Attachment 2 to PLA-6055

Revised Calculation EC-RADN-1126, Revision 1

Information Only

NUCLEAR ENGINEERING CALCULATION COVER SHEET

NEPM-QA-0221-1

1. Page 1 of 57
Total Pages 59

>2. TYPE: CALC >3. NUMBER: EC-RADN-1126 >4. REVISION: 1

*>5. UNIT 3 *>6. QUALITY CLASS: Q

>7. DESCRIPTION: CRHE and Off Site FHA/EHA Doses - AST

8. SUPERSEDED BY:

9. Alternate Number: 10. Cycle: N/A

11. Computer Code/Model used: RADTRAD V3.03 12. Discipline: R

>13. Are any results of this calculation described in the Licensing Documents?

☒ Yes, *Refer to NDAP-QA-0730 and NDAP-QA-0731* ☐ No

>14. Is this calculation changing any method of evaluation described in the FSAR and using the results to support or change the FSAR? (Refer to PPL Resource Manual for Definition of FSAR)

☒ Yes, *50.59 screen or evaluation required.* ☐ No

>15. Is this calculation Prepared by an External Organization?

☒ Yes ☐ No

EG771 Qualifications may not be required for individuals from external organizations (see Section 7.4.3).

>16. Prepared by:	M. M. Waselus	M. M. Waselus	12/5/05	
	Print Name(EG771 Qualification Required)	*Signature*	*Date*	
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>18. Verified by:	P. L. Bunker	P. L. Bunker	12/5/05	
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>19. Approved by:	M. G. Capiotis	M. G. Capiotis	12/5/05	
	Print Name(Qualified per NEPM-QA-0241 and comply with Section 7.8 of NEPM-QA-0221)	*Signature*	*Date*	
>20. Accepted by:	TERRENCE F. MACKAY	[illegible]	12/9/05	
	Print Name(EG771 Qualification Required) and comply with Section 7.9 of NEPM-QA-0221	*Signature*	*Date*	

Rosemarie Stadler

JAN 9 2006

NUCLEAR RE[illegible]

ADD A NEW COVER PAGE FOR EACH REVISION
FORM NEPM-QA-0221-1, Revision 9, Page 1 of 1, ELECTRONIC FORM

* Verified Fields
> REQUIRED FIELDS

CALCULATION REVISION DESCRIPTION SHEET
NEPM-QA-0221-2

REVISION NO: 1	CALCULATION NUMBER: EC-RADN-1126

☐ FULL REVISION	☐ SUPERSEDED
☒ PAGE FOR PAGE	☐ VOIDED

Revised Pages	Add	Rpl	Rmv	Description of Revision on the Listed Pages
1	☐	☒	☐	Replaced Calculation Cover Sheet.
1a	☒	☐	☐	Add Revision Description Sheet.
1b	☒	☐	☐	Add Technical Change Summary Page.
3	☐	☒	☐	Corrected column headings in results summary and rearranged columns.
19	☐	☒	☐	Add clarification to explain significance of results in Table 5.
20	☐	☒	☐	Corrected column headings in results summary and rearranged columns.
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TECHNICAL CHANGE SUMMARY PAGE
NEPM-QA-0221-5

Calculation: EC-RADN-1126 **Revision** 1

This form shall be used to (1) record the Technical Scope of the revision and (2) record the scope of verification if the calculation was verified. It should not be more than one page. Its purpose is to provide summary information to the reviewer, verifier, approver, and acceptor about the technical purpose of the change. For non-technical revisions, state the purpose or reason for the revision.

Scope of Revision: This revision to the calculation only corrects the headings and rearranges the columns for the calculation results on pages 3 and 20 and adds clarification to explain the significance of the results on Table 5 as the limiting case. There are no technical changes as a result of this revision.

Scope of Verification (If verification applies): The verification for this revision only includes the editorial corrections as noted above. There are no technical changes in this revision and hence no need for technical review.

PP&L CALCULATION SHEET

Dept. 0341 Rad & Eff Tech. Date 8/08/05 Designed By M. M. Waselus Checked By K. E. Weise	PROJECT CRHE and Off Site FHA/EHA Doses – AST	Calc. No. EC-RADN-1126 Sh. No. 2

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CRHE and Offsite FHA/EHA Doses - AST

1.0 PURPOSE

This calculation documents the design basis evaluation of the Control Room Habitability Envelope (CRHE) and offsite radiological doses following a postulated fuel handling accident (FHA) and equipment handling accident (EHA) using the Alternate Source Term (AST) methodology described in USNRC Regulatory Guide 1.183 (Reference 1). The doses are calculated using the RADTRAD computer code (Reference 2).
The previous calculations EMF-2851(P) (Reference 3) and EMF-3025(P) (Reference 4) used the TID-14844 methodology described in USNRC Regulatory Guide 1.25 (Reference 5). The major changes in applying the AST methodology are:

- revised fuel rod gap fractions
- revised suppression pool iodine decontamination factor
- dose acceptance criteria based on the total effective dose equivalent (TEDE) versus thyroid, whole body and beta doses.

2.0 CONCLUSIONS AND RECOMMENDATIONS

The offsite dose acceptance criterion for the FHA/EHA is provided in USNRC Regulatory Guide 1.183 (Reference 1), Section 4.4, Table 6. The CRHE dose acceptance criterion for the FHA/EHA is provided in 10CFR50.67, Accident Source Term, subsection 10CRF50.67(b)(2)(iii). The offsite dose acceptance criterion is 6.3 Rem TEDE at the exclusion area boundary (EAB) and the low population zone (LPZ). The CRHE dose acceptance criterion is 5 Rem TEDE. The calculated doses are given as follows.

	EHA Case 2 with 460.8 Failed Rods	EHA Case 2 with 366 Failed Rods	FHA Case 1 with 254.8 Failed Rods	FHA Case 1 with 156 Failed Rods
Acceptance Criterion - Offsite	6.30	6.30	6.30	6.30
EAB	1.74	1.38	0.96	0.59
LPZ	0.10	0.08	0.06	0.03
Acceptance Criterion - CRHE	5.00	5.00	5.00	5.00
CRHE 6901 cfm total inleakage	0.1261	0.1001	0.0697	0.0427
CRHE 5739 cfm total inleakage	0.1263	0.1003	0.0699	0.0428

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3.0 ASSUMPTIONS / INPUT

The input data and assumptions used in this analysis are discussed as follows and are summarized in Table 4 following the discussion of the parameters.

3.1 Core Thermal Power (MWt):

The reactor core thermal power accident analysis for EPU is 4032 MWt [i.e. 102% of 3952 MWt uprated reactor power] per SSES EPUMELLA+ Design Report Request T0200, Core Design. (Reference 19).

3.2 Earliest Fuel Handling Time:

Per Technical Requirements Manual, TRO 3.9.1 (Reference 24), dose calculations are made assuming that the earliest time following shutdown that fuel assemblies can be moved in the core is 24 hours.

3.3 Number of Fuel Rods in Assembly/Number of Assemblies in Core:

The total number of equivalent fuel rods per assembly is 87.8 per Reference 25 is given as follows:

Total # Rod Locations		91
# Full Length Rod Locations		83
# Part Length Fuel Rod Locations	8	
Full Length Fuel Active Height, inch		149.45
Part Length Fuel Active Height, inch		90.0

From this data:

equivalent full length rods per assembly is: [(83 x 149.45) + (8 x 90)] / 149.45 = 87.8

The total number of fuel assemblies in the core is 764 (Reference 26, Tables A28-5 and A28-7).

3.4 Core Radial Peaking Factor:

The core radial peaking factor is conservatively set at 1.6 per Reference 3, Table 8.1.

3.5 Core Activity:

The core activity (Ci) by isotope is provided by EC-FUEL-1615 (Reference 16) for a burnup of 39,000 MWD/MTU. The values used in the analysis are listed in Table 1.

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3.6 Peak Curie per Rod:

The peak activity (Ci/rod) available for release following a postulated LOCA is given as:

(Core Activity, Ci @ 39000 MWD/MTU X 1.6) / (# assemblies in core * # rods in assembly).

Per Reference 1, Appendix B, Section 1.2, the isotopes considered in the radiological analyses include the xenons, kryptons, halogens, cesiums, and rubidiums. Per Reference 1, Appendix B, Section 3, the pool DF for particulates which includes cesiums, and rubidiums is infinite. Therefore, they are neglected from further consideration herein. The peak Curie (Ci) per rod is determined in Table 1.

Table 1
Fuel Source Terms 24 Hours after Discharge
Values per Reference 16

Nuclide	Ci in Core @ 24 hours	# of Assemblies in Core	# of Rods per Assemblies	Peak Ci/rod (Ci/rod X 1.6)
I-131	1.00E+08	764	87.8	2.39E+03
I-132	1.28E+08			3.05E+03
I-133	1.02E+08			2.43E+03
I-134	5.71E+00			1.36E-04
I-135	1.68E+07			4.01E+02
Kr-83m	5.27E+04			1.26E+00
Kr-85m	6.62E+05			1.58E+01
Kr-85	1.48E+06			3.53E+01
Kr-87	1.13E+02			2.70E-03
Kr-88	2.12E+05			5.06E+00
Xe-131m	1.45E+06			3.46E+01
Xe-133m	6.29E+06			1.50E+02
Xe-133	2.06E+08			4.91E+03
Xe-135m	2.74E+06			6.54E+01
Xe-135	5.62E+07			1.34E+03

3.7 EHA/FHA Number of Damaged Rods:

EMF-2851(P), Susquehanna Unit 2 Cycle 13 Reload Licensing Analysis Report, Supplemental 1 Workscope, section 8.2 (Reference 3) provides the basis for the fuel and equipment handling accidents. Two cases are considered.

Case 1 (FHA) considers a dropped fuel assembly unit (fuel assembly, channel, grapple and mast) weighing 1500 lbs falling a distance of 32.95 feet onto the core. The number of failed rods is

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given as 156 rods for the Atrium 10 fuel assemblies. To conservatively address the issue of lead fuel assemblies (whether in the reactor or the in the spent fuel pool) radiological dose results are included which assume that another Atrium 10 assembly representing a lead use assembly (LUA) completely fails resulting in a total of 254.8 failed rods.

Case 2 (EHA) assumes an object weighing 1100 lbs is dropped 150 feet onto the core. The dropped assembly and the core are assumed to be ATRIUM-10 fuel assemblies. The number of failed rods is given as 366 rods considering the Atrium 10 fuel assemblies and 460.8 rods considering the case for Atrium 10 + 1 LUA. EMF-3025(P), Susquehanna Unit 1 Cycle 14 Reload SQB-13 Licensing Analysis Report, Supplement 1 Workscope, section 8.2 (Reference 4) states that the Reference 3 analysis remains bounding.

3.8 Gap Activity in Rods:

The activity in the fuel rod gap available for release from the damaged rods is defined in Reference 1, Section 3, Table 3 as:

8%	I-131
10%	Kr-85
5%	Other Nobles Gases & Halogens
12%	Alkali Metals

Per Reference 1, Table 3: These release fractions have been determined to be acceptable for use with currently approved LWR fuel with a peak burnup up to 62,000 MWD/MTU provided that the maximum linear heat generation rate does not exceed 6.3 kw/ft peak rod average power for burnups exceeding 54 GWD/MTU.

3.9 SSES Core Burnup:

Per EC-FUEL-1615 (Reference 16) for SSES the core average burnup is 39,000 MWD/MTU. In accordance with Reference 1, Section 3.1, for DBA events that do not involve the entire core, the fission product inventory in the damaged fuel rods is determined by dividing the total core inventory by the number of fuel rods in the core. The core fission product inventory used herein uses the 39000 MWD/MTU burnup.

3.10 Fuel Rod Pressurization:

Per EMF-2851(P), Section 8.2.2.2 (Reference 3), the maximum fuel rod pressurization is < 1200 psig. Therefore, pressure does not impact the pool DF used in this analysis. See Section 3.14.

3.11 Activity Release Timing:

In accordance with Reference 1, Appendix B, Section 1.2 the activity released from the failed fuel rods is assumed to be instantaneously released and mixed in the pool water.

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3.12 Minimum Pool Depth:

Per SSES Unit 1 Technical Specifications Bases B3.7.7 and B3.9.6 (Reference 6), the minimum depth of water above the top of the RPV flange and over the top of the fuel assemblies seated in the spent fuel storage racks is ≥ 22 feet. A water depth of 21 feet is conservatively used in this analysis to account for the water depth above the damaged assembly laying on the top of the core or the spent fuel storage racks.

3.13 Iodine Species:

In accordance with Reference 1, Appendix B, Section 1.3, the iodine species released to the pool are assumed to be 99.85% elemental iodine and 0.15% organic iodine.

3.14 Refueling/Spent Fuel Pool DF:

The pool iodine DF for a pool with a depth of 21 feet is determined as follows.

Corrected Pool Decontamination:

Per Reference 1, Appendix B, Section 2:

If the depth of water above the damaged fuel is 23 feet or greater, the decontamination factors for the elemental and organic species are 500 and 1, respectively, giving an overall effective decontamination factor of 200 (i.e., 99.5% of the total iodine released from the damaged rods is retained by the water). This difference in decontamination factors for elemental (99.85%) and organic iodine (0.15%) species results in the iodine above the water being composed of 57% elemental and 43% organic species. If the depth of water is not 23 feet, the decontamination factor will have to be determined on a case-by-case method.

The effective elemental iodine DF is back-calculated to be 285.2857 based on the elemental and organic species fractions of 0.9985 and 0.0015 for a 23 foot pool depth and an overall pool DF of 200.

Per Staff Technical Paper, Evaluation of Fission Product Release and Transport, G. Burley, 1971 (NRC Accession Number 8402080322) (Reference 13, page 26):

DFoverall = 1/[(fraction inorganic/DF inorganic) + (fraction organic/1)]

$DF_{overall} = 200 = [(0.9985/ DF_{inorganic}) + (0.0015/1)]^{-1}$

$200 [(0.9985/ DF_{inorganic}) + (0.0015)] = 1$

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199.7/ DF inorganic + 0.3 = 1

199.7 / DF inorganic = 0.7

DF inorganic = 199.7 / 0.7

DF inorganic = 285.2857

Since the SSES Spent Fuel Pool water depth is modeled as 21 feet, the overall iodine DF of 200 is not applicable. Per Reference 1 (Appendix B, Section 2), a suitable methodology for determining an overall pool DF for water depths less than 23 feet is given in Reference 13.

Pages 32 and 33 of Reference 13 state that the iodine decontamination factor in the pool is primarily a function of bubble contact time, which in turn is a function of release pressure and pool depth. For water depths less than 23 feet, the exponential factor in the equation for DFinorg must be recalculated for the applicable distance, in this case 21 feet.

Per pages 25, 26, & 33 of Reference 13, the DF for pool depths less than 23 feet may be calculated by the following relationship:

DFinorg = exp{[6/db][keff][H/vb]}

where,
DFinorg = I2 decontamination factor
db = bubble diameter (cm)
keff = mass transfer coefficient (cm/sec)
H = bubble rise height (cm)
vb = bubble rise velocity (cm/sec) with spent fuel rod internal pin pressure < 1200 psig

The internal fuel pin pressure is less than 1200 psig, therefore, the pressure correction term is not required (Reference 13, Section XIII and USNRC Regulatory Guide 1.25, paragraph C.1.b).

Using the given effective elemental iodine DF of 285.2857 for a depth of 23 feet, the value of the exponential power in the above equation can be calculated.

DF = 285.2857 = exp(x), then taking the natural log of both sides of the equation yields,
ln(285.2857) = x
5.65349 = x

In accordance with page 33 of Reference 11, the exponential factor in the equation for DFinorg must be recalculated for the applicable distance. Multiplying the ratio of pool depth, 21/23 (pool

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depth / baseline pool depth) by the factor x yields the effective exponential power factor for determining the elemental iodine DF for reduced pool depth,

DFinorg = exp [5.65349*(21/23)] = 174.493

Then the overall SSES Spent Fuel Pool DF is given by

DF = $[(0.9985/174.5) + (0.0015/1)]^{-1}$ = $[0.0057223 + 0.0015]^{-1}$ = 138.46 (USE 138 in analysis)

For a depth of 21 feet, the iodine species above the pool water are 79% elemental and 21% organic.

Total pool release fraction = [Elemental Iodine Fraction / DFinorg] + [Organic Iodine Fraction]

Pool release fraction = [0.9985 / 174.869] + 0.0015 = 0.0072

Elemental release fraction = [Elemental Fraction / DFinorg / pool release fraction]
= [0.9985 / 174.869 / .0072] = 0.79 or 79%

Organic release fraction = [Organic Fraction / pool release fraction]
= [0.0015 / .0072] = 0.21 or 21%

3.15 Activity Airborne in Building:

The activity in the buildings available for release to the environment for the EHA and FHA is determined in Table 2.

Activity Airborne (Ci) = Ci/rod X Isotope gap fraction X # of failed rods / Pool DF

For I-131 for the FHA this is given as:

2385 Ci/rod X 0.08 X 254.8 rods/138 = 352 Ci

The other values are similarly determined as shown in Table 2.

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Table 2 Activity Airborne Available for Release to the Environment

Nuclide	1.6 X Ci/rod Table 1	Gap Activity/rod 8% I-131; 10% Kr-85; 5% others Ci/rod	FHA Gap Activity for 156 Rods Ci	FHA Gap Activity for 254.8 Rods Ci	FHA Activity Airborne w/ (1,2,3) 156 Rods Ci	FHA Activity Airborne w/ (1,2,3) 254.8 Rods Ci
I-131	2.385E+03	1.91E+02	2.98E+04	4.86E+04	2.16E+02	3.52E+02
I-132	3.053E+03	1.53E+02	2.38E+04	3.89E+04	1.73E+02	2.82E+02
I-133	2.433E+03	1.22E+02	1.90E+04	3.10E+04	1.38E+02	2.25E+02
I-134	1.362E-04	6.81E-06	1.06E-03	1.74E-03	7.70E-06	1.26E-05
I-135	4.007E+02	2.00E+01	3.13E+03	5.11E+03	2.26E+01	3.70E+01
Kr-83m	1.257E+00	6.29E-02	9.80E+00	1.60E+01	9.80E+00	1.60E+01
Kr-85m	1.579E+01	7.90E-01	1.23E+02	2.01E+02	1.23E+02	2.01E+02
Kr-85	3.530E+01	3.53E+00	5.51E+02	8.99E+02	5.51E+02	8.99E+02
Kr-87	2.695E-03	1.35E-04	2.10E-02	3.43E-02	2.10E-02	3.43E-02
Kr-88	5.057E+00	2.53E-01	3.94E+01	6.44E+01	3.94E+01	6.44E+01
Xe-131m	3.459E+01	1.73E+00	2.70E+02	4.41E+02	2.70E+02	4.41E+02
Xe-133m	1.500E+02	7.50E+00	1.17E+03	1.91E+03	1.17E+03	1.91E+03
Xe-133	4.914E+03	2.46E+02	3.83E+04	6.26E+04	3.83E+04	6.26E+04
Xe-135m	6.536E+01	3.27E+00	5.10E+02	8.33E+02	5.10E+02	8.33E+02
Xe-135	1.341E+03	6.70E+01	1.05E+04	1.71E+04	1.05E+04	1.71E+04
Nuclide	1.6 X Ci/rod Table 1	Gap Activity/rod 8% I-131; 10% Kr-85; 5% others Ci/rod	EHA Gap Activity for 366 Rods Ci	EHA Gap Activity for 460.8 Rods Ci	EHA Activity Airborne w/ (1,2,3) 366 Rods Ci	EHA Activity Airborne w/ (1,2,3) 460.8 Rods Ci
I-131	2.385E+03	1.91E+02	6.98E+04	8.79E+04	5.06E+02	6.37E+02
I-132	3.053E+03	1.53E+02	5.59E+04	7.03E+04	4.05E+02	5.10E+02
I-133	2.433E+03	1.22E+02	4.45E+04	5.61E+04	3.23E+02	4.06E+02
I-134	1.362E-04	6.81E-06	2.49E-03	3.14E-03	1.81E-05	2.27E-05
I-135	4.007E+02	2.00E+01	7.33E+03	9.23E+03	5.31E+01	6.69E+01
Kr-83m	1.257E+00	6.29E-02	2.30E+01	2.90E+01	2.30E+01	2.90E+01
Kr-85m	1.579E+01	7.90E-01	1.29E+03	3.64E+02	1.29E+03	3.64E+02
Kr-85	3.530E+01	3.53E+00	2.89E+02	1.63E+03	2.89E+02	1.63E+03
Kr-87	2.695E-03	1.35E-04	4.93E-02	6.21E-02	4.93E-02	6.21E-02
Kr-88	5.057E+00	2.53E-01	9.25E+01	1.17E+02	9.25E+01	1.17E+02
Xe-131m	3.459E+01	1.73E+00	6.33E+02	7.97E+02	6.33E+02	7.97E+02
Xe-133m	1.500E+02	7.50E+00	2.75E+03	3.46E+03	2.75E+03	3.46E+03
Xe-133	4.914E+03	2.46E+02	8.99E+04	1.13E+05	8.99E+04	1.13E+05
Xe-135m	6.536E+01	3.27E+00	1.20E+03	1.51E+03	1.20E+03	1.51E+03
Xe-135	1.341E+03	6.70E+01	2.45E+04	3.09E+04	2.45E+04	3.09E+04

(1): Pool DF =138 for iodine calculated above.
(2): Pool DF =1 for noble gases (Reference 1, Appendix B, Section 3)
(3): Pool DF = infinite for Cs, Rb which can be neglected (See Section 3.6)

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3.16 Release Duration:

Per Reference 1, Appendix B, Sections 4.1 and 5.3, the activity release to the environment is assumed to be released over a two hour period.

3.17 Activity Transport Path:

Per References 22 (EC-RADN-0531) and 23 (EC-RADN-0319), the activity transport from the pool to the environment is via the SGTS filters. Reference 22 provides a conservative analysis using realistic assumptions and parameters for a fuel handling accident that demonstrates that the Refueling Floor High Exhaust Duct Radiation Monitors, Refueling Floor Wall Exhaust Duct Radiation Monitors and the Railroad Access Shaft Exhaust Duct Radiation Monitor will sense the event and provide the required signals to the SGTS. Reference 23 provides an analysis that demonstrates that the isolation damper closure time is less than the air travel time. Therefore, the isolation damper will close prior to the activity reaching the damper.

3.18 Activity Transport Path:

The Standby Gas Treatment System charcoal filters provide 8 inches of charcoal for filtration as given in SSES SPEC M-321, Technical Specification For Standby Gas Treatment System For SSES Units 1 & 2 (Reference 7). Per Table 2 of Regulatory Guide 1.52 (Reference 8), an SGTS charcoal filter efficiency of 99% is assumed for all species of iodine.

3.19 Offsite Breathing Rates:

In accordance with Reference 1, Section 4.1.3, the offsite breathing rates are given as:
3.5E-04 m^3/sec, 0-8 hours
1.8E-04 m^3/sec, 8-24 hours
2.3E-04 m^3/sec, 1-30 days

3.20 Dose Conversion Factors:

The dose conversion factors for the isotopes considered in this analysis are taken from Reference 2, NUREG/CR-6604, RADTRAD, Table 1.4.3.3-2 and are reproduced in Attachment 2. The dose conversion factors are derived from Federal Guidance Reports 11 and 12 (References 17 and 18).

3.21 Control Rom Habitability Envelope (CRHE) Volume:

The CRHE is defined for SSES as six separate floors of the control building.
Per Calculation EC-030-502, Control Structure Bldg. Volume (Reference 9), the volume for the CRHE is given as 518,000 ft^3. The Control Room itself has a volume of approximately 110,000 ft^3.

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Since the CRHE is modeled in RADTRAD as a single node with a volume of 518,000 ft^3, the calculated doses are adjusted for the finite volume with a single area of 110,000 ft^3. As shown in Section 2.3.2 of Reference 2, RADTRAD uses the following factor to determine the external dose or EDE portion of TEDE.

$GF = 1173. / V^{0.338}$

where:
GF = geometry factor
V = control room free volume in ft^3

The CRHE dose acceptance criteria is given as 5 Rem TEDE. The TEDE (total effective dose equivalent) is defined as the sum of the external dose equivalent (EDE) from external contamination plus the committed effective dose equivalent (CEDE) from internal contamination in NRC Regulatory Issue Summary 2003-04, Use of the Effective Dose Equivalent in Place of the Deep Dose Equivalent in Dose Assessments (Reference 27).

In order to take credit for the radiation shielding effects of the control structure floors, the EDE portion of the TEDE is adjusted by the ratio of the geometry factor GF for 518,000 ft^3 to the GF for 110,000 ft^3 or
$GF = 1173. / (518{,}000)^{0.338} = 13.74$
$GF = 1173. / (110{,}000)^{0.338} = 23.19$
and the resulting ratio = 0.59 [13.74/23.19].

3.22 CR Isolation Time:

Under accident conditions, habitability for the Control Structure Habitability Envelope (CRHE) is provided by the Control Room Emergency Outside Air Supply System (CREOAS). This system provides habitability zone isolation and a positive pressure for the CRHE. For this event the CRHE automatically isolates and enters the emergency mode in sequence with the SGTS prior to commencement of the release of activity to environment.

3.23 CRHE Emergency Intake Air Flow:

Per SSES Units 1&2 Technical Specifications 3.7.3.4 and 5.5.7a (References 20 and 21), the Control Room Emergency Outside Air System (CREOAS) Filtered Intake Flow ranges from 5229 cfm to 6391 cfm with positive pressure guaranteed at ≤ 5810 cfm. RADTRAD runs were made at 5229 cfm and 6391 cfm and it was determined that the 6391 cfm was limiting.

3.24 CRHE Unfiltered Air Inleakage Ingress/Egress:

In accordance with NUREG-0800, USNRC Standard Review Plan Section 6.4, Control Room Habitability System (Reference 11), 10 cfm of unfiltered inleakage is added to the CRHE to account for ingress/egress of personnel.

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3.25 CRHE Unfiltered Air Inleakage Other:

500 cfm of unidentified unfiltered inleakage is conservatively assumed in the RADTRAD model. This inleakage bounds the tracer gas test results (including error band) from the December 2004 SSES CRHE inleakage test.

3.26 CRHE Exhaust Flow Rate:

The CRHE exhaust flow input to RADTRAD is the sum of the filtered makeup air and unfiltered inleakages to the CRHE. The value ranges from is 5739 cfm [5229 cfm+10 cfm+500 cfm] to 6901 cfm [6391 cfm+10 cfm+500 cfm].

3.27 CREOAS Intake Filter Bed Depth and Filter Efficiency:

The CREOAS intake filter provides 4 inches (SSES SPEC M-325, "Technical Specification For Ventilation Filters High Efficiency", Reference 12) of charcoal for filtration. In accordance with Table 2 of Regulatory Guide 1.52 (Reference 8), a charcoal filter efficiency of 99% is assumed for all species of iodine.

3.28 CRHE Operator Breathing Rates:

Per Reference 1, Section 4.2.6, for the duration of the event, the breathing rate of this CRHE operators is assumed to be 3.5×10^{-4} m^3/sec.

3.29 CRHE Operator Occupancy Times:

Per Reference 1, Section 4.2.6: The dose receptor for these analyses is the hypothetical maximum exposed individual who is present in the control room for 100% of the time during the first 24 hours after the event, 60% of the time between 1 and 4 days, and 40% of the time from 4 days to 30 days.

3.30 Offsite and CRHE χ/Q's

The Offsite χ/Q's are taken from EC-ENVR-1057 (Reference 14).

EAB (2 hr):	
(0 - 2 hrs)	8.3E-04 sec/m^3
LPZ	
(0 - 8 hrs)	4.9E-05 sec/m^3
(8 - 24 hrs)	3.50E-05 sec/m^3
(24 - 96 hrs)	1.70E-05 sec/m^3
(96 - 720 hrs)	6.10E-06 sec/m^3

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For the EHA and FHA the activity release to the environment is via the SGTS vent. The CRHE χ/Q's are taken from Reference 15.

The CRHE CREOAS χ/Q's at the RB Unit 2 CRHE Outside Air Intake Location are taken from EC-ENVR-1059 (Reference 15) and shown as follows in Table 3.

Table 3 CRHE χ/Q's (sec/m3) without Occupancy Correction Factors

Release Point	CRHE χ/Q's (sec/m^3) without Occupancy Correction Factors				
Time Period	0 to 2 hours	2 to 8 hours	8 to 24 hours	1 to 4 days	4 to 30 days
SGTS Exhaust Vent	1.45E-03	1.12E-03	3.55E-04	2.29E-04	2.01E-04

PP&L CALCULATION SHEET		
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Table 4
FHA/EHA Analysis Input and Assumptions

	Parameter	Input	Source
1	Core Thermal Power Level	4032 MWt	Reference 19 See Section 3.1
2	Earliest Fuel Handling Time	24 Hours	Reference 24 See Section 3.2
3	Number of Fuel Rods in Fuel Assembly/Number of Assemblies in Core	87.8/764	Reference 25 See Section 3.3
4	Core Radial Peaking Factor	1.6	Reference 3, Table 8.1 See Section 3.4
5	Core Activity	Table 1	Reference 16 See Section 3.5
6	Peak Ci per Rod	Table 1	Calculated in Section 3.6
7	EHA/FHA – Number of Damaged Rods	Case 1 (FHA): 156/254.8 Case 2 (EHA): 366/460.8	Reference 3, Section 8.2 See Section 3.7
8	Damaged Rods – Gap Activity	8% - I-131 10% - Kr-85 5% - Other Nobles Gases & Halogens 12% - Alkali Metals	Reference 1, Section 3.2, Table 3 See Section 3.8
9	Core Burnup (MWD/MTU)	39,000	Reference 16 See Section 3.9
10	Maximum Fuel Rod Pressurization	<1200 psig	Reference 3, Section 8.2.2.2 See Section 3.10

PP&L CALCULATION SHEET		
Dept. 0341 Rad & EIT Tech. Date 7/27/05 Designed By M. M. Waselus Checked By K. E. Weise	PROJECT CRHE and Off Site FHA/EHA Doses – AST	Calc. No. EC-RADN-1126 Sh. No. 16

Table 4
FHA/EHA Analysis Input and Assumptions

	Parameter	Input	Source
11	EHA Release Timing (Gap)	Instantaneously Released & Mixed into Pool Water	Reference 1, Appendix B, Section 1.2 See Section 3.11
12	Minimum Pool Water Depth	21 feet	See Section 3.12
13	Iodine Species Released to Pool	99.85%Elemental 0.15% Organic	Reference 1, Appendix B, Section 1.3 See Section 3.13
14	Pool DF	Noble gases - 1.0 Aerosols - infinite Iodine - 138 (corrected for 21 feet)	Reference 1, Appendix B, Sections 2 and 3. Calculated in Section 3.14
15	Activity Airborne in Building, Ci	Table 2	Calculated in Section 3.15
16	EHA Release Duration	2 hours	Reference 1, Appendix B, Sections 4.1 and 5.3 See Section 3.16
17	Activity Transport From Pool to Environment	SGTS actuation prior to activity release to environment	References 23 and 24 See section 3.17
18	SGTS Filter Bed Depth	8 in. Charcoal	Reference 7 See Section 3.18
19	SGTS Filter Bed Efficiency	99% for all iodine species	Reference 8 See Section 3.18
20	Offsite Breathing Rates(m^3/sec)	3.5E-04, 0-8 hrs 1.8E-04, 8-24 hrs 2.3E-04, 1-30 d	Reference 1, Section 4.1.3 See Section 3.19
21	Dose Conversion Factors	RADTRAD Table 1.4.3.3-2 Reproduced in Attachment 2	Reference 2 See Section 3.20

PP&L CALCULATION SHEET		
Dept. 0341 Rad & Eff Tech. Date 7/27/05 Designed By M. M. Waselus Checked By K. E. Weise	PROJECT CRHE and Off Site FHA/EHA Doses – AST	Calc. No. EC-RADN-1126 Sh. No. 17

Table 4
FHA/EHA Analysis Input and Assumptions

	Parameter	Input	Source
22	Control Structure Habitability Envelope Total Volume	518,000 ft^3	Reference 9 See section 3.21
23	Control Room Free Air Volume	110,000 ft^3	Reference 9 See section 3.21
24	CRHE Isolation Time	Time = 0	See section 3.22
25	Emergency Intake Air Flow, Total into Control Structure	5229 cfm to 6391 cfm	Reference 20 and 21 See section 3.23
26	Unfiltered Air Inleakage Ingress/egress	10 cfm	Reference 11 See section 3.24
27	Other Unfiltered Air Inleakage	500cfm	See section 3.25
28	CR Exhaust Flow	Emergency Intake Air Flow + Unfiltered Air Inleakage 5739 cfm to 6901 cfm	Calculated in section 3.26
29	Emergency Filter Bed Depth	4 inches Charcoal	Reference 12 See section 3.27
30	Emergency Filter Bed Removal Efficiency	99%	Reference 8 See section 3.27
31	Operator Breathing Rates	3.5E-04 m^3/sec	Reference 1, Section 4.2.6 See section 3.28
32	Operator Occupancy Factors	1.0, 0-24 hrs 0.6, 1-4 days 0.4, 4-30 days	Reference 1, Section 4.2.6 See section 3.29

Table 4
FHA/EHA Analysis Input and Assumptions

	Parameter	Input	Source
33	χ/Q sec/m^3	EAB: 8.3E-04, 0-2 hr LPZ: 4.90E-05, 0-8 hr CRHE χ/Q at Outside Air Intake 1.45E-03, 0-2 hr 1.12E-03, 2-8 hr 3.55E-04, 8-24hr 2.29E-04, 1-4 day 2.01E-04, 4-30 day	Reference 14 Reference 15 See section 3.30

4.0 METHOD

The offsite and CRHE doses are calculated using the RADTRAD computer code and the input and assumptions listed in sections 3.1 to 3.29. The RADTRAD control files used in the model are provided on Attachments 1, 2 and 3. Case 2 (EHA with 460.8 failed fuel rods) was run with RADTRAD and the results are summarized on Table 5. The results are provided on Attachments 4 and 5 for CRHE intake flows of 5739 cfm to 6901 cfm (see section 3.26).

The final dose results are directly proportional to the source term. Therefore, the results for the other cases are determined by multiplying the Case 2 (EHA with 460.8 failed fuel rods) results by the ratio of the number of failed fuel rods. The results are provided in Table 6.

5.0 RESULTS

The results of the RADTRAD computer runs are listed in Table 5 for the limiting case dose results (EHA with 460.8 failed fuel rods). The summary for all cases is provided in Table 6.

Table 5 CRHE Dose Results EHA

EHA with 460.8 Failed Rods	Rem TEDE	Rem CEDE	Rem EDE	Adjusted Rem EDE (1)	Adjusted Rem TEDE (2)	Attachment
CRHE 6901 cfm total inleakage (3)	0.2068	0.0098	0.1970	0.1162	0.1261	4
CRHE 5739 cfm total inleakage	0.2061	0.0115	0.1946	0.1148	0.1263	5

1. TEDE = CEDE + EDE. Adjusted Rem EDE equals the Rem EDE from RADTRAD times the finite volume correction of 0.59 (See Section 3.21).

2. Adjusted Rem TEDE equals the Rem CEDE from RADTRAD plus the Adjusted Rem EDE.

3. The RADTRAD runs demonstrate that this case with the higher CRHE flow is slightly more conservative.

PP&L CALCULATION SHEET		
Dept. 0341 Rad & Eff Tech. Date 12/05/05 Designed By M. M. Waselus Checked By P. L. Bunker	PROJECT CRHE and Off Site FHA/EHA Doses – AST	Calc. No. EC-RADN-1126 Sh. No. 20

Table 6 provides a summary of the Offsite and CRHE Dose Results.

Table 6 Offsite and CRHE Dose Results					
	Case 2 EHA with 460.8 Failed Rods	Source	Case 2 EHA with 366 Failed Rods	Case 1 FHA with 254.8 Failed Rods	Case 1 FHA with 156 Failed Rods
Acceptance Criterion - Offsite	6.30		6.30	6.30	6.30
EAB	1.74	Att. 4 & 5	1.38	0.96	0.59
LPZ	0.10	Att. 4 & 5	0.08	0.06	0.03
Acceptance Criterion - CRHE	5.00		5.00	5.00	5.00
CRHE 6901 cfm total inleakage	0.1261	Table 5	0.1001	0.0697	0.0427
CRHE 5739 cfm total inleakage	0.1263	Table 5	0.1003	0.0699	0.0428

6.0 REFERENCES

1. USNRC Regulatory Guide 1.183, Alternative Radiological Source Terms For Evaluating Design Basis Accidents At Nuclear Power Reactors, July 2000.

2. NUREG/CR-6604, RADTRAD: A Simplified Model for RADionuclide Transport and Removal And Dose Estimation, and Supplement 1, 6/8/99.

3. Calculation EMF-2851(P), Susquehanna Unit 2 Cycle 13 Reload Licensing Analysis Report, Supplemental 1 Workscope, Revision 0, January, 2004.

4. Calculation EMF-3025(P), Susquehanna Unit 1 Cycle 14 Reload SQB-13 Licensing Analysis Report, Supplement 1 Workscope, Revision 0, 12/30/03.

5. USNRC Regulatory Guide 1.25, Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling in the Fuel Handling and Storage Facility Accident for Boiling and Pressurized Water Reactors, 3/23/72..

6. SSES Unit 1 Technical Specifications Bases B3.7.7, Spent Fuel Storage Pool Water Level, Revision 0 and SSES Unit 1 Technical Specifications Bases B3.9.6, Reactor Pressure Vessel Water Level, Revision 0.

7. SSES SPEC M-321, Technical Specification For Standby Gas Treatment System For SSES Units 1 & 2, Revision 7.

8. USNRC Regulatory Guide 1.52, Design, Testing and Maintenance Criteria For Post Accident Engineered-Safety-Feature Atmosphere Cleanup System Air Filtration And Adsorption Units Of Light-Water-Cooled Nuclear Power Plants, Revision 2, March 1978.

9. PPL Calculation EC-030-0502, Control Structure Bldg. Volume, Revision 0, 12/17/93.

10. SSES Drawing E106283, Sheet 1, Revision 30.

11. NUREG-0800, USNRC Standard Review Plan Section 6.4, Control Room Habitability System, Revision 2.

12. SSES SPEC M-325, "Technical Specification For Ventilation Filters High Efficiency", Revision 12.

13. Staff Technical Paper, Evaluation of Fission Product Release and Transport, G. Burley, 1971 (NRC Accession Number 8402080322).

14. PPL Calculation EC-ENVR-1057, Offsite χ/Q Values for the SSES Based on 1999-2003 Meteorological Data, Revision 0.

15. PPL Calculation EC-ENVR-1059, CRHE Accident Dispersion Factors (χ/Q) RB U2 Intake, Revision 0.

16. Calculation EC-FUEL-1615, Revision 1.

17. Federal Guidance Report No. 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," EPA 520/1-88-020,Environmental Protection Agency, Washington, DC (1988).

18. Federal Guidance Report No. 12, "External Exposure to Radionuclides in Air, Water and Soil," EPA 420-r-93-081, Environmental Protection Agency, Washington, DC, 1993.

19. SSES EPUMELLA+ Design Report Request T0200, Core Design, Revision 0.

20. SSES Units 1&2 Technical Specifications 5.5.7a (Amendment 178/151).

21. SSES Units 1&2 Technical Specifications 3.7.3.4 (Amendment 178/151).

22. PPL Calculation EC-RADN-0531, Secondary Containment Isolation Setpoints, Revision 2.

23. PPL Calculation EC-RADN-0319, Isolation Damper Closing Time, Revision 1.

24. Technical Requirements Manual, TRO 3.9.1, Decay Time, 8/31/1998.

25. PPL Calculation EC-FUEL-1186, Fuel Component Weights, Revision 1.

26. PPL Calculation EC-PUPC-1001, Power Uprate Engineering Report for Susquehanna Steam Electric Station Units 1 and 2, Revision 6.

27. NRC Regulatory Issue Summary 2003-04, Use of the Effective Dose Equivalent in Place of the Deep Dose Equivalent in Dose Assessments, 2/13/2003.

Attachment 1 RADTRAD Control File Release Fraction and Timing - PPL-EHA.rft

```
Release Fraction and Timing Name: SSES EHA - Release Gap Activity Over 2 Hours
 BWR, NUREG-1465, Tables 3.11 & 3.13, June 1992
 Duration (h):   Design Basis Accident
  0.2000E+01  0.0000E+00  0.0000E+00  0.0000E+00
 Noble Gases:
  0.1000E+01  0.0000E+00  0.0000E+00  0.0000E+00
 Iodine:
  0.1000E+01  0.0000E+00  0.0000E+00  0.0000E+00
 Cesium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Tellurium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Strontium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Barium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Ruthenium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Cerium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Lanthanum:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Non-Radioactive Aerosols (kg):
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 End of Release File
```

Attachment 2 RADTRAD Control File Dose Conversion File PPL-EHA.inp

FGR11&12 edited+TID_30.inp Kr83m Xe131m 133m 135m beta-test version 1.10
Implicit daughter halflives (m) less than 90 and less than 0.100 of parent
9 ORGANS DEFINED IN THIS FILE: ICRP-30
GONADS
BREAST
LUNGS
RED MARR
BONE SUR
THYROID
REMAINDER
EFFECTIVE
SKIN(FGR)
15 NUCLIDES DEFINED IN THIS FILE:
I-131 D
I-132 D
I-133 D
I-134 D
I-135 D Including:Xe-135m
Xe-131m
Xe-133m
Xe-133
Xe-135m
Xe-135
Kr-83m
Kr-85m
Kr-87
Kr-88
Kr-85

	CLOUDSHINE	GROUND SHINE 8HR	GROUND SHINE 7DAY	GROUND SHINE RATE	INHALED ACUTE	INHALED CHRONIC	INGESTION
I-131							
GONADS	1.780E-14	1.119E-11	1.789E-10	3.940E-16-1.000E+00	2.530E-11	4.070E-11	
BREAST	2.040E-14	1.082E-11	1.730E-10	3.810E-16-1.000E+00	7.880E-11	1.210E-10	
LUNGS	1.760E-14	1.016E-11	1.626E-10	3.580E-16-1.000E+00	6.570E-10	1.020E-10	
RED MARR	1.680E-14	1.022E-11	1.635E-10	3.600E-16-1.000E+00	6.260E-11	9.440E-11	
BONE SUR	3.450E-14	1.675E-11	2.679E-10	5.900E-16-1.000E+00	5.730E-11	8.720E-11	
THYROID	1.810E-14	1.053E-11	1.685E-10	3.710E-16-1.000E+00	2.920E-07	4.760E-07	
REMAINDER	1.670E-14	9.908E-12	1.585E-10	3.490E-16-1.000E+00	8.030E-11	1.570E-10	
EFFECTIVE	1.820E-14	1.067E-11	1.707E-10	3.760E-16-1.000E+00	8.890E-09	1.440E-08	
SKIN(FGR)	2.980E-14	1.825E-11	2.920E-10	6.430E-16-1.000E+00	0.000E+00	0.000E+00	
I-132							
GONADS	1.090E-13	2.523E-11	2.771E-11	2.320E-15-1.000E+00	9.950E-12	2.330E-11	
BREAST	1.240E-13	2.414E-11	2.652E-11	2.220E-15-1.000E+00	1.410E-11	2.520E-11	
LUNGS	1.090E-13	2.305E-11	2.532E-11	2.120E-15-1.000E+00	2.710E-10	2.640E-11	
RED MARR	1.070E-13	2.360E-11	2.592E-11	2.170E-15-1.000E+00	1.400E-11	2.460E-11	
BONE SUR	1.730E-13	3.327E-11	3.655E-11	3.060E-15-1.000E+00	1.240E-11	2.190E-11	
THYROID	1.120E-13	2.381E-11	2.616E-11	2.190E-15-1.000E+00	1.740E-09	3.870E-09	
REMAINDER	1.050E-13	2.283E-11	2.509E-11	2.100E-15-1.000E+00	3.780E-11	1.650E-10	
EFFECTIVE	1.120E-13	2.403E-11	2.640E-11	2.210E-15-1.000E+00	1.030E-10	1.820E-10	
SKIN(FGR)	1.580E-13	8.199E-11	9.007E-11	7.540E-15-1.000E+00	0.000E+00	0.000E+00	
I-133							
GONADS	2.870E-14	1.585E-11	6.748E-11	6.270E-16-1.000E+00	1.950E-11	3.630E-11	
BREAST	3.280E-14	1.519E-11	6.468E-11	6.010E-16-1.000E+00	2.940E-11	4.680E-11	
LUNGS	2.860E-14	1.446E-11	6.156E-11	5.720E-16-1.000E+00	8.200E-10	4.530E-11	
RED MARR	2.770E-14	1.466E-11	6.242E-11	5.800E-16-1.000E+00	2.720E-11	4.300E-11	
BONE SUR	4.870E-14	2.161E-11	9.202E-11	8.550E-16-1.000E+00	2.520E-11	4.070E-11	
THYROID	2.930E-14	1.502E-11	6.393E-11	5.940E-16-1.000E+00	4.860E-08	9.100E-08	
REMAINDER	2.730E-14	1.418E-11	6.038E-11	5.610E-16-1.000E+00	5.000E-11	1.550E-10	
EFFECTIVE	2.940E-14	1.509E-11	6.425E-11	5.970E-16-1.000E+00	1.580E-09	2.800E-09	
SKIN(FGR)	5.830E-14	1.150E-10	4.897E-10	4.550E-15-1.000E+00	0.000E+00	0.000E+00	
I-134							
GONADS	1.270E-13	1.200E-11	1.202E-11	2.640E-15-1.000E+00	4.250E-12	1.100E-11	
BREAST	1.440E-13	1.145E-11	1.147E-11	2.520E-15-1.000E+00	6.170E-12	1.170E-11	
LUNGS	1.270E-13	1.100E-11	1.102E-11	2.420E-15-1.000E+00	1.430E-10	1.260E-11	
RED MARR	1.250E-13	1.127E-11	1.129E-11	2.480E-15-1.000E+00	6.080E-12	1.090E-11	
BONE SUR	1.960E-13	1.568E-11	1.571E-11	3.450E-15-1.000E+00	5.310E-12	9.320E-12	
THYROID	1.300E-13	1.127E-11	1.129E-11	2.480E-15-1.000E+00	2.880E-10	6.210E-10	
REMAINDER	1.220E-13	1.091E-11	1.093E-11	2.400E-15-1.000E+00	2.270E-11	1.340E-10	
EFFECTIVE	1.300E-13	1.150E-11	1.152E-11	2.530E-15-1.000E+00	3.550E-11	6.660E-11	
SKIN(FGR)	1.870E-13	4.477E-11	4.485E-11	9.850E-15-1.000E+00	0.000E+00	0.000E+00	
I-135							
GONADS	8.078E-14	3.113E-11	5.489E-11	1.599E-15-1.000E+00	1.700E-11	3.610E-11	
BREAST	9.143E-14	2.971E-11	5.240E-11	1.526E-15-1.000E+00	2.340E-11	3.850E-11	
LUNGS	8.145E-14	2.886E-11	5.089E-11	1.482E-15-1.000E+00	4.410E-10	3.750E-11	
RED MARR	8.054E-14	2.965E-11	5.228E-11	1.523E-15-1.000E+00	2.240E-11	3.650E-11	
BONE SUR	1.184E-13	3.983E-11	7.024E-11	2.046E-15-1.000E+00	2.010E-11	3.360E-11	
THYROID	8.324E-14	2.852E-11	5.030E-11	1.465E-15-1.000E+00	8.460E-09	1.790E-08	

REMAINDER	7.861E-14	2.883E-11	5.084E-11	1.481E-15-1.000E+00	4.700E-11	1.540E-10
EFFECTIVE	8.294E-14	2.989E-11	5.271E-11	1.535E-15-1.000E+00	3.320E-10	6.080E-10
SKIN(FGR)	1.156E-13	9.826E-11	1.733E-10	5.047E-15-1.000E+00	0.000E+00	0.000E+00
Xe-131m						
GONADS	4.570E-16	7.872E-13	1.371E-11	2.760E-17-1.000E+00	0.000E+00	0.000E+00
BREAST	6.020E-16	8.471E-13	1.475E-11	2.970E-17-1.000E+00	0.000E+00	0.000E+00
LUNGS	2.670E-16	3.565E-13	6.209E-12	1.250E-17-1.000E+00	0.000E+00	0.000E+00
RED MARR	2.270E-16	2.792E-13	4.863E-12	9.790E-18-1.000E+00	0.000E+00	0.000E+00
BONE SUR	1.060E-15	1.677E-12	2.920E-11	5.880E-17-1.000E+00	0.000E+00	0.000E+00
THYROID	3.910E-16	5.220E-13	9.089E-12	1.830E-17-1.000E+00	0.000E+00	0.000E+00
REMAINDER	2.710E-16	3.993E-13	6.954E-12	1.400E-17-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	3.890E-16	5.876E-13	1.023E-11	2.060E-17-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	4.820E-15	1.266E-12	2.205E-11	4.440E-17-1.000E+00	0.000E+00	0.000E+00
Xe-133m						
GONADS	1.420E-15	1.337E-12	1.188E-11	4.890E-17-1.000E+00	0.000E+00	0.000E+00
BREAST	1.700E-15	1.383E-12	1.230E-11	5.060E-17-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.190E-15	8.609E-13	7.656E-12	3.150E-17-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.100E-15	7.844E-13	6.975E-12	2.870E-17-1.000E+00	0.000E+00	0.000E+00
BONE SUR	3.230E-15	2.599E-12	2.311E-11	9.510E-17-1.000E+00	0.000E+00	0.000E+00
THYROID	1.360E-15	1.028E-12	9.138E-12	3.760E-17-1.000E+00	0.000E+00	0.000E+00
REMAINDER	1.150E-15	8.855E-13	7.874E-12	3.240E-17-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.370E-15	1.112E-12	9.892E-12	4.070E-17-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	1.040E-14	1.894E-12	1.684E-11	6.930E-17-1.000E+00	0.000E+00	0.000E+00
Xe-133						
GONADS	1.610E-15	1.465E-12	2.052E-11	5.200E-17-1.000E+00	0.000E+00	0.000E+00
BREAST	1.960E-15	1.505E-12	2.107E-11	5.340E-17-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.320E-15	1.045E-12	1.464E-11	3.710E-17-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.070E-15	8.791E-13	1.231E-11	3.120E-17-1.000E+00	0.000E+00	0.000E+00
BONE SUR	5.130E-15	4.254E-12	5.958E-11	1.510E-16-1.000E+00	0.000E+00	0.000E+00
THYROID	1.510E-15	1.181E-12	1.653E-11	4.190E-17-1.000E+00	0.000E+00	0.000E+00
REMAINDER	1.240E-15	1.042E-12	1.460E-11	3.700E-17-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.560E-15	1.299E-12	1.819E-11	4.610E-17-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	4.970E-15	1.953E-12	2.734E-11	6.930E-17-1.000E+00	0.000E+00	0.000E+00
Xe-135m						
GONADS	2.000E-14	5.929E-13	5.929E-13	4.480E-16-1.000E+00	0.000E+00	0.000E+00
BREAST	2.290E-14	5.691E-13	5.691E-13	4.300E-16-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.980E-14	5.347E-13	5.347E-13	4.040E-16-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.910E-14	5.400E-13	5.400E-13	4.080E-16-1.000E+00	0.000E+00	0.000E+00
BONE SUR	3.500E-14	8.246E-13	8.246E-13	6.230E-16-1.000E+00	0.000E+00	0.000E+00
THYROID	2.040E-14	5.612E-13	5.612E-13	4.240E-16-1.000E+00	0.000E+00	0.000E+00
REMAINDER	1.890E-14	5.241E-13	5.241E-13	3.960E-16-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	2.040E-14	5.612E-13	5.612E-13	4.240E-16-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	2.970E-14	1.866E-12	1.866E-12	1.410E-15-1.000E+00	0.000E+00	0.000E+00
Xe-135						
GONADS	1.170E-14	5.455E-12	1.194E-11	2.530E-16-1.000E+00	0.000E+00	0.000E+00
BREAST	1.330E-14	5.325E-12	1.166E-11	2.470E-16-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.130E-14	4.959E-12	1.086E-11	2.300E-16-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.070E-14	4.959E-12	1.086E-11	2.300E-16-1.000E+00	0.000E+00	0.000E+00
BONE SUR	2.570E-14	9.120E-12	1.997E-11	4.230E-16-1.000E+00	0.000E+00	0.000E+00
THYROID	1.180E-14	5.023E-12	1.100E-11	2.330E-16-1.000E+00	0.000E+00	0.000E+00
REMAINDER	1.080E-14	4.829E-12	1.058E-11	2.240E-16-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.190E-14	5.217E-12	1.142E-11	2.420E-16-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	3.120E-14	4.506E-11	9.867E-11	2.090E-15-1.000E+00	0.000E+00	0.000E+00
Kr-83m						
GONADS	1.710E-18	5.572E-15	5.855E-15	6.160E-19-1.000E+00	0.000E+00	0.000E+00
BREAST	5.050E-18	9.498E-15	9.980E-15	1.050E-18-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.640E-19	1.266E-16	1.331E-16	1.400E-20-1.000E+00	0.000E+00	0.000E+00
RED MARR	3.830E-19	5.617E-16	5.902E-16	6.210E-20-1.000E+00	0.000E+00	0.000E+00
BONE SUR	2.250E-18	3.437E-15	3.612E-15	3.800E-19-1.000E+00	0.000E+00	0.000E+00
THYROID	6.430E-19	7.698E-16	8.088E-16	8.510E-20-1.000E+00	0.000E+00	0.000E+00
REMAINDER	5.300E-19	1.393E-15	1.464E-15	1.540E-19-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.500E-18	3.437E-15	3.612E-15	3.800E-19-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	3.560E-17	1.167E-13	1.226E-13	1.290E-17-1.000E+00	0.000E+00	0.000E+00
Kr-85m						
GONADS	7.310E-15	2.594E-12	3.653E-12	1.570E-16-1.000E+00	0.000E+00	0.000E+00
BREAST	8.410E-15	2.527E-12	3.560E-12	1.530E-16-1.000E+00	0.000E+00	0.000E+00
LUNGS	7.040E-15	2.379E-12	3.351E-12	1.440E-16-1.000E+00	0.000E+00	0.000E+00
RED MARR	6.430E-15	2.346E-12	3.304E-12	1.420E-16-1.000E+00	0.000E+00	0.000E+00
BONE SUR	1.880E-14	5.286E-12	7.446E-12	3.200E-16-1.000E+00	0.000E+00	0.000E+00
THYROID	7.330E-15	2.395E-12	3.374E-12	1.450E-16-1.000E+00	0.000E+00	0.000E+00
REMAINDER	6.640E-15	2.313E-12	3.257E-12	1.400E-16-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	7.480E-15	2.511E-12	3.537E-12	1.520E-16-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	2.240E-14	2.247E-11	3.164E-11	1.360E-15-1.000E+00	0.000E+00	0.000E+00
Kr-87						
GONADS	4.000E-14	4.962E-12	5.026E-12	7.610E-16-1.000E+00	0.000E+00	0.000E+00
BREAST	4.500E-14	4.740E-12	4.802E-12	7.270E-16-1.000E+00	0.000E+00	0.000E+00
LUNGS	4.040E-14	4.603E-12	4.663E-12	7.060E-16-1.000E+00	0.000E+00	0.000E+00

RED MARR	4.000E-14	4.708E-12	4.769E-12	7.220E-16	-1.000E+00	0.000E+00	0.000E+00
BONE SUR	6.020E-14	6.514E-12	6.598E-12	9.990E-16	-1.000E+00	0.000E+00	0.000E+00
THYROID	4.130E-14	4.473E-12	4.531E-12	6.860E-16	-1.000E+00	0.000E+00	0.000E+00
REMAINDER	3.910E-14	4.590E-12	4.650E-12	7.040E-16	-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	4.120E-14	4.773E-12	4.835E-12	7.320E-16	-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	1.370E-13	8.802E-11	8.916E-11	1.350E-14	-1.000E+00	0.000E+00	0.000E+00
Kr-88							
GONADS	9.900E-14	2.278E-11	2.655E-11	1.800E-15	-1.000E+00	0.000E+00	0.000E+00
BREAST	1.110E-13	2.177E-11	2.537E-11	1.720E-15	-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.010E-13	2.139E-11	2.493E-11	1.690E-15	-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.000E-13	2.190E-11	2.552E-11	1.730E-15	-1.000E+00	0.000E+00	0.000E+00
BONE SUR	1.390E-13	2.886E-11	3.363E-11	2.280E-15	-1.000E+00	0.000E+00	0.000E+00
THYROID	1.030E-13	2.012E-11	2.345E-11	1.590E-15	-1.000E+00	0.000E+00	0.000E+00
REMAINDER	9.790E-14	2.139E-11	2.493E-11	1.690E-15	-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.020E-13	2.202E-11	2.567E-11	1.740E-15	-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	1.350E-13	5.607E-11	6.534E-11	4.430E-15	-1.000E+00	0.000E+00	0.000E+00
Kr-85							
GONADS	1.170E-16	8.121E-14	1.704E-12	2.820E-18	-1.000E+00	0.000E+00	0.000E+00
BREAST	1.340E-16	7.891E-14	1.656E-12	2.740E-18	-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.140E-16	7.056E-14	1.481E-12	2.450E-18	-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.090E-16	6.998E-14	1.469E-12	2.430E-18	-1.000E+00	0.000E+00	0.000E+00
BONE SUR	2.200E-16	1.287E-13	2.702E-12	4.470E-18	-1.000E+00	0.000E+00	0.000E+00
THYROID	1.180E-16	7.459E-14	1.565E-12	2.590E-18	-1.000E+00	0.000E+00	0.000E+00
REMAINDER	1.090E-16	6.941E-14	1.457E-12	2.410E-18	-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.190E-16	7.603E-14	1.596E-12	2.640E-18	-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	1.320E-14	2.304E-11	4.835E-10	8.000E-16	-1.000E+00	0.000E+00	0.000E+00

Attachment 3 RADTRAD Control Files - Inventory Files

PPL-EHA-_460_rods_AST.nif

```
Nuclide Inventory Name:
 Pool Activity Released 460.8 Fuel rods; 1.6 PF; AST Gap Release; Pool DF 138
 Power Level:EC-FUEL-1615 R1 39 GWD/MTU
  0.1000E+01
 Nuclides:
  15
 Nuclide 001:
 I-131
   2
  0.6946560000E+06
  0.1310E+03
  0.6370E+03
 Xe-131m  0.1100E-01
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 002:
 I-132
   2
  0.8280000000E+04
  0.1320E+03
  0.5100E+03
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 003:
 I-133
   2
  0.7488000000E+05
  0.1330E+03
  0.4060E+03
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 004:
 I-134
   2
  0.3156000000E+04
  0.1340E+03
  0.2270E-04
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 005:
 I-135
   2
  0.2379600000E+05
  0.1350E+03
  0.6690E+02
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 006:
 Xe-131m
   1
  0.1028160000E+07
  0.1310E+03
  0.7970E+03
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 007:
 Xe-133m
   1
  0.1890432000E+06
  0.1330E+03
  0.3440E+04
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 008:
 Xe-133
   1
  0.4531680000E+06
  0.1330E+03
  0.1130E+06
 none      0.0000E+00
 none      0.0000E+00
```

```
none      0.0000E+00
Nuclide 009:
Xe-135m
  1
 0.9174000000E+03
 0.1350E+03
 0.1510E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 010:
Xe-135
  1
 0.3272400000E+05
 0.1350E+03
 0.3090E+05
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 011:
Kr-83m
  1
 0.6588000000E+04
 0.8300E+02
 0.2900E+02
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 012:
Kr-85m
  1
 0.1612800000E+05
 0.8500E+02
 0.3640E+03
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 013:
Kr-87
  1
 0.4578000000E+04
 0.8700E+02
 0.6210E-01
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 014:
Kr-88
  1
 0.1022400000E+05
 0.8800E+02
 0.1170E+03
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 015:
Kr-85
  1
 0.3382974720E+09
 0.8500E+02
 0.1630E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
End of Nuclear Inventory File
```

Attachment 4 RADTRAD Output EHA--6391_500 cfm_460_rods_39 GWD_MTU.o0

```
##########################################################################
   RADTRAD Version 3.03 (Spring 2001) run on  8/09/2005  at 10:19:44
##########################################################################

##########################################################################
                      File information
##########################################################################

 Plant file           = C:\Program Files\radtrad3.03\EHA_EC_RADN_1126 Input\EHA--6391_500
cfm_460_rods_39 GWD_MTU.psf
 Inventory file       = c:\program files\radtrad3.03\eha_ec_radn_1126 input\ppl-eha-_460_rods_39
gwd_mtu_ast.nif
 Release file         = c:\program files\radtrad3.03\eha_ec_radn_1126 input\ppl-eha.rft
 Dose Conversion file = c:\program files\radtrad3.03\eha_ec_radn_1126 input\ppl-eha.inp


    #####    ####   #####    #  #     #  #####   #    #  #####
    #    #  #       #        #  ##    #  #       #    #    #
    #    #  #       #        #  # #   #  #       #    #    #
    #####    ####   ####     #  #  #  #  #####   #    #    #
    #            #  #        #  #   # #  #       #    #    #
    #            #  #        #  #    ##  #       #    #    #
    #       ####   #        #  #     #  #        ####     #

 Radtrad 3.03 4/15/2001
 SSES EHA
 Nuclide Inventory File:
 c:\program files\radtrad3.03\eha_ec_radn_1126 input\ppl-eha-_460_rods_39 gwd_mtu_ast.nif
 Plant Power Level:
  1.0000E+00
 Compartments:
   3
 Compartment 1:
 SSES RB
   3
  1.0000E+02
   0
   0
   0
   0
   0
 Compartment 2:
 Environment
   2
  0.0000E+00
   0
   0
   0
   0
   0
 Compartment 3:
 Control Bldg
   1
  5.1800E+05
   0
   0
   0
   0
   0
 Pathways:
   5
 Pathway 1:
 SSES RB to Environment - 120 Minute RB Release
   1
   2
   2
 Pathway 2:
 Environment to Control Bldg
   2
   3
   2
 Pathway 3:
```

```
Environment to Control Bldg - Unfiltered Intake
  2
  3
  2
Pathway 4:
Control Bldg to  Environment - Control Room Exhaust
  3
  2
  2
Pathway 5:
Environment to  Control Bldg 10 cfm ingress/egress
  2
  3
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0037E+00
c:\program files\radtrad3.03\eha_ec_radn_1126 input\ppl-eha.inp
c:\program files\radtrad3.03\eha_ec_radn_1126 input\ppl-eha.rft
  0.0000E+00
  1
  0.0000E+00   7.9000E-01   2.1000E-01   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  3
Compartment 1:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 2:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 3:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Pathways:
  5
Pathway 1:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   1.0000E+06   9.9000E+01   9.9000E+01   9.9000E+01
```

```
 7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 0
 0
 0
 0
 0
 0
Pathway 2:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   6.3910E+03   9.9000E+01   9.9000E+01   9.9000E+01
 1.0000E+00   6.3910E+03   9.9000E+01   9.9000E+01   9.9000E+01
 7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 0
 0
 0
 0
 0
 0
Pathway 3:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   5.0000E+02   0.0000E+00   0.0000E+00   0.0000E+00
 7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 0
 0
 0
 0
 0
 0
Pathway 4:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   6.9010E+03   0.0000E+00   0.0000E+00   0.0000E+00
 7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 0
 0
 0
 0
 0
 0
Pathway 5:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   1.0000E+01   0.0000E+00   0.0000E+00   0.0000E+00
 7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 0
 0
 0
 0
 0
 0
Dose Locations:
 3
Location 1:
EHA @ EAB - RB Release
 2
```

```
  1
  2
  0.0000E+00    8.3000E-04
  7.2000E+02    0.0000E+00
  1
  4
  0.0000E+00    3.5000E-04
  8.0000E+00    1.8000E-04
  2.4000E+01    2.3000E-04
  7.2000E+02    0.0000E+00
  0
Location 2:
EHA @ LPZ - RB Release
  2
  1
  5
  0.0000E+00    4.9000E-05
  8.0000E+00    3.5000E-05
  2.4000E+01    1.7000E-05
  9.6000E+01    6.1000E-06
  7.2000E+02    0.0000E+00
  1
  4
  0.0000E+00    3.5000E-04
  8.0000E+00    1.8000E-04
  2.4000E+01    2.3000E-04
  7.2000E+02    0.0000E+00
  0
Location 3:
EHA @ CR
  3
  0
  1
  2
  0.0000E+00    3.5000E-04
  7.2000E+02    0.0000E+00
  1
  4
  0.0000E+00    1.0000E+00
  2.4000E+01    6.0000E-01
  9.6000E+01    4.0000E-01
  7.2000E+02    0.0000E+00
Effective Volume Location:
  1
  6
  0.0000E+00    1.4500E-03
  2.0000E+00    1.1200E-03
  8.0000E+00    3.5500E-04
  2.4000E+01    2.2900E-04
  9.6000E+01    2.0100E-04
  7.2000E+02    0.0000E+00
Simulation Parameters:
  1
  0.0000E+00    0.0000E+00
Output Filename:
C:\Program Files\radtrad3.o0
  1
  1
  1
  0
  1
End of Scenario File
```

```
##########################################################################
  RADTRAD Version 3.03 (Spring 2001) run on  8/09/2005  at 10:19:44
##########################################################################

##########################################################################
                    Plant Description
##########################################################################

Number of Nuclides =  15

Inventory Power =   1.0000E+00 MWth
Plant Power Level =   1.0000E+00 MWth

Number of compartments    =   3

Compartment information

Compartment number  1  (Source term fraction =   1.0037E+00
)
Name: SSES RB
Compartment volume =   1.0000E+02 (Cubic feet)
Compartment type is Normal
Pathways into and out of compartment  1
   Exit Pathway Number    1: SSES RB to Environment - 120 Minute RB Release

Compartment number  2
Name: Environment
Compartment type is Environment
Pathways into and out of compartment  2
   Inlet Pathway Number   1: SSES RB to Environment - 120 Minute RB Release
   Inlet Pathway Number   4: Control Bldg to  Environment - Control Room Exhaus
   Exit Pathway Number    2: Environment to Control Bldg
   Exit Pathway Number    3: Environment to Control Bldg - Unfiltered Intake
   Exit Pathway Number    5: Environment to  Control Bldg 10 cfm ingress/egress

Compartment number  3
Name: Control Bldg
Compartment volume =   5.1800E+05 (Cubic feet)
Compartment type is Control Room
Pathways into and out of compartment  3
   Inlet Pathway Number   2: Environment to Control Bldg
   Inlet Pathway Number   3: Environment to Control Bldg - Unfiltered Intake
   Inlet Pathway Number   5: Environment to  Control Bldg 10 cfm ingress/egress
   Exit Pathway Number    4: Control Bldg to  Environment - Control Room Exhaus

Total number of pathways =   5
```

```
##################################################################
  RADTRAD Version 3.03 (Spring 2001) run on  8/09/2005  at 10:19:44
##################################################################

##################################################################
                    Scenario Description
##################################################################

Radioactive Decay is enabled
Calculation of Daughters is enabled

Release Fractions and Timings
                GAP          EARLY IN-VESSEL   LATE RELEASE     RELEASE MASS
              2.000000 hr      0.0000 hrs       0.0000 hrs         (gm)
NOBLES        1.0000E+00       0.0000E+00       0.0000E+00       4.788E+00
IODINE        1.0000E+00       0.0000E+00       0.0000E+00       5.565E-03
CESIUM        0.0000E+00       0.0000E+00       0.0000E+00       0.000E+00
TELLURIUM     0.0000E+00       0.0000E+00       0.0000E+00       0.000E+00
STRONTIUM     0.0000E+00       0.0000E+00       0.0000E+00       0.000E+00
BARIUM        0.0000E+00       0.0000E+00       0.0000E+00       0.000E+00
RUTHENIUM     0.0000E+00       0.0000E+00       0.0000E+00       0.000E+00
CERIUM        0.0000E+00       0.0000E+00       0.0000E+00       0.000E+00
LANTHANUM     0.0000E+00       0.0000E+00       0.0000E+00       0.000E+00

Inventory Power =          1. MWt

Nuclide  Group  Specific     half      Whole Body   Inhaled     Inhaled
 Name           Inventory    life        DCF       Thyroid     Effective
                (Ci/MWt)     (s)     (Sv-m3/Bq-s)  (Sv/Bq)     (Sv/Bq)
 I-131     2   6.370E+02  6.947E+05   1.820E-14  2.920E-07   8.890E-09
 I-132     2   5.100E+02  8.280E+03   1.120E-13  1.740E-09   1.030E-10
 I-133     2   4.060E+02  7.488E+04   2.940E-14  4.860E-08   1.580E-09
 I-134     2   2.270E-05  3.156E+03   1.300E-13  2.880E-10   3.550E-11
 I-135     2   6.690E+01  2.380E+04   8.294E-14  8.460E-09   3.320E-10
 Xe-131m   1   7.970E+02  1.028E+06   3.890E-16  0.000E+00   0.000E+00
 Xe-133m   1   3.440E+03  1.890E+05   1.370E-15  0.000E+00   0.000E+00
 Xe-133    1   1.130E+05  4.532E+05   1.560E-15  0.000E+00   0.000E+00
 Xe-135m   1   1.510E+03  9.174E+02   2.040E-14  0.000E+00   0.000E+00
 Xe-135    1   3.090E+04  3.272E+04   1.190E-14  0.000E+00   0.000E+00
 Kr-83m    1   2.900E+01  6.588E+03   1.500E-18  0.000E+00   0.000E+00
 Kr-85m    1   3.640E+02  1.613E+04   7.480E-15  0.000E+00   0.000E+00
 Kr-87     1   6.210E-02  4.578E+03   4.120E-14  0.000E+00   0.000E+00
 Kr-88     1   1.170E+02  1.022E+04   1.020E-13  0.000E+00   0.000E+00
 Kr-85     1   1.630E+03  3.383E+08   1.190E-16  0.000E+00   0.000E+00

Nuclide    Daughter  Fraction   Daughter  Fraction   Daughter  Fraction
 I-131     Xe-131m    0.01        none      0.00       none      0.00

Iodine fractions
     Aerosol      =  0.0000E+00
     Elemental    =  7.9000E-01
     Organic      =  2.1000E-01

COMPARTMENT DATA

Compartment number   1: SSES RB

Compartment number   2: Environment

Compartment number   3: Control Bldg

PATHWAY DATA

Pathway number  1: SSES RB to Environment - 120 Minute RB Release

     Pathway Filter: Removal Data

       Time (hr)       Flow Rate          Filter Efficiencies (%)
                        (cfm)        Aerosol      Elemental     Organic
     0.0000E+00     1.0000E+06   9.9000E+01   9.9000E+01   9.9000E+01
     7.2000E+02     0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00

Pathway number  2: Environment to Control Bldg

     Pathway Filter: Removal Data
```

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	6.3910E+03	9.9000E+01	9.9000E+01	9.9000E+01
1.0000E+00	6.3910E+03	9.9000E+01	9.9000E+01	9.9000E+01
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Pathway number 3: Environment to Control Bldg - Unfiltered Intake

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	5.0000E+02	0.0000E+00	0.0000E+00	0.0000E+00
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Pathway number 4: Control Bldg to Environment - Control Room Exhaus

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	6.9010E+03	0.0000E+00	0.0000E+00	0.0000E+00
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Pathway number 5: Environment to Control Bldg 10 cfm ingress/egress

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	1.0000E+01	0.0000E+00	0.0000E+00	0.0000E+00
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

LOCATION DATA

Location EHA @ EAB - RB Release is in compartment 2

Location X/Q Data

Time (hr)	X/Q (s * m^-3)
0.0000E+00	8.3000E-04
7.2000E+02	0.0000E+00

Location Breathing Rate Data

Time (hr)	Breathing Rate (m^3 * sec^-1)
0.0000E+00	3.5000E-04
8.0000E+00	1.8000E-04
2.4000E+01	2.3000E-04
7.2000E+02	0.0000E+00

Location EHA @ LPZ - RB Release is in compartment 2

Location X/Q Data

Time (hr)	X/Q (s * m^-3)
0.0000E+00	4.9000E-05
8.0000E+00	3.5000E-05
2.4000E+01	1.7000E-05
9.6000E+01	6.1000E-06
7.2000E+02	0.0000E+00

Location Breathing Rate Data

Time (hr)	Breathing Rate (m^3 * sec^-1)
0.0000E+00	3.5000E-04
8.0000E+00	1.8000E-04
2.4000E+01	2.3000E-04
7.2000E+02	0.0000E+00

Location EHA @ CR is in compartment 3

Location X/Q Data

Time (hr)	X/Q (s * m^-3)
0.0000E+00	1.4500E-03
2.0000E+00	1.1200E-03
8.0000E+00	3.5500E-04
2.4000E+01	2.2900E-04
9.6000E+01	2.0100E-04
7.2000E+02	0.0000E+00

Location Breathing Rate Data

Time (hr)	Breathing Rate (m^3 * sec^-1)
0.0000E+00	3.5000E-04

7.2000E+02	0.0000E+00

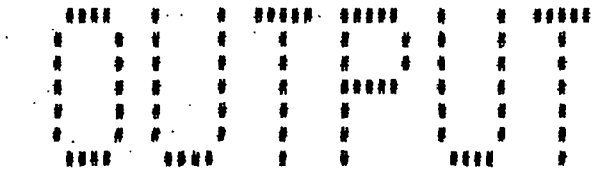
Location Occupancy Factor Data

Time (hr)	Occupancy Factor
0.0000E+00	1.0000E+00
2.4000E+01	6.0000E-01
9.6000E+01	4.0000E-01
7.2000E+02	0.0000E+00

USER SPECIFIED TIME STEP DATA - SUPPLEMENTAL TIME STEPS

Time	Time step
0.0000E+00	0.0000E+00

```
##########################################################################
  RADTRAD Version 3.03 (Spring 2001) run on  8/09/2005  at 10:19:44
##########################################################################
```



```
##########################################################################
                              Dose Output
##########################################################################

Detailed model information at time (H) =    1.0000

EHA @ EAB - RB Release Doses:

Time (h) =   1.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        8.6699E-01  1.1137E+00  9.0126E-01
Accumulated dose (rem)  8.6699E-01  1.1137E+00  9.0126E-01

EHA @ LPZ - RB Release Doses:

Time (h) =   1.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        5.1184E-02  6.5747E-02  5.3207E-02
Accumulated dose (rem)  5.1184E-02  6.5747E-02  5.3207E-02

EHA @ CR Doses:

Time (h) =   1.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        3.3717E-02  5.0279E-02  3.5264E-02
Accumulated dose (rem)  3.3717E-02  5.0279E-02  3.5264E-02

Detailed model information at time (H) =    2.0000

EHA @ EAB - RB Release Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        8.0345E-01  1.1053E+00  8.3743E-01
Accumulated dose (rem)  1.6704E+00  2.2189E+00  1.7387E+00

EHA @ LPZ - RB Release Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        4.7433E-02  6.5251E-02  4.9438E-02
Accumulated dose (rem)  9.8616E-02  1.3100E-01  1.0265E-01

EHA @ CR Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        7.0331E-02  1.1082E-01  7.3736E-02
Accumulated dose (rem)  1.0405E-01  1.6110E-01  1.0900E-01

Detailed model information at time (H) =    8.0000

EHA @ EAB - RB Release Doses:

Time (h) =   8.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.2976E-06  1.8347E-06  1.3540E-06
Accumulated dose (rem)  1.6704E+00  2.2189E+00  1.7387E+00

EHA @ LPZ - RB Release Doses:

Time (h) =   8.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        7.6607E-08  1.0831E-07  7.9934E-08
Accumulated dose (rem)  9.8617E-02  1.3100E-01  1.0265E-01

EHA @ CR Doses:
```

```
Time (h) =   8.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        9.2391E-02  1.5714E-01  9.7214E-02
Accumulated dose (rem)  1.9644E-01  3.1824E-01  2.0621E-01

Detailed model information at time (H) =   24.0000

EHA @ EAB - RB Release Doses:

Time (h) =  24.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)  1.6704E+00  2.2189E+00  1.7387E+00

EHA @ LPZ - RB Release Doses:

Time (h) =  24.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)  9.8617E-02  1.3100E-01  1.0265E-01

EHA @ CR Doses:

Time (h) =  24.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        5.7851E-04  1.2607E-03  6.1711E-04
Accumulated dose (rem)  1.9702E-01  3.1950E-01  2.0683E-01

Detailed model information at time (H) =   96.0000

EHA @ EAB - RB Release Doses:

Time (h) =  96.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)  1.6704E+00  2.2189E+00  1.7387E+00

EHA @ LPZ - RB Release Doses:

Time (h) =  96.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)  9.8617E-02  1.3100E-01  1.0265E-01

EHA @ CR Doses:

Time (h) =  96.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        6.0782E-10  2.0365E-09  6.7003E-10
Accumulated dose (rem)  1.9702E-01  3.1950E-01  2.0683E-01

Detailed model information at time (H) =  720.0000

EHA @ EAB - RB Release Doses:

Time (h) = 720.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)  1.6704E+00  2.2189E+00  1.7387E+00

EHA @ LPZ - RB Release Doses:

Time (h) = 720.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        0.0000E+00  0.0000E+00  0.0000E+00
Accumulated dose (rem)  9.8617E-02  1.3100E-01  1.0265E-01

EHA @ CR Doses:

Time (h) = 720.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.0259E-35  1.0153E-34  2.3351E-35
Accumulated dose (rem)  1.9702E-01  3.1950E-01  2.0683E-01

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##########################################################################
                          I-131 Summary
##########################################################################

                  SSES RB              Environment          Control Bldg
Time (hr)     I-131 (Curies)       I-131 (Curies)       I-131 (Curies)
   0.000       5.3280E-04           1.7707E-03           6.9526E-07
   0.401       5.3203E-04           1.2811E+00           4.3022E-04
   0.701       5.3146E-04           2.2381E+00           6.7218E-04
   1.000       5.3089E-04           3.1905E+00           8.6136E-04
```

1.300	5.3032E-04	4.1454E+00	1.0103E-03
1.600	5.2974E-04	5.0993E+00	1.1270E-03
1.900	5.2917E-04	6.0521E+00	1.2184E-03
2.000	5.2898E-04	6.3695E+00	1.2442E-03
2.300	0.0000E+00	6.3695E+00	9.7784E-04
2.600	0.0000E+00	6.3695E+00	7.6852E-04
2.900	0.0000E+00	6.3695E+00	6.0401E-04
3.200	0.0000E+00	6.3695E+00	4.7471E-04
3.500	0.0000E+00	6.3695E+00	3.7309E-04
3.800	0.0000E+00	6.3695E+00	2.9323E-04
4.100	0.0000E+00	6.3695E+00	2.3046E-04
4.400	0.0000E+00	6.3695E+00	1.8112E-04
4.700	0.0000E+00	6.3695E+00	1.4235E-04
5.000	0.0000E+00	6.3695E+00	1.1188E-04
5.300	0.0000E+00	6.3695E+00	8.7930E-05
5.600	0.0000E+00	6.3695E+00	6.9107E-05
5.900	0.0000E+00	6.3695E+00	5.4314E-05
6.200	0.0000E+00	6.3695E+00	4.2687E-05
6.500	0.0000E+00	6.3695E+00	3.3549E-05
6.800	0.0000E+00	6.3695E+00	2.6368E-05
7.100	0.0000E+00	6.3695E+00	2.0723E-05
7.400	0.0000E+00	6.3695E+00	1.6287E-05
7.700	0.0000E+00	6.3695E+00	1.2801E-05
8.000	0.0000E+00	6.3695E+00	1.0060E-05
8.300	0.0000E+00	6.3695E+00	7.9069E-06
8.600	0.0000E+00	6.3695E+00	6.2143E-06
8.900	0.0000E+00	6.3695E+00	4.8840E-06
9.200	0.0000E+00	6.3695E+00	3.8385E-06
9.500	0.0000E+00	6.3695E+00	3.0168E-06
9.800	0.0000E+00	6.3695E+00	2.3710E-06
10.100	0.0000E+00	6.3695E+00	1.8635E-06
10.400	0.0000E+00	6.3695E+00	1.4646E-06
24.000	0.0000E+00	6.3695E+00	2.6500E-11
96.000	0.0000E+00	6.3695E+00	2.0705E-36
720.000	0.0000E+00	6.3695E+00	5.2562-254

Cumulative Dose Summary

	EHA @ EAB - RB Releas		EHA @ LPZ - RB Releas		EHA @ CR	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.401	4.4775E-01	3.7312E-01	2.6433E-02	2.2027E-02	9.3639E-03	6.8008E-03
0.701	7.8171E-01	6.4085E-01	4.6149E-02	3.7834E-02	2.6559E-02	1.8909E-02
1.000	1.1137E+00	9.0126E-01	6.5747E-02	5.3207E-02	5.0279E-02	3.5264E-02
1.300	1.4461E+00	1.1575E+00	8.5373E-02	6.8337E-02	7.9258E-02	5.4905E-02
1.600	1.7778E+00	1.4093E+00	1.0496E-01	8.3202E-02	1.1228E-01	7.6950E-02
1.900	2.1088E+00	1.6570E+00	1.2449E-01	9.7824E-02	1.4846E-01	1.0076E-01
2.000	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	1.6110E-01	1.0900E-01
2.300	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	1.9513E-01	1.3100E-01
2.600	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	2.2184E-01	1.4804E-01
2.900	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	2.4282E-01	1.6125E-01
3.200	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	2.5929E-01	1.7148E-01
3.500	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	2.7222E-01	1.7941E-01
3.800	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	2.8237E-01	1.8556E-01
4.100	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	2.9035E-01	1.9033E-01
4.400	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	2.9661E-01	1.9403E-01
4.700	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.0152E-01	1.9689E-01
5.000	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.0538E-01	1.9912E-01
5.300	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.0841E-01	2.0084E-01
5.600	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1079E-01	2.0218E-01
5.900	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1266E-01	2.0322E-01
6.200	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1413E-01	2.0403E-01
6.500	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1528E-01	2.0465E-01
6.800	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1618E-01	2.0514E-01
7.100	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1690E-01	2.0552E-01
7.400	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1745E-01	2.0581E-01
7.700	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1789E-01	2.0604E-01
8.000	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1824E-01	2.0621E-01
8.300	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1851E-01	2.0635E-01
8.600	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1872E-01	2.0646E-01
8.900	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1889E-01	2.0654E-01
9.200	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1902E-01	2.0661E-01
9.500	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1912E-01	2.0666E-01
9.800	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1920E-01	2.0669E-01

10.100	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1926E-01	2.0672E-01
10.400	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1931E-01	2.0675E-01
24.000	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1950E-01	2.0683E-01
96.000	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1950E-01	2.0683E-01
720.000	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1950E-01	2.0683E-01

##

Worst Two-Hour Doses

##

EHA & EAB - RB Release

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	1.6704E+00	2.2189E+00	1.7387E+00

Attachment 5 RADTRAD Output EHA--5229_500 cfm_460_rods_39_GWD_MTU.o0

```
##################################################################
   RADTRAD Version 3.03 (Spring 2001) run on  8/09/2005  at 12:20:57
##################################################################

##################################################################
                    File information
##################################################################

 Plant file           = C:\Program Files\radtrad3.03\EHA_EC_RADN_1126 Input\EHA--5229_500
cfm_460_rods_39_GWD_MTU.psf
 Inventory file       = c:\program files\radtrad3.03\eha_ec_radn_1126 input\ppl-eha-_460_rods_39
gwd_mtu_ast.nif
 Release file         = c:\program files\radtrad3.03\eha_ec_radn_1126 input\ppl-eha.rft
 Dose Conversion file = c:\program files\radtrad3.03\eha_ec_radn_1126 input\ppl-eha.inp



    #####    ####   #####    #  #     #  #####  #    #  #####
    #    #  #       #        #  ##    #  #    #  #    #    #
    #    #  #       #        #  # #   #  #    #  #    #    #
    #####    ####   ####     #  #  #  #  #####   #    #    #
    #            #  #        #  #   # #  #       #    #    #
    #            #  #        #  #    ##  #       #    #    #
    #       ####   #        #  #     #  #        ####     #

Radtrad 3.03 4/15/2001
SSES EHA
Nuclide Inventory File:
c:\program files\radtrad3.03\eha_ec_radn_1126 input\ppl-eha-_460_rods_39 gwd_mtu_ast.nif
Plant Power Level:
 1.0000E+00
Compartments:
  3
Compartment 1:
SSES RB
  3
 1.0000E+02
  0
  0
  0
  0
  0
Compartment 2:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Compartment 3:
Control Bldg
  1
 5.1800E+05
  0
  0
  0
  0
  0
Pathways:
  5
Pathway 1:
SSES RB to Environment - 120 Minute RB Release
  1
  2
  2
Pathway 2:
Environment to Control Bldg
  2
  3
  2
```

```
Pathway 3:
Environment to Control Bldg - Unfiltered Intake
  2
  3
  2
Pathway 4:
Control Bldg to  Environment - Control Room Exhaust
  3
  2
  2
Pathway 5:
Environment to  Control Bldg 10 cfm ingress/egress
  2
  3
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0037E+00
c:\program files\radtrad3.03\eha_ec_radn_1126 input\ppl-eha.inp
c:\program files\radtrad3.03\eha_ec_radn_1126 input\ppl-eha.rft
  0.0000E+00
  1
  0.0000E+00   7.9000E-01   2.1000E-01   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  3
Compartment 1:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 2:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 3:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Pathways:
  5
Pathway 1:
  0
  0
  0
  0
  0
  1
  2
```

```
  0.0000E+00   1.0000E+06   9.9000E+01   9.9000E+01   9.9000E+01
  7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Pathway 2:
  0
  0
  0
  0
  0
  1
  3
  0.0000E+00   5.2290E+03   9.9000E+01   9.9000E+01   9.9000E+01
  1.0000E+00   5.2290E+03   9.9000E+01   9.9000E+01   9.9000E+01
  7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Pathway 3:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   5.0000E+02   0.0000E+00   0.0000E+00   0.0000E+00
  7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Pathway 4:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   5.7390E+03   0.0000E+00   0.0000E+00   0.0000E+00
  7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Pathway 5:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   1.0000E+01   0.0000E+00   0.0000E+00   0.0000E+00
  7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Dose Locations:
  3
Location 1:
EHA @ EAB - RB Release
```

```
  2
  1
  2
  0.0000E+00    8.3000E-04
  7.2000E+02    0.0000E+00
  1
  4
  0.0000E+00    3.5000E-04
  8.0000E+00    1.8000E-04
  2.4000E+01    2.3000E-04
  7.2000E+02    0.0000E+00
  0
Location 2:
EHA @ LPZ - RB Release
  2
  1
  5
  0.0000E+00    4.9000E-05
  8.0000E+00    3.5000E-05
  2.4000E+01    1.7000E-05
  9.6000E+01    6.1000E-06
  7.2000E+02    0.0000E+00
  1
  4
  0.0000E+00    3.5000E-04
  8.0000E+00    1.8000E-04
  2.4000E+01    2.3000E-04
  7.2000E+02    0.0000E+00
  0
Location 3:
EHA @ CR
  3
  0
  1
  2
  0.0000E+00    3.5000E-04
  7.2000E+02    0.0000E+00
  1
  4
  0.0000E+00    1.0000E+00
  2.4000E+01    6.0000E-01
  9.6000E+01    4.0000E-01
  7.2000E+02    0.0000E+00
Effective Volume Location:
  1
  6
  0.0000E+00    1.4500E-03
  2.0000E+00    1.1200E-03
  8.0000E+00    3.5500E-04
  2.4000E+01    2.2900E-04
  9.6000E+01    2.0100E-04
  7.2000E+02    0.0000E+00
Simulation Parameters:
  1
  0.0000E+00    0.0000E+00
Output Filename:
C:\Program Files\radtrad3.o0
  1
  1
  1
  0
  1
End of Scenario File
```

```
##########################################################################
   RADTRAD Version 3.03 (Spring 2001) run on  8/09/2005  at 12:20:57
##########################################################################

##########################################################################
                     Plant Description
##########################################################################

Number of Nuclides =  15

Inventory Power =   1.0000E+00 MWth
Plant Power Level =   1.0000E+00 MWth

Number of compartments    =   3

Compartment information

Compartment number  1  (Source term fraction =   1.0037E+00
)
Name: SSES RB
Compartment volume =   1.0000E+02 (Cubic feet)
Compartment type is Normal
Pathways into and out of compartment  1
   Exit Pathway Number    1: SSES RB to Environment - 120 Minute RB Release

Compartment number  2
Name: Environment
Compartment type is Environment
Pathways into and out of compartment  2
   Inlet Pathway Number   1: SSES RB to Environment - 120 Minute RB Release
   Inlet Pathway Number   4: Control Bldg to  Environment - Control Room Exhaus
   Exit Pathway Number    2: Environment to Control Bldg
   Exit Pathway Number    3: Environment to Control Bldg - Unfiltered Intake
   Exit Pathway Number    5: Environment to  Control Bldg 10 cfm ingress/egress

Compartment number  3
Name: Control Bldg
Compartment volume =   5.1800E+05 (Cubic feet)
Compartment type is Control Room
Pathways into and out of compartment  3
   Inlet Pathway Number   2: Environment to Control Bldg
   Inlet Pathway Number   3: Environment to Control Bldg - Unfiltered Intake
   Inlet Pathway Number   5: Environment to  Control Bldg 10 cfm ingress/egress
   Exit Pathway Number    4: Control Bldg to  Environment - Control Room Exhaus

Total number of pathways =   5
```

```
##################################################################
  RADTRAD Version 3.03 (Spring 2001) run on  8/09/2005  at 12:20:57
##################################################################

##################################################################
                    Scenario Description
##################################################################

Radioactive Decay is enabled
Calculation of Daughters is enabled

Release Fractions and Timings
                 GAP          EARLY IN-VESSEL   LATE RELEASE     RELEASE MASS
              2.000000 hr       0.0000 hrs       0.0000 hrs          (gm)
NOBLES        1.0000E+00        0.0000E+00       0.0000E+00        4.788E+00
IODINE        1.0000E+00        0.0000E+00       0.0000E+00        5.565E-03
CESIUM        0.0000E+00        0.0000E+00       0.0000E+00        0.000E+00
TELLURIUM     0.0000E+00        0.0000E+00       0.0000E+00        0.000E+00
STRONTIUM     0.0000E+00        0.0000E+00       0.0000E+00        0.000E+00
BARIUM        0.0000E+00        0.0000E+00       0.0000E+00        0.000E+00
RUTHENIUM     0.0000E+00        0.0000E+00       0.0000E+00        0.000E+00
CERIUM        0.0000E+00        0.0000E+00       0.0000E+00        0.000E+00
LANTHANUM     0.0000E+00        0.0000E+00       0.0000E+00        0.000E+00

Inventory Power =          1. MWt

Nuclide  Group  Specific     half      Whole Body   Inhaled     Inhaled
 Name           Inventory    life      DCF          Thyroid     Effective
                (Ci/MWt)     (s)       (Sv-m3/Bq-s) (Sv/Bq)     (Sv/Bq)
 I-131     2   6.370E+02  6.947E+05   1.820E-14  2.920E-07   8.890E-09
 I-132     2   5.100E+02  8.280E+03   1.120E-13  1.740E-09   1.030E-10
 I-133     2   4.060E+02  7.488E+04   2.940E-14  4.860E-08   1.580E-09
 I-134     2   2.270E-05  3.156E+03   1.300E-13  2.880E-10   3.550E-11
 I-135     2   6.690E+01  2.380E+04   8.294E-14  8.460E-09   3.320E-10
 Xe-131m   1   7.970E+02  1.028E+06   3.890E-16  0.000E+00   0.000E+00
 Xe-133m   1   3.440E+03  1.890E+05   1.370E-15  0.000E+00   0.000E+00
 Xe-133    1   1.130E+05  4.532E+05   1.560E-15  0.000E+00   0.000E+00
 Xe-135m   1   1.510E+03  9.174E+02   2.040E-14  0.000E+00   0.000E+00
 Xe-135    1   3.090E+04  3.272E+04   1.190E-14  0.000E+00   0.000E+00
 Kr-83m    1   2.900E+01  6.588E+03   1.500E-18  0.000E+00   0.000E+00
 Kr-85m    1   3.640E+02  1.613E+04   7.480E-15  0.000E+00   0.000E+00
 Kr-87     1   6.210E-02  4.578E+03   4.120E-14  0.000E+00   0.000E+00
 Kr-88     1   1.170E+02  1.022E+04   1.020E-13  0.000E+00   0.000E+00
 Kr-85     1   1.630E+03  3.383E+08   1.190E-16  0.000E+00   0.000E+00

Nuclide   Daughter  Fraction  Daughter  Fraction  Daughter  Fraction
 I-131    Xe-131m    0.01       none      0.00       none      0.00

Iodine fractions
     Aerosol      =   0.0000E+00
     Elemental    =   7.9000E-01
     Organic      =   2.1000E-01

COMPARTMENT DATA

Compartment number   1: SSES RB

Compartment number   2: Environment

Compartment number   3: Control Bldg

PATHWAY DATA

Pathway number  1: SSES RB to Environment - 120 Minute RB Release

     Pathway Filter: Removal Data

       Time (hr)      Flow Rate          Filter Efficiencies (%)
                       (cfm)        Aerosol      Elemental     Organic
     0.0000E+00    1.0000E+06   9.9000E+01   9.9000E+01   9.9000E+01
     7.2000E+02    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00

Pathway number  2: Environment to Control Bldg

     Pathway Filter: Removal Data
```

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	5.2290E+03	9.9000E+01	9.9000E+01	9.9000E+01
1.0000E+00	5.2290E+03	9.9000E+01	9.9000E+01	9.9000E+01
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Pathway number 3: Environment to Control Bldg - Unfiltered Intake

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	5.0000E+02	0.0000E+00	0.0000E+00	0.0000E+00
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Pathway number 4: Control Bldg to Environment - Control Room Exhaus

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	5.7390E+03	0.0000E+00	0.0000E+00	0.0000E+00
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Pathway number 5: Environment to Control Bldg 10 cfm ingress/egress

Pathway Filter: Removal Data

Time (hr)	Flow Rate (cfm)	Filter Efficiencies (%) Aerosol	Elemental	Organic
0.0000E+00	1.0000E+01	0.0000E+00	0.0000E+00	0.0000E+00
7.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

LOCATION DATA

Location EHA @ EAB - RB Release is in compartment 2

Location X/Q Data

Time (hr)	X/Q (s * m^-3)
0.0000E+00	8.3000E-04
7.2000E+02	0.0000E+00

Location Breathing Rate Data

Time (hr)	Breathing Rate (m^3 * sec^-1)
0.0000E+00	3.5000E-04
8.0000E+00	1.8000E-04
2.4000E+01	2.3000E-04
7.2000E+02	0.0000E+00

Location EHA @ LPZ - RB Release is in compartment 2

Location X/Q Data

Time (hr)	X/Q (s * m^-3)
0.0000E+00	4.9000E-05
8.0000E+00	3.5000E-05
2.4000E+01	1.7000E-05
9.6000E+01	6.1000E-06
7.2000E+02	0.0000E+00

Location Breathing Rate Data

Time (hr)	Breathing Rate (m^3 * sec^-1)
0.0000E+00	3.5000E-04
8.0000E+00	1.8000E-04
2.4000E+01	2.3000E-04
7.2000E+02	0.0000E+00

Location EHA @ CR is in compartment 3

Location X/Q Data

Time (hr)	X/Q (s * m^-3)
0.0000E+00	1.4500E-03
2.0000E+00	1.1200E-03
8.0000E+00	3.5500E-04
2.4000E+01	2.2900E-04
9.6000E+01	2.0100E-04
7.2000E+02	0.0000E+00

Location Breathing Rate Data

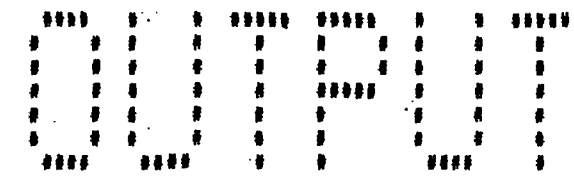
Time (hr)	Breathing Rate (m^3 * sec^-1)
0.0000E+00	3.5000E-04

```
      7.2000E+02                0.0000E+00

    Location Occupancy Factor Data
     Time (hr)          Occupancy Factor
      0.0000E+00             1.0000E+00
      2.4000E+01             6.0000E-01
      9.6000E+01             4.0000E-01
      7.2000E+02             0.0000E+00

USER SPECIFIED TIME STEP DATA - SUPPLEMENTAL TIME STEPS
    Time              Time step
     0.0000E+00        0.0000E+00
```

```
##########################################################################
   RADTRAD Version 3.03 (Spring 2001) run on  8/09/2005  at 12:20:57
##########################################################################
```



```
##########################################################################
                                Dose Output
##########################################################################

Detailed model information at time (H) =    1.0000

EHA @ EAB - RB Release Doses:

Time (h) =   1.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        8.6699E-01  1.1137E+00  9.0126E-01
Accumulated dose (rem)  8.6699E-01  1.1137E+00  9.0126E-01

EHA @ LPZ - RB Release Doses:

Time (h) =   1.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        5.1184E-02  6.5747E-02  5.3207E-02
Accumulated dose (rem)  5.1184E-02  6.5747E-02  5.3207E-02

EHA @ CR Doses:

Time (h) =   1.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        2.9171E-02  5.1263E-02  3.0748E-02
Accumulated dose (rem)  2.9171E-02  5.1263E-02  3.0748E-02

Detailed model information at time (H) =    2.0000

EHA @ EAB - RB Release Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        8.0345E-01  1.1053E+00  8.3743E-01
Accumulated dose (rem)  1.6704E+00  2.2189E+00  1.7387E+00

EHA @ LPZ - RB Release Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        4.7433E-02  6.5251E-02  4.9438E-02
Accumulated dose (rem)  9.8616E-02  1.3100E-01  1.0265E-01

EHA @ CR Doses:

Time (h) =   2.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        6.3577E-02  1.1804E-01  6.7205E-02
Accumulated dose (rem)  9.2748E-02  1.6930E-01  9.7953E-02

Detailed model information at time (H) =    8.0000

EHA @ EAB - RB Release Doses:

Time (h) =   8.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        1.2976E-06  1.8347E-06  1.3540E-06
Accumulated dose (rem)  1.6704E+00  2.2189E+00  1.7387E+00

EHA @ LPZ - RB Release Doses:

Time (h) =   8.0000    Whole Body   Thyroid       TEDE
Delta dose (rem)        7.6607E-08  1.0831E-07  7.9934E-08
Accumulated dose (rem)  9.8617E-02  1.3100E-01  1.0265E-01

EHA @ CR Doses:
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Time (h) = 8.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.0039E-01	2.0278E-01	1.0662E-01
Accumulated dose (rem)	1.9314E-01	3.7208E-01	2.0457E-01

Detailed model information at time (H) = 24.0000

EHA @ EAB - RB Release Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	1.6704E+00	2.2189E+00	1.7387E+00

EHA @ LPZ - RB Release Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	9.8617E-02	1.3100E-01	1.0265E-01

EHA @ CR Doses:

Time (h) = 24.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.4243E-03	3.6868E-03	1.5372E-03
Accumulated dose (rem)	1.9457E-01	3.7576E-01	2.0611E-01

Detailed model information at time (H) = 96.0000

EHA @ EAB - RB Release Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	1.6704E+00	2.2189E+00	1.7387E+00

EHA @ LPZ - RB Release Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	9.8617E-02	1.3100E-01	1.0265E-01

EHA @ CR Doses:

Time (h) = 96.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	1.2747E-08	5.0525E-08	1.4291E-08
Accumulated dose (rem)	1.9457E-01	3.7576E-01	2.0611E-01

Detailed model information at time (H) = 720.0000

EHA @ EAB - RB Release Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	1.6704E+00	2.2189E+00	1.7387E+00

EHA @ LPZ - RB Release Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	0.0000E+00	0.0000E+00	0.0000E+00
Accumulated dose (rem)	9.8617E-02	1.3100E-01	1.0265E-01

EHA @ CR Doses:

Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Delta dose (rem)	6.8967E-30	4.0740E-29	8.1376E-30
Accumulated dose (rem)	1.9457E-01	3.7576E-01	2.0611E-01

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I-131 Summary

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Time (hr)	SSES RB I-131 (Curies)	Environment I-131 (Curies)	Control Bldg I-131 (Curies)
0.000	5.3280E-04	1.7707E-03	6.8120E-07
0.401	5.3203E-04	1.2811E+00	4.3247E-04
0.701	5.3146E-04	2.2381E+00	6.8762E-04
1.000	5.3089E-04	3.1905E+00	8.9535E-04

1.300	5.3032E-04	4.1454E+00	1.0657E-03
1.600	5.2974E-04	5.0993E+00	1.2047E-03
1.900	5.2917E-04	6.0521E+00	1.3181E-03
2.000	5.2898E-04	6.3695E+00	1.3511E-03
2.300	0.0000E+00	6.3695E+00	1.1056E-03
2.600	0.0000E+00	6.3695E+00	9.0474E-04
2.900	0.0000E+00	6.3695E+00	7.4036E-04
3.200	0.0000E+00	6.3695E+00	6.0585E-04
3.500	0.0000E+00	6.3695E+00	4.9578E-04
3.800	0.0000E+00	6.3695E+00	4.0571E-04
4.100	0.0000E+00	6.3695E+00	3.3200E-04
4.400	0.0000E+00	6.3695E+00	2.7168E-04
4.700	0.0000E+00	6.3695E+00	2.2232E-04
5.000	0.0000E+00	6.3695E+00	1.8193E-04
5.300	0.0000E+00	6.3695E+00	1.4888E-04
5.600	0.0000E+00	6.3695E+00	1.2183E-04
5.900	0.0000E+00	6.3695E+00	9.9695E-05
6.200	0.0000E+00	6.3695E+00	8.1582E-05
6.500	0.0000E+00	6.3695E+00	6.6760E-05
6.800	0.0000E+00	6.3695E+00	5.4631E-05
7.100	0.0000E+00	6.3695E+00	4.4706E-05
7.400	0.0000E+00	6.3695E+00	3.6584E-05
7.700	0.0000E+00	6.3695E+00	2.9937E-05
8.000	0.0000E+00	6.3695E+00	2.4498E-05
8.300	0.0000E+00	6.3695E+00	2.0047E-05
8.600	0.0000E+00	6.3695E+00	1.6405E-05
8.900	0.0000E+00	6.3695E+00	1.3425E-05
9.200	0.0000E+00	6.3695E+00	1.0986E-05
9.500	0.0000E+00	6.3695E+00	8.9898E-06
9.800	0.0000E+00	6.3695E+00	7.3565E-06
10.100	0.0000E+00	6.3695E+00	6.0200E-06
10.400	0.0000E+00	6.3695E+00	4.9263E-06
24.000	0.0000E+00	6.3695E+00	5.5593E-10
96.000	0.0000E+00	6.3695E+00	7.0231E-31
720.000	0.0000E+00	6.3695E+00	5.3238-212

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Cumulative Dose Summary

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	EHA @ EAB - RB Releas		EHA @ LPZ - RB Releas		EHA @ CR	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.401	4.4775E-01	3.7312E-01	2.6433E-02	2.2027E-02	9.3375E-03	5.7995E-03
0.701	7.8171E-01	6.4085E-01	4.6149E-02	3.7834E-02	2.6790E-02	1.6312E-02
1.000	1.1137E+00	9.0126E-01	6.5747E-02	5.3207E-02	5.1263E-02	3.0748E-02
1.300	1.4461E+00	1.1575E+00	8.5373E-02	6.8337E-02	8.1618E-02	4.8352E-02
1.600	1.7778E+00	1.4093E+00	1.0496E-01	8.3202E-02	1.1669E-01	6.8390E-02
1.900	2.1088E+00	1.6570E+00	1.2449E-01	9.7824E-02	1.5561E-01	9.0309E-02
2.000	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	1.6930E-01	9.7953E-02
2.300	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	2.0698E-01	1.1880E-01
2.600	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	2.3777E-01	1.3562E-01
2.900	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	2.6295E-01	1.4918E-01
3.200	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	2.8353E-01	1.6013E-01
3.500	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.0035E-01	1.6897E-01
3.800	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.1411E-01	1.7611E-01
4.100	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.2535E-01	1.8187E-01
4.400	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.3455E-01	1.8652E-01
4.700	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.4206E-01	1.9028E-01
5.000	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.4821E-01	1.9331E-01
5.300	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.5323E-01	1.9576E-01
5.600	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.5734E-01	1.9774E-01
5.900	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.6070E-01	1.9934E-01
6.200	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.6344E-01	2.0064E-01
6.500	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.6569E-01	2.0168E-01
6.800	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.6752E-01	2.0253E-01
7.100	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.6903E-01	2.0321E-01
7.400	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.7025E-01	2.0376E-01
7.700	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.7126E-01	2.0421E-01
8.000	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.7208E-01	2.0457E-01
8.300	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.7275E-01	2.0486E-01
8.600	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.7330E-01	2.0510E-01
8.900	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.7375E-01	2.0529E-01
9.200	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.7411E-01	2.0545E-01
9.500	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.7441E-01	2.0557E-01
9.800	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.7466E-01	2.0567E-01

10.100	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.7486E-01	2.0576E-01
10.400	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.7502E-01	2.0582E-01
24.000	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.7576E-01	2.0611E-01
96.000	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.7576E-01	2.0611E-01
720.000	2.2189E+00	1.7387E+00	1.3100E-01	1.0265E-01	3.7576E-01	2.0611E-01

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Worst Two-Hour Doses
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EHA @ EAB - RB Release

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	1.6704E+00	2.2189E+00	1.7387E+00