.
Kr-85	(5.70 E7)(1.94 E-3) (4.83 E-7) = 27.5	(5.70 E7)(1.94 E-3) (4.43 E-7) = 25.2	(5.70 E7)(1.94 E-3) (2.57 E-7) = 14.6	(2.94 E10)(1.94E-3) (4.79 E-5) = 2,730

The above doses are compared to those computed by the PERC2 Code and displayed on the last page of the Attachments 1 (PWR) and 2 (BWR) computer output. The gamma doses from Kr-85 are for submersion, calculated to be 3.149 E-2 Rem (= 31.5 mrem), for the PWR canister and 3.178 E-2 Rem (= 31.8 mrem), for the BWR canister. These values compare with the Kr-85 submersion doses presented above calculated using the Reference 7 DCFs of 27.3 mrem for PWR fuel and 27.5 mrem for BWR fuel. Since the methodology used in Attachments 1 and 2 produces more conservative results (approximately 15% higher) for Kr-85 gamma doses resulting from submersion, these PERC2 Code submersion doses will be added to the inhalation doses calculated above to arrive at total doses, rather than using the submersion calculated by the Reference 7 DCFs shown above. In addition, it is noted from this last page of

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Attachments 1 and 2 that gamma and beta doses resulting from submersion in a cloud of airborne radioactive material are calculated not only for H-3 and Kr-85, but for all radionuclides of interest. The gamma dose represents a whole body penetrating dose, and the beta dose represents a skin dose.

The total gamma and beta doses resulting from submersion in clouds containing the radionuclides of interest from the last page of the PERC2 Code output, Attachments 1 and 2, are stated to be 3.291 E-2 Rem gamma and 3.253 E0 Rem beta for the PWR canister, and 3.474 E-2 Rem gamma and 3.283 E0 Rem beta for the BWR canister. However, in order to account for inhalation of the 0.05 fraction of particulates, these computations reduced the Sr-90 and Co-60 concentrations in air by a factor of 20. While this results in the correct quantity of the particulates inhaled, it underestimates (by a factor of 20) the concentration of these radionuclides in the plume, which contribute to gamma and beta doses to the whole body. Therefore, the Co-60 and Sr-90 gamma and beta submersion doses are multiplied by a factor of 20 to obtain values representative of the concentrations of these radionuclides in the plumes, as follows:

Table 11 Submersion Doses From Co-60 and Sr-90, Postulated PWR Canister Breach, Using Output of PERC2 Code (Reference 8)

Radio-nuclide	Gamma Dose from Individual Radionuclide (mrem)	Beta Dose from Individual Radionuclide (mrem)
Co-60	$(5.159 \text{ E-1})(20) = 10.32$	$(1.814 \text{ E-2})(20) = 0.36$
Sr-90	N.A.	$(1.025 \text{ E-2})(20) = 0.25$

Thus, for the PWR canister: the Co-60 contribution to the total gamma dose increases by $10.32 - 5.159 \text{ E-1} = 9.80 \text{ mrem}$ and the Co-60 contribution to the total beta dose increases by $0.36 - 0.0184 = 0.34 \text{ mrem}$; the Sr-90 contribution to the total beta dose increases by $0.25 - .0125 = 0.24 \text{ mrem}$.

The total corrected gamma and beta doses resulting from submersion are as follows:

Gamma: $32.91 + 9.80 = 42.71 \text{ mrem}$

Beta: $3,253 + 0.34 + 0.25 = 3,254 \text{ mrem}$

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J.O. OR W.O. NO. 05996.01	DIVISION & GROUP Rad. Protection	CALCULATION NO. UR-2	OPTIONAL TASK CODE N.A.	

Table 12 Submersion Doses From Co-60 and Sr-90, Postulated BWR Canister Breach, Using Output of PERC2 Code (Reference 8)

Radio-nuclide	Gamma Dose from Individual Radionuclide (mrem)	Beta Dose from Individual Radionuclide (mrem)
Co-60	$(2.124 \text{ E}0)(20) = 42.48$	$(7.469 \text{ E-}2)(20) = 1.49$
Sr-90	N.A.	$(1.055 \text{ E-}2)(20) = 0.21$

Thus, for the BWR canister: the Co-60 contribution to the total gamma dose increases by $42.48 - 2.124 = 40.36$ mrem and the Co-60 contribution to the total beta dose increases by $1.49 - 7.469 \text{ E-}2 = 1.42$ mrem; the Sr-90 contribution to the total beta dose increases by $0.21 - 1.055 \text{ E-}2 = 0.20$ mrem.

The total corrected gamma and beta doses are as follows:

Gamma: $34.74 + 40.36 = 75.10$ mrem

Beta: $3,283 + 1.42 + 0.20 = 3,285$ mrem

Total Doses - Inhalation + Submersion

The gamma dose contribution from submersion in the plume is added to the total CEDE for inhalation, and to the CDE for each organ, to arrive at total CEDE and CDEs, as follows:

Table 13 Total Doses From Postulated Breach of a PWR Canister

CEDE (mrem)	CDE to the Lungs (mrem)	CDE to the Thyroid (mrem)
$504 + 42.7 = 546.7$	$2,430 + 42.7 = 2,473$	$253 + 42.7 = 295.7$

Table 14 Total Doses From Postulated Breach of a BWR Canister

CEDE (mrem)	CDE to the Lungs (mrem)	CDE to the Thyroid (mrem)
$677 + 75.1 = 752.1$	$3,400 + 75.1 = 3,475$	$304 + 75.1 = 379.1$

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J.O. OR W.O. NO. 05996.01	DIVISION & GROUP Rad. Protection	CALCULATION NO. UR-2	OPTIONAL TASK CODE N.A.	

Skin Dose

Skin dose is generally considered separately from the dose to organs. Skin dose is calculated by adding the total beta dose from submersion in the plume (which is a beta skin dose) to the total gamma dose, since the gamma dose to the whole body also exposes the skin.

For the PWR canister, the total skin dose is $3,254 + 42.71 = 3,297$ mrem

For the BWR canister, the total skin dose is $3,285 + 75.10 = 3,360$ mrem

Determination of Doses to an Individual Assumed to be at the Nearest Residence

The nearest residence from the PFSF is in a direction of east-southeast from the PFSF. The distance from the PFSF to the nearest residence was measured at 2.0 miles on the USGS Quad Map (No. 40112-D7-TF-024, 1993) entitled "Hickman Knolls Quad". A χ/Q of $9.42 \text{ E-5 sec/cu meter}$ was calculated in accordance with Regulatory Guide 1.145, assuming a distance of 2 miles (3,219 meters) from the release source to the dose receptor, a wind speed of 1 meter/sec, atmospheric stability class F, with no consideration for plume meander. Since the source term is identical, the difference in doses at 3,219 meters vs. 500 meters is proportional to the ratio of χ/Q s at the two distances, assuming the wind direction directs the release plume toward the nearest residence, and an individual at 2.0 miles from the release point remains in the plume for the duration of the release. The ratio of χ/Q s is:

$$\frac{\chi/Q (3,219 \text{ meters})}{\chi/Q (500 \text{ meters})} = \frac{9.42 \text{ E-5 sec/ m}^3}{1.94 \text{ E-3 sec/m}^3} = 0.049$$

Doses at 2.0 miles from the PFSF are calculated by multiplying doses at 500 meters by the ratio of χ/Q s (0.049), as has been done in the following table which summarizes dose consequences.

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Summary of Doses

The following table summarizes the total doses to postulated individuals positioned in the wind plume at 500 meters (the closest point on the OCA boundary) and 3,219 meters (the nearest residence, 2.0 miles from the PFSF) from the hypothetical canister breach accident. Doses are calculated for canisters assumed to contain both PWR and BWR spent fuel assemblies.

Distance From Release	Calculated Doses From Postulated PWR Canister Breach (mrem)		Calculated Doses From Postulated BWR Canister Breach (mrem)	
	500 meters	3,219 meters (2.0 miles)	500 meters	3,219 meters (2.0 miles)
CEDE	547	26.8	752	36.8
CDE - Lungs	2,473	121	3,475	170
CDE - Thyroid	296	14.5	379	18.6
CDE - Skin	3,297	162	3,360	165

The CEDE and CDEs to organs, based on a hypothetical accident with extremely conservative assumptions, are within the 5 Rem limit to the whole body or any organ from any design basis accident specified in 10 CFR 72.106(b).

ATTACHMENT 1

Output of PERC2 Code Run To Determine Dose Consequences From a Hypothetical PWR Canister Breach Accident

* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:35:57.34 PAGE 1
 S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

UNIT 55 (SEQ 1) INPUT ECHO 1 2 3 4 5 6 7 8
 1234567890123456789012345678901234567890123456789012345678901234567890

1	* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK	1
2	* INPUT FILE NAMES	2
3	'PCASK_AT.DAT', 'CASK_ISO.DAT', 'DOSECONV.I30', 'ENERGY.DAT'	3
4	* CONTROL CARD	4
5	2 1 1 1.00 1.00 .F. .F. .T.	5
6	* TIME INTERVALS	6
7	0.0000	7
8	* 90 Seconds AFTER ACCIDENT	8
9	0.025000 /	9
10	* 120 MINUTES AFTER ACCIDENT	10
11	2.000 /	11
12	*	12
13	*	13
14	* CASK VOLUME	14
15	*	15
16	* ASSUME VOLUME = 100 FT3	16
17	*	17
18	* ASSUME PURGE RATE = 10 CFM (REMOVES ALL ACTIVITY IN 2 HOURS)	18
19	*	19
20	* CASK PLATEOUT/REMOVAL FACTORS	20
21	*	21
22	* CS, I, RU 90% PLATES OUT IN CASK TABLE XIX SAND80-2124	22
23	* "TRANSPORTATION-ACCIDENT SCENARIOS FOR COMMERCIAL	23
24	* SPENT FUEL" (5% + 5% OF MATERIAL RELEASED FROM FUEL	24
25	* IS RELEASED FROM GAS-COOLED CASK)	25
26	*	26
27	* SR, CO 90% SETTLES OR IS FILTERED OUT IN RELEASE FROM CASK	27
28	* TABLE XIX SAND80-2124	28
29	* "TRANSPORTATION-ACCIDENT SCENARIOS FOR COMMERCIAL	29
30	* SPENT FUEL" (5% + 5% OF MATERIAL RELEASED FROM FUEL	30
31	* IS RELEASED FROM GAS-COOLED CASK)	31
32	*	32
33	* KR, H ASSUMED RELEASED	33
34	*	34
35	*	35
36	* RESPIRABLE FRACTION	36
37	*	37
38	* SR, CO 5% (MODELLED AS FILTER DF)	38
39	* TABLE XX SAND80-2124	39
40	* "TRANSPORTATION-ACCIDENT SCENARIOS FOR COMMERCIAL	40
41	* SPENT FUEL"	41
42	*	42
43	*	43
44	* VOLUME	44

```

45 *
46 *
47 100.      0.0      0.0      0.0      0.0      1.0000      1
48 *
49 *
50 * CASK ACTIVITY RELEASE FRACTIONS

```

* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:35:57.34 PAGE 2
S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

UNIT 55 (SEQ 1) INPUT ECHO 1 2 3 4 5 6 7 8
1234567890123456789012345678901234567890123456789012345678901234567890

```

51 * 51
52 0.00000 0.025 1.0000000 52
53 0.30 .10 2.30-5 0.0 2.30-5 1.50-5 0.0 0.0 0.0 0.0 0.0 0.15 53
54 * 54
55 1.0 0.1 0.1 1.0 0.1 0.1 1.0 1.0 1.0 1.0 1.0 0.1 55
56 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 56
57 * 57
58 * 58
59 * 59
60 * #1 TIME INTERVAL (UP TO 90s) INPUT PARAMETERS 60
61 * SITE BNDRY RESPIRATION (SBRATE), OCCUPANCY FACTOR (SOCFAC) 61
62 3.30E-04 1.000E+00 62
63 **** 63
64 * REGION 1 (CASK) 64
65 * EFFLUENT FLOW (EF) TO ENVIRONMENT (CFM) 65
66 * SITE BNDRY (SDISPC) AND CNTRL ROOM (CDISPC) DISPERSION COEF (SEC/M3) 66
67 * REGION OCCUPANCY FACTOR (COCFAC) 67
68 10.0 1.94E-03 0.00-00 1.000E+00 68
69 **REGION MIXING AND RECIRC FLOWRATES (CFM) - F12(K),F13(K),F14(K),F15(K),R(1,K) 69
70 * F(S-U) F(S-A) F(S-O) F(S-CR) F(RECIRC IN SPRAYED REGION) 70
71 0.0 0.0 0.0 0.0 0.0 71
72 * REMOVAL LAMBDA (/HR) : XLR(1,K,NM) 72
73 0.0 / 73
74 * PARTITION COEF TO AIR - P12(K,NM),P13(K,NM),P14(K,NM),P15(K,NM) 74
75 1.0 / 75
76 1.0 / 76
77 1.0 / 77
78 1.0 / 78
79 * RECIRC FILTER DECONTAMINATION FACTORS DFR1(K,NM) 79
80 1.0 / 80
81 * DAUGHTER PRODUCTS STRIPPED FROM RECIRC FILTER SR1(K,NM) 81
82 0.0 / 82
83 * EFFLUENT FILTER DECONTAMINATION FACTORS DFE1(K,NM) 83
84 1.0 5 20. 12 20./ 84
85 * DAUGHTER PRODUCTS STRIPPED FROM EFFLUENT FILTER - SE(1,K,NM) 85
86 0.0 / 86
87 * DAUGHTER PRODUCTS EVOLVED FROM WALLS - VW(1,K,NM) 87
88 0.0 1 1.0/ 88
89 * 89
90 * 90
91 * 91
92 * #2 TIME INTERVAL (TO 2 HR) INPUT PARAMETERS 92
93 * SITE BNDRY RESPIRATION (SBRATE), OCCUPANCY FACTOR (SOCFAC) 93
94 3.30E-04 1.000E+00 94

```

95	****	95
96	* REGION 1 (CASK)	96
97	* EFFLUENT FLOW (EF) TO ENVIRONMENT (CFM)	97
98	* SITE BNDRY (SDISPC) AND CNTRL ROOM (CDISPC) DISPERSION COEF (SEC/M3)	98
99	* REGION OCCUPANCY FACTOR (COCFAC)	99
100	10.0 1.94E-03 0.00-00 1.000E+00	100

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* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:35:57.34 PAGE 3
 S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

UNIT 55 (SEQ 1) INPUT ECHO 1 2 3 4 5 6 7 8
 1234567890123456789012345678901234567890123456789012345678901234567890

101	**REGION MIXING AND RECIRC FLOWRATES (CFM) - F12(K),F13(K),F14(K),F15(K),R(1,K)	101
102	* F(S-U) F(S-A) F(S-O) F(S-CR) F(RECIRC IN SPRAYED REGION)	102
103	0.0 0.0 0.0 0.0 0.00000	103
104	* REMOVAL LAMBDA (/HR) : XLR(1,K,NM)	104
105	0.0 /	105
106	* PARTITION COEF TO AIR - P12(K,NM),P13(K,NM),P14(K,NM),P15(K,NM)	106
107	1.0 /	107
108	1.0 /	108
109	1.0 /	109
110	1.0 /	110
111	* RECIRC FILTER DECONTAMINATION FACTORS DFR1(K,NM)	111
112	1.0 /	112
113	* DAUGHTER PRODUCTS STRIPPED FROM RECIRC FILTER SR1(K,NM)	113
114	0.0 /	114
115	* EFFLUENT FILTER DECONTAMINATION FACTORS DFE1(K,NM)	115
116	1.0 5 20. 12 20./	116
117	* DAUGHTER PRODUCTS STRIPPED FROM EFFLUENT FILTER - SE(1,K,NM)	117
118	0.0 /	118
119	* DAUGHTER PRODUCTS EVOLVED FROM WALLS - VW(1,K,NM)	119
120	0.0 1 1.0/	120
121	*	121

123456789012345678901234567890123456789012345678901234567890 <EOF> COPIED TO UNIT 5
 W/O CMTS

* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:35:57.34 PAGE 4
 S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

CORE INITIAL ACTIVITY DATA FROM FILE - PCASK_AT.DAT
 ISOTOPE DECAY CHAIN DATA FROM FILE - CASK_ISO.DAT
 INHALATION DOSE CONVERSION FROM FILE - DOSECONV.130
 BETA AND PHOTON ENERGY FROM FILE - ENERGY.DAT
 NUMBER OF TIME STEPS = 2
 CORE POWER NORMALIZATION FACTOR = 1.0000E+00
 BETA QUALITY FACTOR (GLOBAL) = 1.0000E+00
 RELEASE POINTS TO THE SITE BOUNDARY ARE FROM REGION 1
 PARTICULATE, ORGANIC, AND ELEMENTAL HALOGENS TRACKED
 DETAILED DIAGNOSTIC OUTPUT SELECTED
 START TIME (HRS) = 0.0000
 END TIME (HRS) FOR 2 INTERVALS:
 0.0250 2.0000
 # OF SUBSTEPS FOR 2 INTERVALS:
 0 0
 REGION VOLUMES (FT3) = 1.000E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 FRACT RECIRC FILTER FLOW RETURNED TO REGION 1 = 1.000E+00

* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:35:57.34 PAGE 5
S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:35:57.34 PAGE 6
S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

DECAY LIBRARY - DATA TBL. OF ISO. 7TH - ED C. LEDERER
LISTING OF ELEMENTS BY CHEMICAL GROUP

GROUP 1

KR XE RN H

GROUP 2

BR I

GROUP 3

CS RB

GROUP 4

AG AS CD GA GE IN SB SE SN TE ZN

GROUP 5

SR RA

GROUP 6

MO PD RH RU TC

GROUP 7

AM CM EU GD HO LA NB ND PH PR SM TB Y ZR DY

GROUP 8

CE NP PU TH U PA CF AC

GROUP 9

BA

GROUP 12

CO

*** WARNING: ELEMENT H- IS ASSIGNED TO GROUP 1 WHICH IS USED FOR NOBLE GAS ***

* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:35:57.34 PAGE 7
 S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

NUCLIDE		(CURIE)	PWR CASK INVENTORY (TRITIUM X 1.5 TO								
INITIAL ACTIVITY FOR		8 ISOTOPES									
H-3	8.610E+03	CO-60	5.660E+02	I-129	5.040E-01	KR-85	9.700E+04	SR-90	1.020E+06	RU-106	2.930E+05
CS-134	5.230E+05	CS-137	1.510E+06								

* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:35:57.34 PAGE 8
 S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

NUCLIDE (CURIE) PWR CASK INVENTORY (TRITIUM X 1.5 TO
 ISOTOPE GROUPING, DECAY CHAIN, LAMBDA (1/SEC), AND BRANCHING FRACTIONS

CO-60	DECAY CHAIN: GROUP = 12:	ACTIVITY = 5.660E+02:	LAMBDA = 4.169E-09		
PARENT:	CO-60M	12	0.000E+00	1.103E-03:	BRANCHING FRACTION = 9.975E-01
GRAND PARENT:	NULL	12	0.000E+00	0.000E+00	0.000E+00
2ND PARENT:	NULL	12	0.000E+00	0.000E+00	0.000E+00
CS-134	DECAY CHAIN: GROUP = 3:	ACTIVITY = 5.230E+05:	LAMBDA = 1.066E-08		
PARENT:	CS-134M	3	0.000E+00	6.607E-05:	BRANCHING FRACTION = 1.000E+00
GRAND PARENT:	NULL	12	0.000E+00	0.000E+00	0.000E+00
2ND PARENT:	NULL	12	0.000E+00	0.000E+00	0.000E+00
CS-137	DECAY CHAIN: GROUP = 3:	ACTIVITY = 1.510E+06:	LAMBDA = 7.284E-10		
PARENT:	XE-137	1	0.000E+00	3.024E-03:	BRANCHING FRACTION = 1.000E+00
GRAND PARENT:	I-137	2	0.000E+00	2.829E-02	9.390E-01
2ND PARENT:	NULL	12	0.000E+00	0.000E+00	0.000E+00
H-3	DECAY CHAIN: GROUP = 1:	ACTIVITY = 8.610E+03:	LAMBDA = 1.780E-09		
PARENT:	NULL	12	0.000E+00	0.000E+00:	BRANCHING FRACTION = 0.000E+00
GRAND PARENT:	NULL	12	0.000E+00	0.000E+00	0.000E+00
2ND PARENT:	NULL	12	0.000E+00	0.000E+00	0.000E+00
I-129	DECAY CHAIN: GROUP = 2:	ACTIVITY = 5.040E-01:	LAMBDA = 1.400E-15		
PARENT:	TE-129	4	0.000E+00	1.662E-04:	BRANCHING FRACTION = 1.000E+00
GRAND PARENT:	TE-129M	4	0.000E+00	2.393E-07	6.300E-01
2ND PARENT:	TE-129M	4	0.000E+00	2.393E-07	3.700E-01
KR-85	DECAY CHAIN: GROUP = 1:	ACTIVITY = 9.700E+04:	LAMBDA = 2.054E-09		
PARENT:	KR-85M	1	0.000E+00	4.298E-05:	BRANCHING FRACTION = 2.100E-01
GRAND PARENT:	BR-85	2	0.000E+00	4.025E-03	9.982E-01
2ND PARENT:	BR-85	2	0.000E+00	4.025E-03	1.800E-03
RU-106	DECAY CHAIN: GROUP = 6:	ACTIVITY = 2.930E+05:	LAMBDA = 2.189E-08		
PARENT:	TC-106	6	0.000E+00	1.925E-02:	BRANCHING FRACTION = 1.000E+00
GRAND PARENT:	MO-106	6	0.000E+00	7.296E-02	1.000E+00
2ND PARENT:	NULL	12	0.000E+00	0.000E+00	0.000E+00
SR-90	DECAY CHAIN: GROUP = 5:	ACTIVITY = 1.020E+06:	LAMBDA = 7.627E-10		
PARENT:	RB-90	3	0.000E+00	4.530E-03:	BRANCHING FRACTION = 1.000E+00
GRAND PARENT:	KR-90	1	0.000E+00	2.145E-02	8.810E-01
2ND PARENT:	RB-90M	3	0.000E+00	2.687E-03	9.770E-01

* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:35:57.34 PAGE 9
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TABLE 2.1 CONVERSION FACTORS
 8 INHALATION DOSE CONVERSION FACTORS FOR 8 ISOTOPES (MREM/PCI)

ISOTOPE	GONAD	BREAST	LUNG	MARROW	BONE SRF	THYROID	REMAINDER	EFFECTIVE
CO-60	1.760E-05	6.810E-05	1.280E-03	6.360E-05	5.000E-05	5.990E-05	1.330E-04	2.190E-04
CS-134	4.810E-05	4.000E-05	4.370E-05	4.370E-05	4.070E-05	4.110E-05	5.140E-05	4.630E-05
CS-137	3.240E-05	2.900E-05	3.260E-05	3.070E-05	2.940E-05	2.930E-05	3.370E-05	3.190E-05
H-3	6.400E-08	6.400E-08	6.400E-08	6.400E-08	6.400E-08	6.400E-08	6.400E-08	6.400E-08
I-129	3.220E-07	7.730E-07	1.160E-06	5.180E-07	5.110E-07	5.770E-03	4.370E-07	1.740E-04
KR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-106	5.110E-05	5.070E-05	3.850E-03	4.880E-05	5.070E-05	5.070E-05	6.250E-05	4.770E-04
SR-90	9.770E-06	9.770E-06	1.060E-02	1.240E-03	2.690E-03	9.770E-06	2.120E-05	1.300E-03

* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:35:57.34 PAGE 11
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BETA & GAMMA ENERGY (BY ORIGEN ENERGY GROUPS)

GAMMA AND BETA AVERAGE ENERGY (MEV/DIS). NOTE: GAMMA ENERGY ADJUSTED BY SITE BOUNDARY SHIELDING FACTOR

ISOTOPE	GAMMA	BETA	ISOTOPE	GAMMA	BETA	ISOTOPE	GAMMA	BETA	ISOTOPE	GAMMA	BETA
CO-60	2.506E+00	9.579E-02	CS-134	1.555E+00	1.568E-01	CS-137	0.000E+00	1.708E-01	H-3	0.000E+00	5.685E-03
I-129	2.466E-02	4.090E-02	KR-85	2.231E-03	2.500E-01	RU-106	0.000E+00	1.003E-02	SR-90	0.000E+00	1.958E-01

* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:35:57.34 PAGE 12
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* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:35:57.34 PAGE 13
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* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:35:57.34 PAGE 14
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SITE BNDRY ACTIVITY (CURIES) AND DOSE (REM) BETWEEN 0.0000 AND 0.0250 HOURS											
ISOTOPE	ACTIVITY	GONAD	BREAST	LUNG	MARROW	BONE SRF	THYROID	REMAINDER	EFFECTIVE	GAMMA	BETA
GROUP 1											
H-3	1.845E+02	7.559E-03	7.559E-03	7.559E-03	7.559E-03	7.559E-03	7.559E-03	7.559E-03	7.559E-03	0.000E+00	4.680E-04
KR-85	2.079E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.249E-03	2.319E-01
TOTAL GRP	2.263E+03	7.559E-03	7.559E-03	7.559E-03	7.559E-03	7.559E-03	7.559E-03	7.559E-03	7.559E-03	2.249E-03	2.323E-01
GROUP 2											
I-129	3.598E-04	7.418E-08	1.781E-07	2.672E-07	1.193E-07	1.177E-07	1.329E-03	1.007E-07	4.009E-05	4.304E-09	6.567E-09
ORGN	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ELEM	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL PAR	3.598E-04	7.418E-08	1.781E-07	2.672E-07	1.193E-07	1.177E-07	1.329E-03	1.007E-07	4.009E-05	4.304E-09	6.567E-09
TOTAL ORG	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL ELM	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GROUP 3											
CS-134	8.587E-02	2.644E-03	2.199E-03	2.402E-03	2.402E-03	2.237E-03	2.259E-03	2.826E-03	2.545E-03	6.476E-05	6.008E-06
CS-137	2.479E-01	5.143E-03	4.603E-03	5.174E-03	4.873E-03	4.666E-03	4.651E-03	5.349E-03	5.063E-03	0.000E+00	1.889E-05
TOTAL GRP	3.338E-01	7.787E-03	6.802E-03	7.577E-03	7.275E-03	6.904E-03	6.910E-03	8.175E-03	7.609E-03	6.476E-05	2.490E-05
GROUP 5											
SR-90	8.374E-03	5.238E-05	5.238E-05	5.682E-02	6.647E-03	1.442E-02	5.238E-05	1.136E-04	6.969E-03	0.000E+00	7.316E-07
TOTAL GRP	8.374E-03	5.238E-05	5.238E-05	5.682E-02	6.647E-03	1.442E-02	5.238E-05	1.136E-04	6.969E-03	0.000E+00	7.316E-07
GROUP 6											
RU-106	3.137E-02	1.026E-03	1.018E-03	7.733E-02	9.802E-04	1.018E-03	1.018E-03	1.255E-03	9.581E-03	0.000E+00	1.404E-07
TOTAL GRP	3.137E-02	1.026E-03	1.018E-03	7.733E-02	9.802E-04	1.018E-03	1.018E-03	1.255E-03	9.581E-03	0.000E+00	1.404E-07
GROUP 12											
CO-60	3.031E-02	3.415E-04	1.322E-03	2.484E-02	1.234E-03	9.703E-04	1.162E-03	2.581E-03	4.250E-03	3.684E-05	1.296E-06
TOTAL GRP	3.031E-02	3.415E-04	1.322E-03	2.484E-02	1.234E-03	9.703E-04	1.162E-03	2.581E-03	4.250E-03	3.684E-05	1.296E-06

* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:35:57.34 PAGE 15
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SITE BNDRY ACTIVITY (CURIES) AND DOSE (REM) BETWEEN 0.0250 AND 2.0000 HOURS

ISOTOPE	ACTIVITY	GONAD	BREAST	LUNG	MARROW	BONE SRF	THYROID	REMAINDER	EFFECTIVE	GAMMA	BETA
GROUP 1											
H-3	2.398E+03	9.827E-02	9.827E-02	9.827E-02	9.827E-02	9.827E-02	9.827E-02	9.827E-02	9.827E-02	0.000E+00	6.084E-03
KR-85	2.702E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.924E-02	3.014E+00
TOTAL GRP	2.942E+04	9.827E-02	9.827E-02	9.827E-02	9.827E-02	9.827E-02	9.827E-02	9.827E-02	9.827E-02	2.924E-02	3.020E+00
GROUP 2											
I-129	4.680E-03	9.648E-07	2.316E-06	3.476E-06	1.552E-06	1.531E-06	1.729E-02	1.309E-06	5.213E-04	5.597E-08	8.541E-08
ORGN	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ELEM	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL PAR	4.680E-03	9.648E-07	2.316E-06	3.476E-06	1.552E-06	1.531E-06	1.729E-02	1.309E-06	5.213E-04	5.597E-08	8.541E-08
TOTAL ORG	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL ELM	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GROUP 3											
CS-134	1.117E+00	3.440E-02	2.860E-02	3.125E-02	3.125E-02	2.911E-02	2.939E-02	3.676E-02	3.311E-02	8.425E-04	7.815E-05
CS-137	3.225E+00	6.690E-02	5.988E-02	6.731E-02	6.339E-02	6.070E-02	6.050E-02	6.958E-02	6.586E-02	0.000E+00	2.458E-04
TOTAL GRP	4.342E+00	1.013E-01	8.848E-02	9.856E-02	9.464E-02	8.981E-02	8.989E-02	1.063E-01	9.897E-02	8.425E-04	3.239E-04
GROUP 5											
SR-90	1.089E-01	6.813E-04	6.813E-04	7.392E-01	8.647E-02	1.876E-01	6.813E-04	1.478E-03	9.065E-02	0.000E+00	9.516E-06
TOTAL GRP	1.089E-01	6.813E-04	6.813E-04	7.392E-01	8.647E-02	1.876E-01	6.813E-04	1.478E-03	9.065E-02	0.000E+00	9.516E-06
GROUP 6											
RU-106	4.081E-01	1.335E-02	1.325E-02	1.006E+00	1.275E-02	1.325E-02	1.325E-02	1.633E-02	1.246E-01	0.000E+00	1.826E-06
TOTAL GRP	4.081E-01	1.335E-02	1.325E-02	1.006E+00	1.275E-02	1.325E-02	1.325E-02	1.633E-02	1.246E-01	0.000E+00	1.826E-06
GROUP 12											
CO-60	3.942E-01	4.441E-03	1.719E-02	3.230E-01	1.605E-02	1.262E-02	1.512E-02	3.356E-02	5.527E-02	4.791E-04	1.685E-05
TOTAL GRP	3.942E-01	4.441E-03	1.719E-02	3.230E-01	1.605E-02	1.262E-02	1.512E-02	3.356E-02	5.527E-02	4.791E-04	1.685E-05

* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:35:57.34 PAGE 16
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TOTAL SITE BNDRY ACTIVITY (CURIES) AND DOSE (REM) FROM 0.0000 TO 2.0000 HOURS

ISOTOPE	ACTIVITY	GONAD	BREAST	LUNG	MARROW	BONE SRF	THYROID	REMAINDER	EFFECTIVE	GAMMA	BETA
GROUP 1											
H-3	2.583E+03	1.058E-01	1.058E-01	1.058E-01	1.058E-01	1.058E-01	1.058E-01	1.058E-01	1.058E-01	0.000E+00	6.552E-03
KR-85	2.910E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.149E-02	3.246E+00
TOTAL GRP	3.168E+04	1.058E-01	1.058E-01	1.058E-01	1.058E-01	1.058E-01	1.058E-01	1.058E-01	1.058E-01	3.149E-02	3.253E+00
GROUP 2											
I-129	5.040E-03	1.039E-06	2.494E-06	3.743E-06	1.671E-06	1.649E-06	1.862E-02	1.410E-06	5.614E-04	6.027E-08	9.198E-08
ORGN	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ELEM	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL PAR	5.040E-03	1.039E-06	2.494E-06	3.743E-06	1.671E-06	1.649E-06	1.862E-02	1.410E-06	5.614E-04	6.027E-08	9.198E-08
TOTAL ORG	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL ELM	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GROUP 3											
CS-134	1.203E+00	3.704E-02	3.080E-02	3.365E-02	3.365E-02	3.134E-02	3.165E-02	3.958E-02	3.565E-02	9.072E-04	8.416E-05
CS-137	3.473E+00	7.204E-02	6.448E-02	7.248E-02	6.826E-02	6.537E-02	6.515E-02	7.493E-02	7.093E-02	0.000E+00	2.647E-04
TOTAL GRP	4.676E+00	1.091E-01	9.528E-02	1.061E-01	1.019E-01	9.671E-02	9.680E-02	1.145E-01	1.066E-01	9.072E-04	3.488E-04
GROUP 5											
SR-90	1.173E-01	7.337E-04	7.337E-04	7.960E-01	9.312E-02	2.020E-01	7.337E-04	1.592E-03	9.762E-02	0.000E+00	1.025E-05
TOTAL GRP	1.173E-01	7.337E-04	7.337E-04	7.960E-01	9.312E-02	2.020E-01	7.337E-04	1.592E-03	9.762E-02	0.000E+00	1.025E-05
GROUP 6											
RU-106	4.395E-01	1.438E-02	1.427E-02	1.083E+00	1.373E-02	1.427E-02	1.427E-02	1.759E-02	1.342E-01	0.000E+00	1.967E-06
TOTAL GRP	4.395E-01	1.438E-02	1.427E-02	1.083E+00	1.373E-02	1.427E-02	1.427E-02	1.759E-02	1.342E-01	0.000E+00	1.967E-06
GROUP 12											
CO-60	4.245E-01	4.783E-03	1.851E-02	3.479E-01	1.728E-02	1.359E-02	1.628E-02	3.614E-02	5.952E-02	5.159E-04	1.814E-05
TOTAL GRP	4.245E-01	4.783E-03	1.851E-02	3.479E-01	1.728E-02	1.359E-02	1.628E-02	3.614E-02	5.952E-02	5.159E-04	1.814E-05

* RUN #2 -- PWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:35:57.34 PAGE 17
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TOTAL SITE BNDRY ACTIVITY (CURIES) AND DOSE (REM) FROM 0.0000 TO 2.0000 HOURS

ISOTOPE	ACTIVITY	GONAD	BREAST	LUNG	MARROW	BONE SRF	THYROID	REMAINDER	EFFECTIVE	GAMMA	BETA
NOBLE GAS	3.168E+04	1.058E-01	1.058E-01	1.058E-01	1.058E-01	1.058E-01	1.058E-01	1.058E-01	1.058E-01	3.149E-02	3.253E+00
HALOGENS	5.040E-03	1.039E-06	2.494E-06	3.743E-06	1.671E-06	1.649E-06	1.862E-02	1.410E-06	5.614E-04	6.027E-08	9.198E-08
ORGANIC	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ELEMENT	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GROUP 3	4.676E+00	1.091E-01	9.528E-02	1.061E-01	1.019E-01	9.671E-02	9.680E-02	1.145E-01	1.066E-01	9.072E-04	3.488E-04
GROUP 5	1.173E-01	7.337E-04	7.337E-04	7.960E-01	9.312E-02	2.020E-01	7.337E-04	1.592E-03	9.762E-02	0.000E+00	1.025E-05
GROUP 6	4.395E-01	1.438E-02	1.427E-02	1.083E+00	1.373E-02	1.427E-02	1.427E-02	1.759E-02	1.342E-01	0.000E+00	1.967E-06
GROUP 12	4.245E-01	4.783E-03	1.851E-02	3.479E-01	1.728E-02	1.359E-02	1.628E-02	3.614E-02	5.952E-02	5.159E-04	1.814E-05
TOTAL	3.169E+04	2.348E-01	2.346E-01	2.439E+00	3.319E-01	4.324E-01	2.525E-01	2.757E-01	5.043E-01	3.291E-02	3.253E+00

WARNING: TRITIUM DOSES DO NOT REFLECT SKIN ABSORPTION

END PROCESSING. ELAPSED CPU TIME = 3.90

ATTACHMENT 2

Output of PERC2 Code Run To Determine Dose Consequences From a Hypothetical BWR Canister Breach Accident

* RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:32:55.21 PAGE 1
 S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

UNIT 55 (SEQ 1) INPUT ECHO 1 2 3 4 5 6 7 8
 1234567890123456789012345678901234567890123456789012345678901234567890

```

1 * RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK 1
2 * INPUT FILE NAMES 2
3 'BCASK_AT.DAT','CASK_ISO.DAT','DOSECONV.I30','ENERGY.DAT' 3
4 * CONTROL CARD 4
5 2 1 1 1.00 1.00 .F. .F. .T. 5
6 * TIME INTERVALS 6
7 0.0000 7
8 * 90 Seconds AFTER ACCIDENT 8
9 0.025000 / 9
10 * 120 MINUTES AFTER ACCIDENT 10
11 2.000 / 11
12 * 12
13 * 13
14 * CASK VOLUME 14
15 * 15
16 * ASSUME VOLUME = 100 FT3 16
17 * 17
18 * ASSUME PURGE RATE = 10 CFM (REMOVES ALL ACTIVITY IN 2 HOURS) 18
19 * 19
20 * CASK PLATEOUT/REMOVAL FACTORS 20
21 * 21
22 * CS, I, RU 90% PLATES OUT IN CASK TABLE XIX SAND80-2124 22
23 * "TRANSPORTATION-ACCIDENT SCENARIOS FOR COMMERCIAL 23
24 * SPENT FUEL" (5% + 5% OF MATERIAL RELEASED FROM FUEL 24
25 * IS RELEASED FROM GAS-COOLED CASK) 25
26 * 26
27 * SR, CO 90% SETTLES OR IS FILTERED OUT IN RELEASE FROM CASK 27
28 * TABLE XIX SAND80-2124 28
29 * "TRANSPORTATION-ACCIDENT SCENARIOS FOR COMMERCIAL 29
30 * SPENT FUEL" (5% + 5% OF MATERIAL RELEASED FROM FUEL 30
31 * IS RELEASED FROM GAS-COOLED CASK) 31
32 * 32
33 * KR, H ASSUMED RELEASED 33
34 * 34
35 * 35
36 * RESPIRABLE FRACTION 36
37 * 37
38 * SR, CO 5% (MODELLED AS FILTER DF) 38
39 * TABLE XX SAND80-2124 39
40 * "TRANSPORTATION-ACCIDENT SCENARIOS FOR COMMERCIAL 40
41 * SPENT FUEL" 41
42 * 42
43 * 43
44 * VOLUME 44

```

```

45 *
46 *
47 100.    0.0    0.0    0.0    0.0    1.0000    1
48 *
49 *
50 * CASK ACTIVITY RELEASE FRACTIONS

```

45
46
47
48
49
50

1234567890123456789012345678901234567890123456789012345678901234567890

* RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:32:55.21 PAGE 2
S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

UNIT 55 (SEQ 1) INPUT ECHO 1 2 3 4 5 6 7 8
123456789012345678901234567890123456789012345678901234567890

```

51 *
52 0.00000 0.025 1.0000000
53 0.30 .10 2.30-5 0.0 2.30-5 1.50-5 0.0 0.0 0.0 0.0 0.0 0.15
54 *
55 1.0 0.1 0.1 1.0 0.1 0.1 1.0 1.0 1.0 1.0 1.0 0.1
56 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
57 *
58 *
59 *
60 * #1 TIME INTERVAL (UP TO 90s) INPUT PARAMETERS
61 * SITE BNDRY RESPIRATION (SBRATE), OCCUPANCY FACTOR (SOCFAC)
62 3.30E-04 1.000E+00
63 ****
64 * REGION 1 (CASK)
65 * EFFLUENT FLOW (EF) TO ENVIRONMENT (CFM)
66 * SITE BNDRY (SDISPC) AND CNTRL ROOM (CDISPC) DISPERSION COEF (SEC/M3)
67 * REGION OCCUPANCY FACTOR (COCFAC)
68 10.0 1.94E-03 0.00-00 1.000E+00
69 **REGION MIXING AND RECIRC FLOWRATES (CFM) - F12(K),F13(K),F14(K),F15(K),R(1,K)
70 * F(S-U) F(S-A) F(S-O) F(S-CR) F(RECIRC IN SPRAYED REGION)
71 0.0 0.0 0.0 0.0 0.0
72 * REMOVAL LAMBDA (/HR) : XLR(1,K,NM)
73 0.0 /
74 * PARTITION COEF TO AIR - P12(K,NM),P13(K,NM),P14(K,NM),P15(K,NM)
75 1.0 /
76 1.0 /
77 1.0 /
78 1.0 /
79 * RECIRC FILTER DECONTAMINATION FACTORS DFR1(K,NM)
80 1.0 /
81 * DAUGHTER PRODUCTS STRIPPED FROM RECIRC FILTER SR1(K,NM)
82 0.0 /
83 * EFFLUENT FILTER DECONTAMINATION FACTORS DFE1(K,NM)
84 1.0 5 20. 12 20./
85 * DAUGHTER PRODUCTS STRIPPED FROM EFFLUENT FILTER - SE(1,K,NM)
86 0.0 /
87 * DAUGHTER PRODUCTS EVOLVED FROM WALLS - VW(1,K,NM)
88 0.0 1 1.0/
89 *
90 *
91 *
92 * #2 TIME INTERVAL (TO 2 HR) INPUT PARAMETERS
93 * SITE BNDRY RESPIRATION (SBRATE), OCCUPANCY FACTOR (SOCFAC)
94 3.30E-04 1.000E+00

```

95	****	95
96	* REGION 1 (CASK)	96
97	* EFFLUENT FLOW (EF) TO ENVIRONMENT (CFM)	97
98	* SITE BNDRY (SDISPC) AND CNTRL ROOM (CDISPC) DISPERSION COEF (SEC/M3)	98
99	* REGION OCCUPANCY FACTOR (COCFAC)	99
100	10.0 1.94E-03 0.00-00 1.000E+00	100

1234567890123456789012345678901234567890123456789012345678901234567890

* RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:32:55.21 PAGE 3
 S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

UNIT 55 (SEQ 1) INPUT ECHO 1 2 3 4 5 6 7 8
 1234567890123456789012345678901234567890123456789012345678901234567890

101	**REGION MIXING AND RECIRC FLOWRATES (CFM) - F12(K),F13(K),F14(K),F15(K),R(1,K)	101
102	* F(S-U) F(S-A) F(S-O) F(S-CR) F(RECIRC IN SPRAYED REGION)	102
103	0.0 0.0 0.0 0.0 0.00000	103
104	* REMOVAL LAMBDA (/HR) : XLR(1,K,NM)	104
105	0.0 /	105
106	* PARTITION COEF TO AIR - P12(K,NM),P13(K,NM),P14(K,NM),P15(K,NM)	106
107	1.0 /	107
108	1.0 /	108
109	1.0 /	109
110	1.0 /	110
111	* RECIRC FILTER DECONTAMINATION FACTORS DFR1(K,NM)	111
112	1.0 /	112
113	* DAUGHTER PRODUCTS STRIPPED FROM RECIRC FILTER SR1(K,NM)	113
114	0.0 /	114
115	* EFFLUENT FILTER DECONTAMINATION FACTORS DFE1(K,NM)	115
116	1.0 5 20. 12 20./	116
117	* DAUGHTER PRODUCTS STRIPPED FROM EFFLUENT FILTER - SE(1,K,NM)	117
118	0.0 /	118
119	* DAUGHTER PRODUCTS EVOLVED FROM WALLS - VW(1,K,NM)	119
120	0.0 1 1.0/	120
121	*	121

1234567890123456789012345678901234567890123456789012345678901234567890 <EOF> COPIED TO UNIT 5
 W/O CMTS

* RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:32:55.21 PAGE 4
 S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

CORE INITIAL ACTIVITY DATA FROM FILE - BCASK_AT.DAT
 ISOTOPE DECAY CHAIN DATA FROM FILE - CASK_ISO.DAT
 INHALATION DOSE CONVERSION FROM FILE - DOSECONV.130
 BETA AND PHOTON ENERGY FROM FILE - ENERGY.DAT
 NUMBER OF TIME STEPS = 2
 CORE POWER NORMALIZATION FACTOR = 1.0000E+00
 BETA QUALITY FACTOR (GLOBAL) = 1.0000E+00
 RELEASE POINTS TO THE SITE BOUNDARY ARE FROM REGION 1
 PARTICULATE, ORGANIC, AND ELEMENTAL HALOGENS TRACKED
 DETAILED DIAGNOSTIC OUTPUT SELECTED
 START TIME (HRS) = 0.0000
 END TIME (HRS) FOR 2 INTERVALS:
 0.0250 2.0000
 # OF SUBSTEPS FOR 2 INTERVALS:
 0 0
 REGION VOLUMES (FT3) = 1.000E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 FRACT RECIRC FILTER FLOW RETURNED TO REGION 1 = 1.000E+00

* RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:32:55.21 PAGE 5
S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

CORE RELEASE DATA FOR 1 PERIODS:

PERIOD 1 BEGINS AT 0.0000 HRS AND ENDS AT 0.0250 HRS. THE SPLIT FRACTION TO REGION 1 IS 1.00000

CORE RELEASE FRACTION BY GROUP:

3.000E-01 1.000E-01 2.300E-05 0.000E+00 2.300E-05 1.500E-05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.500E-01

RELEASE TO REGION 1 PARTITION TO AIR:

1.000E+00 1.000E-01 1.000E-01 1.000E+00 1.000E-01 1.000E-01 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E-01

RELEASE TO REGION 2 PARTITION TO AIR:

[illegible]

* RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:32:55.21 PAGE 6
S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

DECAY LIBRARY - DATA TBL. OF ISO. 7TH - ED C. LEDERER

LISTING OF ELEMENTS BY CHEMICAL GROUP

GROUP 1

KR XE RN H

GROUP 2

BR I

GROUP 3

CS RB

GROUP 4

AG AS CD GA GE IN SB SE SN TE ZN

GROUP 5

SR RA

GROUP 6

MO PD RH RU TC

GROUP 7

AM CM EU GD HO LA NB ND PM PR SM TB Y ZR DY

GROUP 8

CE NP PU TH U PA CF AC

GROUP 9

BA

GROUP 12

CO

*** WARNING: ELEMENT H- IS ASSIGNED TO GROUP 1 WHICH IS USED FOR NOBLE GAS ***

* RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:32:55.21 PAGE 7
S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

NUCLIDE (CURIE) BWR CASK INVENTORY (TRITIUM X 1.5 TO A
INITIAL ACTIVITY FOR 8 ISOTOPES

H-3	8.760E+03	CO-60	2.330E+03	I-129	5.190E-01	KR-85	9.790E+04	SR-90	1.050E+06	RU-106	2.550E+05
CS-134	4.850E+05	CS-137	1.560E+06								

* RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:32:55.21 PAGE 8
 S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

NUCLIDE (CURIE) BWR CASK INVENTORY (TRITIUM X 1.5 TO A
 ISOTOPE GROUPING, DECAY CHAIN, LAMBDA (1/SEC), AND BRANCHING FRACTIONS

CO-60	DECAY CHAIN: GROUP = 12:	ACTIVITY = 2.330E+03:	LAMBDA = 4.169E-09	
PARENT: CO-60M	12	0.000E+00	1.103E-03:	BRANCHING FRACTION = 9.975E-01
GRAND PARENT: NULL	12	0.000E+00	0.000E+00	0.000E+00
2ND PARENT: NULL	12	0.000E+00	0.000E+00	0.000E+00
CS-134	DECAY CHAIN: GROUP = 3:	ACTIVITY = 4.850E+05:	LAMBDA = 1.066E-08	
PARENT: CS-134M	3	0.000E+00	6.607E-05:	BRANCHING FRACTION = 1.000E+00
GRAND PARENT: NULL	12	0.000E+00	0.000E+00	0.000E+00
2ND PARENT: NULL	12	0.000E+00	0.000E+00	0.000E+00
CS-137	DECAY CHAIN: GROUP = 3:	ACTIVITY = 1.560E+06:	LAMBDA = 7.284E-10	
PARENT: XE-137	1	0.000E+00	3.024E-03:	BRANCHING FRACTION = 1.000E+00
GRAND PARENT: I-137	2	0.000E+00	2.829E-02	9.390E-01
2ND PARENT: NULL	12	0.000E+00	0.000E+00	0.000E+00
H-3	DECAY CHAIN: GROUP = 1:	ACTIVITY = 8.760E+03:	LAMBDA = 1.780E-09	
PARENT: NULL	12	0.000E+00	0.000E+00:	BRANCHING FRACTION = 0.000E+00
GRAND PARENT: NULL	12	0.000E+00	0.000E+00	0.000E+00
2ND PARENT: NULL	12	0.000E+00	0.000E+00	0.000E+00
I-129	DECAY CHAIN: GROUP = 2:	ACTIVITY = 5.190E-01:	LAMBDA = 1.400E-15	
PARENT: TE-129	4	0.000E+00	1.662E-04:	BRANCHING FRACTION = 1.000E+00
GRAND PARENT: TE-129M	4	0.000E+00	2.393E-07	6.300E-01
2ND PARENT: TE-129M	4	0.000E+00	2.393E-07	3.700E-01
KR-85	DECAY CHAIN: GROUP = 1:	ACTIVITY = 9.790E+04:	LAMBDA = 2.054E-09	
PARENT: KR-85M	1	0.000E+00	4.298E-05:	BRANCHING FRACTION = 2.100E-01
GRAND PARENT: BR-85	2	0.000E+00	4.025E-03	9.982E-01
2ND PARENT: BR-85	2	0.000E+00	4.025E-03	1.800E-03
RU-106	DECAY CHAIN: GROUP = 6:	ACTIVITY = 2.550E+05:	LAMBDA = 2.189E-08	
PARENT: TC-106	6	0.000E+00	1.925E-02:	BRANCHING FRACTION = 1.000E+00
GRAND PARENT: MO-106	6	0.000E+00	7.296E-02	1.000E+00
2ND PARENT: NULL	12	0.000E+00	0.000E+00	0.000E+00
SR-90	DECAY CHAIN: GROUP = 5:	ACTIVITY = 1.050E+06:	LAMBDA = 7.627E-10	
PARENT: RB-90	3	0.000E+00	4.530E-03:	BRANCHING FRACTION = 1.000E+00
GRAND PARENT: KR-90	1	0.000E+00	2.145E-02	8.810E-01
2ND PARENT: RB-90M	3	0.000E+00	2.687E-03	9.770E-01

* RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:32:55.21 PAGE 9
 S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

TABLE 2.1 CONVERSION FACTORS
 8 INHALATION DOSE CONVERSION FACTORS FOR 8 ISOTOPES (MREM/PCI)

ISOTOPE	GONAD	BREAST	LUNG	MARROW	BONE SRF	THYROID	REMAINDER	EFFECTIVE
CO-60	1.760E-05	6.810E-05	1.280E-03	6.360E-05	5.000E-05	5.990E-05	1.330E-04	2.190E-04
CS-134	4.810E-05	4.000E-05	4.370E-05	4.370E-05	4.070E-05	4.110E-05	5.140E-05	4.630E-05
CS-137	3.240E-05	2.900E-05	3.260E-05	3.070E-05	2.940E-05	2.930E-05	3.370E-05	3.190E-05
H-3	6.400E-08	6.400E-08	6.400E-08	6.400E-08	6.400E-08	6.400E-08	6.400E-08	6.400E-08
I-129	3.220E-07	7.730E-07	1.160E-06	5.180E-07	5.110E-07	5.770E-03	4.370E-07	1.740E-04
KR-85	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-106	5.110E-05	5.070E-05	3.850E-03	4.880E-05	5.070E-05	5.070E-05	6.250E-05	4.770E-04
SR-90	9.770E-06	9.770E-06	1.060E-02	1.240E-03	2.690E-03	9.770E-06	2.120E-05	1.300E-03

* RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:32:55.21 PAGE 10
S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

**BETA & GAMMA ENERGY (BY ORIGIN ENERGY GROUPS)
PHOTON ENERGY DISTRIBUTION FOR 18 BINS**

BIN	AVE. ENERGY (MEV)	DOSE CONV. IN AIR (REM/HR/(MEV/CM2/SEC)	SITE BOUNDARY SHIELDING FACTOR	REGION AIR SPACE SHIELDING FACTOR
1	1.000E-02	3.960E-04	1.000E+00	1.000E+00
2	2.500E-02	3.200E-05	1.000E+00	1.000E+00
3	3.800E-02	1.050E-05	1.000E+00	1.000E+00
4	5.800E-02	4.670E-06	1.000E+00	1.000E+00
5	8.500E-02	3.110E-06	1.000E+00	1.000E+00
6	1.250E-01	2.610E-06	1.000E+00	1.000E+00
7	2.250E-01	2.510E-06	1.000E+00	1.000E+00
8	3.750E-01	2.490E-06	1.000E+00	1.000E+00
9	5.750E-01	2.290E-06	1.000E+00	1.000E+00
10	8.500E-01	2.070E-06	1.000E+00	1.000E+00
11	1.250E+00	1.860E-06	1.000E+00	1.000E+00
12	1.750E+00	1.670E-06	1.000E+00	1.000E+00
13	2.250E+00	1.540E-06	1.000E+00	1.000E+00
14	2.750E+00	1.440E-06	1.000E+00	1.000E+00
15	3.500E+00	1.320E-06	1.000E+00	1.000E+00
16	5.000E+00	1.160E-06	1.000E+00	1.000E+00
17	7.000E+00	1.040E-06	1.000E+00	1.000E+00
18	9.500E+00	9.620E-07	1.000E+00	1.000E+00

ISOTOPE PHOTON ENERGY (MEV/DIS) FOR 18 BINS

[illegible]

* RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:32:55.21 PAGE 11
 S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

BETA & GAMMA ENERGY (BY ORIGEN ENERGY GROUPS)

GAMMA AND BETA AVERAGE ENERGY (MEV/DIS). NOTE: GAMMA ENERGY ADJUSTED BY SITE BOUNDARY SHIELDING FACTOR

ISOTOPE	GAMMA	BETA	ISOTOPE	GAMMA	BETA	ISOTOPE	GAMMA	BETA	ISOTOPE	GAMMA	BETA
CO-60	2.506E+00	9.579E-02	CS-134	1.555E+00	1.568E-01	CS-137	0.000E+00	1.708E-01	H-3	0.000E+00	5.685E-03
I-129	2.466E-02	4.090E-02	KR-85	2.231E-03	2.500E-01	RU-106	0.000E+00	1.003E-02	SR-90	0.000E+00	1.958E-01

* RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:32:55.21 PAGE 12
S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

REGION INPUT DATA FOR 0.0000 TO 0.0250 HOURS
SITE BOUNDARY BREATHING RATE (M3/SEC): 3.300E-04 - OCCUPANCY FACTOR: 1.000E+00

[illegible]

[illegible]

* RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:32:55.21 PAGE 14
 S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

SITE BNDRY ACTIVITY (CURIES) AND DOSE (REM) BETWEEN 0.0000 AND 0.0250 HOURS											
ISOTOPE	ACTIVITY	GONAD	BREAST	LUNG	MARROW	BONE SRF	THYROID	REMAINDER	EFFECTIVE	GAMMA	BETA
GROUP 1											
H-3	1.877E+02	7.691E-03	7.691E-03	7.691E-03	7.691E-03	7.691E-03	7.691E-03	7.691E-03	7.691E-03	0.000E+00	4.762E-04
KR-85	2.098E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.270E-03	2.340E-01
TOTAL GRP	2.286E+03	7.691E-03	7.691E-03	7.691E-03	7.691E-03	7.691E-03	7.691E-03	7.691E-03	7.691E-03	2.270E-03	2.345E-01
GROUP 2											
I-129	3.706E-04	7.639E-08	1.834E-07	2.752E-07	1.229E-07	1.212E-07	1.369E-03	1.037E-07	4.128E-05	4.432E-09	6.763E-09
ORGN	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ELEM	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL PAR	3.706E-04	7.639E-08	1.834E-07	2.752E-07	1.229E-07	1.212E-07	1.369E-03	1.037E-07	4.128E-05	4.432E-09	6.763E-09
TOTAL ORG	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL ELM	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GROUP 3											
CS-134	7.963E-02	2.452E-03	2.039E-03	2.228E-03	2.228E-03	2.075E-03	2.095E-03	2.620E-03	2.360E-03	6.006E-05	5.571E-06
CS-137	2.561E-01	5.313E-03	4.755E-03	5.346E-03	5.034E-03	4.821E-03	4.805E-03	5.526E-03	5.231E-03	0.000E+00	1.952E-05
TOTAL GRP	3.358E-01	7.765E-03	6.795E-03	7.573E-03	7.262E-03	6.896E-03	6.900E-03	8.146E-03	7.591E-03	6.006E-05	2.509E-05
GROUP 5											
SR-90	8.620E-03	5.392E-05	5.392E-05	5.850E-02	6.843E-03	1.484E-02	5.392E-05	1.170E-04	7.174E-03	0.000E+00	7.531E-07
TOTAL GRP	8.620E-03	5.392E-05	5.392E-05	5.850E-02	6.843E-03	1.484E-02	5.392E-05	1.170E-04	7.174E-03	0.000E+00	7.531E-07
GROUP 6											
RU-106	2.731E-02	8.933E-04	8.863E-04	6.730E-02	8.531E-04	8.863E-04	8.863E-04	1.093E-03	8.338E-03	0.000E+00	1.222E-07
TOTAL GRP	2.731E-02	8.933E-04	8.863E-04	6.730E-02	8.531E-04	8.863E-04	8.863E-04	1.093E-03	8.338E-03	0.000E+00	1.222E-07
GROUP 12											
CO-60	1.248E-01	1.406E-03	5.440E-03	1.023E-01	5.081E-03	3.994E-03	4.785E-03	1.062E-02	1.749E-02	1.517E-04	5.333E-06
TOTAL GRP	1.248E-01	1.406E-03	5.440E-03	1.023E-01	5.081E-03	3.994E-03	4.785E-03	1.062E-02	1.749E-02	1.517E-04	5.333E-06

* RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:32:55.21 PAGE 15
 S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

SITE BNDRY ACTIVITY (CURIES) AND DOSE (REM) BETWEEN 0.0250 AND 2.0000 HOURS											
ISOTOPE	ACTIVITY	GONAD	BREAST	LUNG	MARROW	BONE SRF	THYROID	REMAINDER	EFFECTIVE	GAMMA	BETA
GROUP 1											
H-3	2.440E+03	9.998E-02	9.998E-02	9.998E-02	9.998E-02	9.998E-02	9.998E-02	9.998E-02	9.998E-02	0.000E+00	6.190E-03
KR-85	2.727E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.951E-02	3.042E+00
TOTAL GRP	2.971E+04	9.998E-02	9.998E-02	9.998E-02	9.998E-02	9.998E-02	9.998E-02	9.998E-02	9.998E-02	2.951E-02	3.048E+00
GROUP 2											
I-129	4.819E-03	9.935E-07	2.385E-06	3.579E-06	1.598E-06	1.577E-06	1.780E-02	1.348E-06	5.369E-04	5.764E-08	8.795E-08
ORGN	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ELEM	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL PAR	4.819E-03	9.935E-07	2.385E-06	3.579E-06	1.598E-06	1.577E-06	1.780E-02	1.348E-06	5.369E-04	5.764E-08	8.795E-08
TOTAL ORG	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL ELM	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GROUP 3											
CS-134	1.036E+00	3.190E-02	2.653E-02	2.898E-02	2.898E-02	2.699E-02	2.726E-02	3.409E-02	3.070E-02	7.812E-04	7.247E-05
CS-137	3.332E+00	6.911E-02	6.186E-02	6.954E-02	6.548E-02	6.271E-02	6.250E-02	7.188E-02	6.804E-02	0.000E+00	2.539E-04
TOTAL GRP	4.368E+00	1.010E-01	8.838E-02	9.852E-02	9.446E-02	8.970E-02	8.975E-02	1.060E-01	9.875E-02	7.812E-04	3.264E-04
GROUP 5											
SR-90	1.121E-01	7.013E-04	7.013E-04	7.609E-01	8.901E-02	1.931E-01	7.013E-04	1.522E-03	9.332E-02	0.000E+00	9.796E-06
TOTAL GRP	1.121E-01	7.013E-04	7.013E-04	7.609E-01	8.901E-02	1.931E-01	7.013E-04	1.522E-03	9.332E-02	0.000E+00	9.796E-06
GROUP 6											
RU-106	3.552E-01	1.162E-02	1.153E-02	8.755E-01	1.110E-02	1.153E-02	1.153E-02	1.421E-02	1.085E-01	0.000E+00	1.590E-06
TOTAL GRP	3.552E-01	1.162E-02	1.153E-02	8.755E-01	1.110E-02	1.153E-02	1.153E-02	1.421E-02	1.085E-01	0.000E+00	1.590E-06
GROUP 12											
CO-60	1.623E+00	1.828E-02	7.075E-02	1.330E+00	6.607E-02	5.194E-02	6.223E-02	1.382E-01	2.275E-01	1.972E-03	6.936E-05
TOTAL GRP	1.623E+00	1.828E-02	7.075E-02	1.330E+00	6.607E-02	5.194E-02	6.223E-02	1.382E-01	2.275E-01	1.972E-03	6.936E-05

* RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:32:55.21 PAGE 16
 S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

TOTAL SITE BNDRY ACTIVITY (CURIES) AND DOSE (REM) FROM 0.0000 TO 2.0000 HOURS

ISOTOPE	ACTIVITY	GONAD	BREAST	LUNG	MARROW	BONE SRF	THYROID	REMAINDER	EFFECTIVE	GAMMA	BETA
GROUP 1											
H-3	2.628E+03	1.077E-01	1.077E-01	1.077E-01	1.077E-01	1.077E-01	1.077E-01	1.077E-01	1.077E-01	0.000E+00	6.666E-03
KR-85	2.937E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.178E-02	3.276E+00
TOTAL GRP	3.200E+04	1.077E-01	1.077E-01	1.077E-01	1.077E-01	1.077E-01	1.077E-01	1.077E-01	1.077E-01	3.178E-02	3.283E+00
GROUP 2											
I-129	5.190E-03	1.070E-06	2.568E-06	3.854E-06	1.721E-06	1.698E-06	1.917E-02	1.452E-06	5.781E-04	6.207E-08	9.471E-08
ORGN	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ELEM	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL PAR	5.190E-03	1.070E-06	2.568E-06	3.854E-06	1.721E-06	1.698E-06	1.917E-02	1.452E-06	5.781E-04	6.207E-08	9.471E-08
TOTAL ORG	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL ELM	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GROUP 3											
CS-134	1.115E+00	3.435E-02	2.857E-02	3.121E-02	3.121E-02	2.907E-02	2.935E-02	3.671E-02	3.306E-02	8.413E-04	7.804E-05
CS-137	3.588E+00	7.442E-02	6.661E-02	7.488E-02	7.052E-02	6.753E-02	6.730E-02	7.741E-02	7.327E-02	0.000E+00	2.734E-04
TOTAL GRP	4.703E+00	1.088E-01	9.518E-02	1.061E-01	1.017E-01	9.660E-02	9.665E-02	1.141E-01	1.063E-01	8.413E-04	3.515E-04
GROUP 5											
SR-90	1.207E-01	7.553E-04	7.553E-04	8.194E-01	9.586E-02	2.079E-01	7.553E-04	1.639E-03	1.005E-01	0.000E+00	1.055E-05
TOTAL GRP	1.207E-01	7.553E-04	7.553E-04	8.194E-01	9.586E-02	2.079E-01	7.553E-04	1.639E-03	1.005E-01	0.000E+00	1.055E-05
GROUP 6											
RU-106	3.825E-01	1.251E-02	1.241E-02	9.428E-01	1.195E-02	1.241E-02	1.241E-02	1.530E-02	1.168E-01	0.000E+00	1.712E-06
TOTAL GRP	3.825E-01	1.251E-02	1.241E-02	9.428E-01	1.195E-02	1.241E-02	1.241E-02	1.530E-02	1.168E-01	0.000E+00	1.712E-06
GROUP 12											
CO-60	1.747E+00	1.969E-02	7.619E-02	1.432E+00	7.115E-02	5.594E-02	6.701E-02	1.488E-01	2.450E-01	2.124E-03	7.469E-05
TOTAL GRP	1.747E+00	1.969E-02	7.619E-02	1.432E+00	7.115E-02	5.594E-02	6.701E-02	1.488E-01	2.450E-01	2.124E-03	7.469E-05

* RUN #1 -- BWR CASK RELEASE WITH INCREASED TRITIUM INVENTORY TO ACCOUNT FOR SK PERC2 05/16/97 04:32:55.21 PAGE 17
 S & W ENGR CORP PASSIVE/EVOLUTIONARY REGULATORY CONSEQUENCE CODE VERSION 00 LEVEL 01 CREATED 22 JUN 1994 UNIT 6

TOTAL SITE BNDRY ACTIVITY (CURIES) AND DOSE (REM) FROM 0.0000 TO 2.0000 HOURS											
ISOTOPE	ACTIVITY	GONAD	BREAST	LUNG	MARROW	BONE SRF	THYROID	REMAINDER	EFFECTIVE	GAMMA	BETA
NOBLE GAS	3.200E+04	1.077E-01	1.077E-01	1.077E-01	1.077E-01	1.077E-01	1.077E-01	1.077E-01	1.077E-01	3.178E-02	3.283E+00
HALOGENS	5.190E-03	1.070E-06	2.568E-06	3.854E-06	1.721E-06	1.698E-06	1.917E-02	1.452E-06	5.781E-04	6.207E-08	9.471E-08
ORGANIC	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ELEMENT	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GROUP 3	4.703E+00	1.088E-01	9.518E-02	1.061E-01	1.017E-01	9.660E-02	9.665E-02	1.141E-01	1.063E-01	8.413E-04	3.515E-04
GROUP 5	1.207E-01	7.553E-04	7.553E-04	8.194E-01	9.586E-02	2.079E-01	7.553E-04	1.639E-03	1.005E-01	0.000E+00	1.055E-05
GROUP 6	3.825E-01	1.251E-02	1.241E-02	9.428E-01	1.195E-02	1.241E-02	1.241E-02	1.530E-02	1.168E-01	0.000E+00	1.712E-06
GROUP 12	1.747E+00	1.969E-02	7.619E-02	1.432E+00	7.115E-02	5.594E-02	6.701E-02	1.488E-01	2.450E-01	2.124E-03	7.469E-05
TOTAL	3.200E+04	2.494E-01	2.922E-01	3.408E+00	3.884E-01	4.806E-01	3.037E-01	3.875E-01	6.769E-01	3.474E-02	3.283E+00

WARNING: TRITIUM DOSES DO NOT REFLECT SKIN ABSORPTION

END PROCESSING. ELAPSED CPU TIME = 3.90