ATTACHMENT 6

NDQ099920010019
Ex-Containment Removal Coefficients
for Alternative Source Term Analyses

Attached is the non-proprietary version of Calculation NDQ099920010019, Ex-Containment Removal Coefficients For Alternate Source Term Analyses

NPG CALCULATION COVERSHEET / CTS UPDATE

REV 0 EDMS/RIMS NO.	CTS TYPE:	EDMS TYPE:	EDMS ACCESSION NO (N/A for REV. 0)
R14020401103	Calculation	Calculations (nuclear)	

Calc Title:
Ex-Containment Removal Coefficients for Alternative Source Term Analyses

	ORG	PLANT	BRANCH	NUMBER	CUR REV	NEW REV
CALC ID	NUC	BFN	NTB	NDQ099920010019	002	003

CTS UPDATE ONLY ☐ (Verifier and Approval Signatures Not Required)

NO CTS CHANGES ☐ (For calc revision, CTS has been reviewed and no CTS changes required)

UNITS (check one)	SYSTEMS	UNIDS
☒ 0 ☐, 1 ☐, 2 ☐, 3 ☐	999	N/A

DCN,EDC,N/A	APPLICABLE DESIGN DOCUMENT(S)	CLASSIFICATION
N/A	N/A	E

QUALITY RELATED?	SAFETY RELATED? (If yes, QR = yes)	UNVERIFIED ASSUMPTION	SPECIAL REQUIREMENTS AND/OR LIMITING CONDITIONS?	DESIGN OUTPUT ATTACHMENT?	SAR/TS and/or ISFSI SAR/CoC AFFECTED
Yes ☒ No ☐	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒

CALCULATION NUMBER REQUESTOR	PREPARING DISCIPLINE	VERIFICATION METHOD	NEW METHOD OF ANALYSIS
Name: PHONE:	N	Design Review	☐ Yes ☒ No

PREPARER (PRINT NAME AND SIGN)	DATE	CHECKER (PRINT NAME AND SIGN)	DATE
Jun Li By Direction	10-17-13	Dave Leaver BY DIRECTION	10-17-13
VERIFIER (PRINT NAME AND SIGN)	DATE	APPROVAL (PRINT NAME AND SIGN)	DATE
Dave Leaver BY DIRECTION	10-17-13		

STATEMENT OF PROBLEM/ABSTRACT

Determine aerosol and elemental iodine removal coefficients in the steam lines and main condenser.

Revision 3 added Appendix E to document updated analyses for aerosol and elemental iodine removal coefficients in the steam lines and main condenser with reduced MSIV leak rates and a reduced condenser flow area fraction.

MICROFICHE/EFICHE Yes ☐ No ☒ FICHE NUMBER(S)

NPG CALCULATION COVERSHEET / CTS UPDATE

CALC ID	ORG	PLANT	BRANCH	NUMBER	REV
	NUC	BFN	NTB	NDQ099920010019	003

BLDG	ROOM	ELEV	COORD/AZIM	FIRM
NA	NA	NA	NA	WorleyParsons

CATEGORIES

KEY NOUNS (A-add, D-delete)

ACTION (A/D)	KEY NOUN	A/D	KEY NOUN

CROSS-REFERENCES (A-add, C-change, D-delete)

ACTION (A/C/D)	XREF CODE	XREF PLANT	XREF TYPE	XREF NUMBER	XREF REV
A	P	BFN	CALCULATION	MDQ0001870126	11

CTS ONLY UPDATES:

Following are required only when making keyword/cross reference CTS updates and page 1 of form NEDP-2-1 is not included:

PREPARER (PRINT NAME AND SIGN)	DATE	CHECKER (PRINT NAME AND SIGN)	DATE
PREPARER PHONE NO.	EDMS ACCESSION NO.		

TVAN CALCULATION RECORD OF REVISION

CALCULATION IDENTIFIER NDQ0-999-2001-0019

Title	Ex-Containment Removal Coefficients for Alternate Source Term Analyses.
Revision No.	**DESCRIPTION OF REVISION**
00	Initial Issue. 41 pages
01	Revised the calculation to reflect changes in Reference 1 (i.e., peak drywell pressure changing from 62.6 psia to 62.9 psia and peak drywell temperature from 294.9 F to 295.2 psia). Note that since the volumetric flowrate out of the drywell through the MSIVs varies approximately with the square-root of the absolute temperature (sonic flow); this change is negligible in terms of activity released from the drywell through the MSIVs (0.02% increase). Removal efficiencies are potentially affected to a somewhat greater degree in the steam line sections beyond the MSIVs because of a volumetric flow rate dependency on pressure. Any efficiency changing by less than on one digit in the third significant figure has been left as is, both as output and as input to the appendices. This eliminates unnecessary impact on subsequent calculations. Pages added: None Pages deleted: None Pages changed: 1 - 6, 9 - 12, 17, 20 – 25 41 pages total This calculation revision is part of the AST radiological dose determination methodology implementation consistent with the guidance and requirements presented in 10 CFR 50.67, "Accident Source Term," and Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Plants." 10 CFR 50.67(b)(1) states in part: "A licensee who seeks to revise its current accident source term in design basis radiological consequence analyses shall apply for a license amendment under 50.90." Therefore, this calculation revision is within the scope of 10 CFR 50.90 and not within the scope nor applicability of 10 CFR 50.59. FSAR Sections 5.3, 14.6, 14.10, 14.11, and the Technical Specifications have been reviewed for changes associated with this revision. This calculation revision reflects parameters, values, and methods associated with the implementation of AST. AST requires the approval of a license amendment by the NRC and will involve revisions to multiple sections of the FSAR and Technical Specifications. Incorporation of AST conditions into the FSAR and Technical Specifications will be accomplished as part of the implementation of the AST license amendment following NRC approval. The other changes associated with this revision do not impact the FSAR or Technical Specifications.
02	Revised the calculation to change Reference 1 from PSAT 04000U.03, "Design Data Base for Application of the Revised DBA Source Term to the TVA Browns Ferry Nuclear Power Plant", Revision 8 to ND-Q0999-980016, "Parameters Used in Dose Analyses, Revision 6 and, thereby, to extend the applicability of the calculation to Unit 1. Also clarified basis for using 122,400 ft^3 condenser volume on page 11. Pages added: None Pages deleted: 1 (page 4, TVA Calculation Verification Form) Pages changed: 1-5, 7, 8, 10, 11, 16, 23, 24 (after renumbering; i.e., all pages after 3 renumbered due to deletion of TVA Calculation Verification Form) 40 pages total This calculation revision is part of the AST radiological dose determination methodology implementation consistent with the guidance and requirements presented in 10 CFR 50.67, "Accident Source Term," and Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Plants." 10 CFR 50.67(b)(1) states in part: "A licensee who seeks to revise its current accident source term in design basis radiological consequence analyses shall apply for a license amendment under 50.90." Therefore, this calculation revision is within the scope of 10 CFR 50.90 and not within the scope nor applicability of 10 CFR 50.59. FSAR Sections 5.3, 14.6, 14.10, 14.11, and the Technical Specifications have been reviewed for changes associated with this revision. This calculation revision reflects parameters, values, and methods associated with the implementation of AST. AST requires the approval of a license amendment by the NRC and will involve revisions to multiple sections of the FSAR and Technical Specifications. Incorporation of AST conditions into the FSAR and Technical Specifications will be accomplished as part of the implementation of the AST license amendment following NRC approval. The other changes associated with this revision do not impact the FSAR or Technical Specifications.

NPG CALCULATION RECORD OF REVISION		
CALCULATION IDENTIFIER	NDQ099920010019	Page 3a
Title	Ex-Containment Removal Coefficients for Alternative Source Term Analyses	

Revision No.	DESCRIPTION OF REVISION
003	Appendix E was developed to support Appendix I of NDQ0031920075, Revision 22. Appendix I of NDQ0031920075, Revision 22 calculates control room and offsite doses using reduced MSIV leak rates and a reduced main condenser flow area fraction. The MSIV leak rate is being decreased from 100/150 SCFH to 60/85 SCFH and the main condenser flow area fraction is being reduced from 99.5% to 48.9%. These changes support a license amendment request. SAR and ISFSI SAR have been reviewed by Thomas R Hefer 10-18-13 and this revision of the calculation does not impact the SAR or the ISFSI SAR. Tech Specs and ISFSI CoC have been reviewed and determined not to be impacted. A review of the successor documents determined that NDQ0031920075 is impacted by this revision. Pages added: 3a, 3b, Appendix E pages E1 - E23 Pages deleted: None Pages revised: None Pages replaced: 1, 2, 4 Total pages: 65

NPG COMPUTER INPUT FILE

STORAGE INFORMATION SHEET

Document NDQ099920010019	Rev. 003	Plant: BFN	

Subject:

Ex-Containment Removal Coefficients for Alternative Source Term Analyses

☐ Electronic storage of the input files for this calculation is not required. Comments:

☒ Input files for this calculation have been stored electronically and sufficient identifying information is provided below for each input file. (Any retrieved file requires re-verification of its contents before use.)

The Word files utilized in revision 003 are permanently stored in FILEKEEPER file # 322642

☐ Microfiche/eFiche

NPG CALCULATION TABLE OF CONTENTS

Calculation Identifier: NDQ099920010019	Revision:	003

TABLE OF CONTENTS

1.0 Purpose

The purpose of this calculation is to determine aerosol and elemental iodine removal coefficients in the steam lines and main condenser to be used in Alternate Source Term dose calculations.

2.0 Introduction

Aerosol and elemental iodine removal due to sedimentation is credited in the main steam lines and in the main condenser. It is assumed that an inboard MSIV of one main steam line fails to close. Downstream of the outboard MSIV, most of the steam line leakage is directed to the drain lines and does not reach the turbine stop valves. Therefore, in the case of the line with the failed MSIV, sedimentation will be credited in one single volume from the outboard MSIV to the point where the drain line taps off to go to the condenser. The other three steam lines are assumed to be normally isolated. In these lines, sedimentation will be credited in the inboard-to-outboard MSIV volumes and in the volumes from the outboard MSIVs to the points where the drains lines tap off. Finally, sedimentation will be credited in the main condenser, where activity leaking out of the steam lines is collected.

Due to drywell sprays being credited after one hour accident time, removal coefficients will be calculated for two different phases: before one hour accident time, and after one hour accident time. Additionally, removal coefficients will be independently calculated for aerosols and elemental iodine.

3.0 Design Input Data

Design input data is taken from Ref 1, Appendix A (item numbers provided below). They are as follows:

1. Reference pressure at BFN site: 14.4 psi (Item 8.4)
2. DW sprays assumed to start at t = 1 hour accident time (Item 9.1)
3. DW spray nozzle: 7G25 (Item 9.2)
4. MSIV leakage: 150 scfh total, 100 scfh max per line (Items 3.9 and 3.10)
5. MSIV leakage test pressure: Greater than or equal to 25 psig (Item 12.9)
6. Accident Conditions: P = 62.9 psia (48.5 psig), T = 295.2 F (Item 8.5)
7. Reference Pressure for Determination of Steam Line Temperature: 1050 psia (Item 8.2)
8. Volume from Inboard to Outboard MSIV: 53.7 cuft (17.6 ft long from Item 7.2, 23.647" ID from Item 7.1)
9. Volume from Outboard MSIV to Drain Line Tap: 173.1 cuft (68.25 ft long from Item 7.2, 21.562" ID from Item 7.1)
10. Condenser Leakage Bypass: 0.5% (Item 3.14)
11. Sedimentation Height in Main Condenser: 8.3 m = 27.2 ft (Item 7.9)

4.0 Assumptions

Assumption 1: Each steam line control volume is assumed to be well mixed (either the volume from the outboard MSIV to the point where the drain line taps - failed inboard MSIV - or the volumes from the inboard to the outboard MSIV and from the outboard MSIV to the point where the drain lines tap off - fully isolated lines).

Justification 1: The MSIV leakage flow is expected to be a plug flow, in other words, at a very low velocity with very little mixing. As a result, aerosols will experience removal processes with very long residence times as they travel along the entire length of the steam lines before reaching the point where the drain lines come off. This will significantly reduce the aerosol mass leaked to the environment. However, assuming that the MSIV leakage instantly mixes into the steam lines is a conservative assumption, as it will decrease the removal rates due to sedimentation.

Insofar as the main condenser is concerned, assuming an instantaneous mixing is conservative as it will reduce the aerosol concentration and particles won't interact as much as they could, should greater local concentrations corresponding to a more limited mixing were assumed.

Assumption 2: It is assumed that the actual representative droplet size for the BFN spray nozzles in the drywell would be between 1000 and 1500 μm.

Justification 2: The spray nozzle used by BFN for drywell sprays is the 7G-25 (Item 9.2 of Ref 1). The design nozzle differential pressure is 125 psid (Item 9.3 of Ref 1). For a 7G-25 nozzle, the mass mean spray droplet size at 100 psid (6.8 atmospheres gauge) is about 1000 microns according to Figure 12 of Ref 2. However, Ref 3 gives a mass median diameter of about 1500 microns with a mass mean only slightly greater. (Note that the mass mean is developed from the table below that takes the values at 5 percent increments off of Ref 3 and then averages the values).

Since the droplet size decreases with increasing spray pressure, it is assumed that the actual representative droplet size for the BFN nozzles would be between 1000 and 1500 um.

Upper Percentile	Upper Bound Droplet (μm)	Ave Droplet (μm)
5	620	~310
10	760	690
15	860	810
20	960	910
25	1060	1010
30	1130	1095
35	1210	1170
40	1300	1255
45	1390	1345
50	1480	1435
55	1570	1525
60	1660	1615
65	1770	1715
70	1890	1830
75	2010	1950
80	2130	2070
85	2300	2215
90	2530	2415
95	2830	2680
~100	3200	3015
Mass mean droplet =		1553

5.0 Special Requirements / Limiting Conditions

There are no special requirements or limiting conditions in this calculation.

6.0 Computation and Analysis

Three steam lines are assumed to be intact up to the turbine stop valve, while the inboard MSIV is assumed to be failed open in one steam line (practically eliminating consideration of the section of the piping between the vessel and the inboard MSIV).

Sedimentation occurs in the intact steam lines from the vessel up to the turbine stop valves. However, only the piping between the inboard MSIV and the point where the drain line taps off to go to the main condenser is credited for removal of activity. This piping is divided into two adjacent volumes: (1) the volume between closed MSIVs, and (2) the volume between the outboard MSIV and the point where the drain lines tap off to go to the condenser.

As for the steam line with the failed open MSIV, sedimentation is being credited in one single piping volume, between the outboard MSIV and the point where the drain line taps off as it would be difficult to justify deposition in the section upstream of the outboard MSIV.

6.1 Leakage Rate into the Steam Lines

6.1.1 Mass Flow Rate

Item 3.9 of Ref 1 provides mass leak rates into the steam lines. One assumes that 2/3 of the total drywell to steam lines leakage enters one failed line referred to as line "A" and 1/3 leaks into one other line ("B", assumed to be intact), which means that the two other intact lines ("C" and "D") are assumed to be leak tight.

The MSIV leakage partition is, therefore, as follows:

Failed Line A	100 SCFH
Intact Line B	50 SCFH
Intact Line C	No Leakage
Intact Line D	No Leakage

Note that line B is made of two sub control volumes: (i) B1, inboard MSIV to outboard MSIV and (ii) B2, outboard MSIV to the point where the drain line taps off.

The case matrix for the aerosol removal analysis in the steam lines is then:

Case	Leakage	Volume where Aerosol Removal Occurs
A	100 SCFH	Outboard MSIV to Drain Line Tap
B:		
B1	50 SCFH	Inboard to Outboard MSIV
B2	50 SCFH	Outboard MSIV to Drain Line Tap

6.1.2 Volumetric Flow Rate

Since Ref 1 only states MSIV leakage in terms of mass flow rates, one needs to convert these SCFH values into volumetric flow rates (CFH) based on the actual conditions in the drywell.
The methodology used to perform this conversion is:

1. Determine an orifice size corresponding to MSIV leakage under test conditions,
2. Determine a volumetric leak rate per unit of orifice surface area under accident conditions,
3. Multiply the results from 1. and 2. to come up with a volumetric leak rate under accident conditions,
4. Compare this method with a more simplified method.

6.1.2.1 Step 1: Test Conditions

Considering the MSIV test conditions in the drywell, the medium is air at P=25 psig (Item 12.9 of Ref 1).

The critical pressure P_{cr}, function of the ratio of the specific heats for air (k), is expressed as:

$$P_{cr} = P \times \left(\frac{2}{k+1}\right)^{\frac{k}{k-1}} \qquad [1]$$

With P=25 psig (or 5674 psfa) per Item 12.9 of Ref 1 and k=1.4, P_{cr} = 2997 psfa. Since the test pressure is greater than the critical pressure, one can be assured that the volumetric flow through the leak orifice of the valve will remain constant for a constant temperature.

Noting "v" the specific volume of air at pressure P, one may calculate a mass flow per unit of surface area G as follows:

$$G = \sqrt{2 \times g_c \times \frac{k}{k-1} \times \frac{P}{v} \times \left(\left(\frac{P_{cr}}{P}\right)^{\frac{2}{k}} - \left(\frac{P_{cr}}{P}\right)^{\frac{k+1}{k}}\right)} \qquad [2]$$

Numerically, with P = 5674 psfa, P_{cr} = 2997 psfa and v = 14.7/(0.075 x (14.4 + 25)) = 4.97 ft^3/lbm,

$$G = \sqrt{2 \times 32.2 \times \frac{1.4}{1.4-1} \times \frac{5674}{4.97} \times \left(\left(\frac{2997}{5674}\right)^{\frac{2}{1.4}} - \left(\frac{2997}{5674}\right)^{\frac{1.4+1}{1.4}}\right)} = 131.2 \ \text{lbm/(s} \times \text{ft}^2\text{)}$$

Now, considering that the MSIV leakage under test conditions totals 100 SCFH per Item 3.10 of Ref 1, or 100x0.075/3600 = 2.1E-3 lbm/s, one may determine an orifice size for the MSIV leakage dividing this mass flow by G calculated above. One obtains an area A_{100} such as:

A_{100} = 1.59E-5 ft^2

Its corresponding diameter is: D_{100} = 0.137 cm

In like manner, the 50 scfh leakage in line B corresponds to 1.05E-3 lbm/s. Thus,

A_{50} = 7.94E-6 ft^2

D_{50} = 0.097 cm

6.1.2.2 Step 2: Accident Conditions

Under accident conditions, steam rather than air is assumed to be leaking out of the drywell (note that k for steam is 1.3). Per Item 8.5 of Ref 1, accident pressure is P = 48.5 psig (or 9058 psfa), and accident temperature is T = 295.2 F, which is the saturation temperature at 62.9 psia. Under these conditions, the specific volume of steam is v = 6.9 ft^3/lbm.

Using equation [1], one may calculate a critical pressure P_{cr} of 4943 psfa, showing that once again, the volumetric flow of steam through the leak orifice of the valve would remain constant for a constant temperature.

In like manner, per equation [2] one calculates a volumetric flow of steam per unit of surface area, and ends up with:

$$(v \times G)_{accident} = 946.6 \text{ ft}^3/\text{ft}^2\text{-s}$$

6.1.2.3 Step 3: Volumetric Flow Rate

Multiplying the steam volumetric flow per unit of surface area from Step 2 (946.6 ft^3/ft^2-s) with the leak areas (50 scfh and 100 scfh cases) calculated in Step 1, one obtains:

$$Q = A \times (v \times G)_{accident} \quad [3]$$

Numerically,

$$Q_{100} = 1.59\text{E-}5 \times 946.6 \times 3600 = 54.2 \text{ cfh}$$
$$Q_{50} = 7.94\text{E-}6 \times 946.6 \times 3600 = 27.1 \text{ cfh}$$

6.1.2.4 Simplified Method

To convert SCFH measured during a test of the MSIVs to a true volumetric flow, one may want to use a somewhat simpler method. This time, the steps are: (a) get volumetric flow of test by dividing SCFH times atmospheric pressure by absolute test pressure, (b) verify the test pressure to be above critical pressure (to establish that volumetric flow through the valve would remain constant for a constant temperature; i.e., the maximum temperature for the accident to be considered), and (c) convert volumetric flow of air (at test pressure and standard temperature) to steam (at test pressure and maximum temperature) by comparing sonic velocities.

1. The volumetric flow rate under test conditions is CFH_{test} = 100 SCFH x 14.7 / (25 + 14.4) = 37.3 cfh,
2. We already showed in Step 1 of the previous method that the test pressure is above the critical pressure,
3. The ratio of the sonic velocities is as follows (' is used to identify accident conditions):

$$\frac{v'_{sonic}}{v_{sonic}} = \frac{\sqrt{(k'-1)\dfrac{c'_p}{M'}T'}}{\sqrt{(k-1)\dfrac{c_p}{M}T_{standard}}} = \sqrt{\frac{k'-1}{k-1}\frac{c'_p}{c_p}\frac{M}{M'}\frac{T'}{T}} = \left(\frac{(0.3)(8)(29)(755.2R)}{(0.4)(7)(18)(530R)}\right)^{0.5} = 1.403 \quad [4]$$

One may now retrieve the volumetric flow rate under accident conditions multiplying the result under (a) by this ratio. One finds:

$$Q_{100} = 52.3 \text{ cfh}$$

In like manner,

$$Q_{50} = 26.15 \text{ cfh}$$

The results obtained with this simplified method are actually very close to that of the first method. Consequently, one chose to carry these results over to the next steps of the calculation.

The table below summarizes the SCFH to CFH conversion:

Volumetric Leak Rates in the Steam Lines

Steam Line	SCFH	CFH
A	100	52.3
B	50	26.15

6.2 Leakage Rate out of Each Steam Line Volume

Volume B1

The volume between the inboard and outboard MSIVs is 53.7 ft^3 (17.6 ft long, 23.647" inside diameter per Items 7.1 & 7.2 of Ref 1). In this space, the pressure is nearly that of the drywell (62.9 psia per Item 8.5 of Ref 1). The temperature is assumed to be equal to the saturation temperature in the reactor dome where the pressure is 1050 psia per Item 8.2 of Ref 1. The temperature is then 550.6 F, a conservative high value as the steam line temperature is expected to drop along the line as the pressure drops. Because of the temperature difference, the volumetric flow out of that space must be increased by the ratio of the sonic velocities for the two conditions, that is to say the square root of the ratio of the temperatures. One will find:

Leak Rate (B1) = 26.15 cfh x $[(460 + 550.6)/(460 + 295.2)]^{1/2}$
= 30.3 cfh
= 0.56 vol/hour

Volumes A and B2

The volume between the outboard MSIV and the point where the drain line comes off is 173.1 ft^3 (68.25 ft long, 21.562" inside diameter per Items 7.1 & 7.2 of Ref 1). In this space, the pressure is assumed to be atmospheric, with a temperature of 550.6 F (see previous paragraph). Therefore, one needs to apply a temperature and pressure correction to calculate the volumetric flow rates out of that space. One will find:

Leak Rate (A) = 52.3 cfh x (460 + 550.6)/(460 + 295.2) x (62.9 / 14.4)
= 305.7 cfh
= 1.76 vol/hour

Leak Rate (B2) = 26.15 cfh x (460 + 550.6)/(460 + 295.2) x (62.9 / 14.4)
= 152.9 cfh
= 0.88 vol/hour

6.3 Leakage In and out of the Main Condenser Volume

The total mass flow rate entering the main condenser from the two upstream control volumes A and B2 is approximately the total MSIV tested leak rate (150 scfh), increased by the ratio of the accident pressure divided by the test pressure, i.e., 150 x (62.9/39.4) = 239.5 scfh and decreased by 0.5% to account for condenser bypass; i.e., to 238.3 scfh. Note that this supposes that the condenser is full or air.

In terms of volumetric flow entering the condenser, it amounts to 0.995 times the sum of the volumetric flows leaking out of the two steam lines, that is to say 0.995 x (305.7 + 152.9) = 456.3 cfh as calculated above.

In the condenser, the pressure is assumed to be atmospheric (as it is the case in the A and B2 steam line control volumes) and the temperature is assumed to be standard (compared to 550.6 F in the steam lines). Consequently, the volumetric flow rate going out of the main condenser equals the volumetric flow rate leaking out of the steam line volumes A and B2 but converted to standard temperature (i.e., multiplied by the ratio 530R/1010.6R). One obtains a volumetric flow rate of 239.3 cfh. This is good in agreement with what leaks in, as the leakage is close to the value of 238.3 scfh calculated above.

Note that the Main Condenser volume used in what follows is based on a fraction of the sum of the Main Condenser volume (136,000 ft^3 per Item 12.15 of Ref 1). For conservatism, only 90% of this entire volume is used, or 122,400 ft^3; and the entire Low Pressure Turbine free volume is ignored. Consequently, a flow rate of 239.3 cfh corresponds to a leakage of 1.96E-3 vol/hour.

6.4 Sprays in Operation (t>1hr): Calculation of the Aerosol Settling velocities in the Steam Lines and Main Condenser

The subject analysis is based on the settling velocity distribution presented in the AEB-98-03 Appendix A document (Ref 4). This distribution represents the settling velocities of aerosols leaking in the steam lines from an unsprayed drywell.

Modification of the AEB-98-03 settling velocity distribution because of the drywell spray credit after one hour accident time is performed in three steps as described below.

Note that referring to Assumption 2, there is uncertainty as to what would be the representative droplet size for the Browns Ferry spray nozzles (from 1000 to 1500 microns). Both min and max sizes will be considered in determining the spray impact on the sedimentation velocity distribution for the steam lines, and the more conservative result will be used thereafter.

6.4.1 Step 1: Discretization of the AEB-98-03 Cumulative Distribution Function for Sedimentation Velocity

The cumulative distribution for sedimentation velocity seen on Figure A-1 of Ref 4 can be fitted with the following fourth order polynomial:

$$y = 0.000757419 + 547.22488x - 113835.58x^2 + 10532698x^3 - 3.63E{+}08x^4 \qquad [5]$$

As a check of this function, the following points from Ref 4 are confirmed:

Check*	V sed* (m/s)	Calc'd %-tile
10th	2.10E-04	0.110751332
40th	8.10E-04	0.374763377
50th	1.17E-03	0.501370443
60th	1.48E-03	0.593708891

As can be seen, the calculated values are, at most, within a few percentile points of the actual percentile values.

Using this function, the spreadsheet presented in Appendix A was prepared. In this spreadsheet, the first column is the sedimentation velocity in 1E-4 m/s increments. The second column is the cumulative distribution of the sedimentation velocity calculated from the above expression. The third is the average sedimentation velocity between the bin lower bound (previous row) and the bin upper bound (same row). The fourth column is the discrete portion of the distribution characterized by that average velocity. This is determined by subtracting the cumulative distribution value in the same row from the cumulative distribution value in the previous row. When divided by the bin sedimentation velocity increment (1E-4 m/s), this difference becomes the slope of the cumulative distribution (i.e., the probability density function evaluated at that value of the sedimentation velocity). This is done in the fifth column, and this step completes the discretization of the sedimentation velocity cumulative distribution. Figure 1 shows the cumulative distribution (Column 2) and the probability density (Column 5) as a function of the sedimentation velocity (Column 1).

6.4.2 Step 2: Creating a Distribution of Spray Removal Efficiency Consistent with the Distribution of Sedimentation Velocity

The next step in the process of revising the sedimentation velocity distribution to be consistent with spray removal is to create a consistent distribution of spray removal efficiency. The question to be asked here is, "What would the spray removal efficiency be for a set of particles that have a given sedimentation velocity"? The answer to this question is straightforward. This is because sedimentation velocity is determined by the expression below (from Ref 4):

$$u_s = \frac{\rho d_e^2 g}{18 \mu k} \qquad [6]$$

This is assuming that the particles are large enough to have a slip factor of approximately unity. In this expression, u_s is the sedimentation velocity, ρ is the particle theoretical density, d_e is the particle diameter, μ is the gas viscosity, and k is the particle shape factor. This may be rewritten (using an effective density = ρ/k) as

$$u_s = \frac{\rho_{eff} d_e^2 g}{18 \mu} \qquad [7]$$

When one considers that the expression for Stokes Number is (Ref 5):

$$Stk = \frac{\rho_{eff} d_e^2 U_S}{18 \mu R_d} \qquad [8]$$

then one can see how readily the distribution of sedimentation velocity can be changed to a distribution of Stokes Number by simply multiplying the X axis by U_s, the spray droplet terminal velocity, and then dividing that product by Rd, the droplet radius, and g, the acceleration of gravity. In other words,

$$Stk = u_{\tau} \frac{U_S}{gR_d} \qquad [9]$$

For a 1.5 mm diameter droplet (approximately the mass median and/or mass mean for a 7G-25 nozzle spraying at 100 psid – see Assumption 2), the Us/(g*Rd) factor is about 500 sec/m. For a one mm diameter droplet, the Us/(g*Rd) factor is about 615 sec/m. Note that the terminal velocities, U_S, for a one and 1.5 mm droplets are calculated at the top of the Appendix A spreadsheet. They respectively amount to 3.01 m/s and 3.69 m/s.

Figure 2 shows the same cumulative distribution as Figure 1 but now plotted against Stokes Number. There are two plots shown; one for a one mm spray droplet and one for 1.5 mm spray droplet. In Appendix A, Column 6 shows the Stokes Number (6a and 6b, respectively, for one mm and 1.5 mm droplets).

Given that the Stokes Number distribution is now known, the distributed probability of spray removal efficiency can be calculated. It will be assumed that spray removal is governed only by impaction (this will conservatively maximize the downward shift of the sedimentation velocity distribution) and that the impaction efficiency is governed by the following expression (Ref 5):

$$\varepsilon = \left(\frac{Stk}{Stk + 0.35} \right)^2 \qquad [10]$$

Using this expression, the efficiency for each bin can be calculated, and from the efficiency value, the corresponding ε/D value can also be determined (7a and 7b, respectively, for one mm and 1.5 mm droplets).

This completes the work of this step.

6.4.3 Step 3: Modifying the Sedimentation Velocity Bin Probabilities, Probability Density Function, and Cumulative Distribution Considering Spray Removal

For Mark I containments in general, the high spray flows and very small drywell volumes tend to make the removal rates very large. If the removal rates are large enough so that only a few percent of what is injected remains airborne (i.e., greater than about 10 per hour), then the question of mass distribution (i.e., does it need to be considered or not) becomes increasingly moot because the remaining mass becomes concentrated in only one or two of the sedimentation velocity bins. For such a situation, the relative mass being represented by each one of those bins becomes unimportant.

It is immediately evident that the 1.5 mm droplet case produces the more limiting result; i.e., the upper limit of the first sedimentation velocity bin (0.0001 m/s) is the 68th percentile for the one mm droplet case, but it is the 71st percentile for the 1.5 mm droplet case (the 66 original bins have basically been collapsed into one or two significant bins.) In any case, the results are very close and are shown on Figure 3. Since, the 1.5 mm droplet case produces a greater slightly greater downward shift in the sedimentation velocity distribution than does the one mm droplet case, this calculation will proceed on the basis of the 1.5 mm droplet assumption.

Since the upper limit of the first bin (0.0001 m/s) is already greater than the median value for the adjusted sedimentation velocity (i.e., it is the 71st percentile assuming a 1.5 mm spray droplet), an interpolation scheme is used to obtain the median value. The first few points of the cumulative distribution are fitted using an exponential growth curve of the form:

$$y = a(1 - e^{-bx}) \qquad [11]$$

where a = 0.843 and b = 18227.
Using this expression, the median sedimentation velocity is interpolated to be about 5E-5 m/s.

This revised distribution is reasonably consistent with the assumption of a 1.5 percent spray removal efficiency for the drywell (remembering that $\varepsilon = 0.015$ if $\varepsilon/D = 10$ per meter and if D = 0.0015 meter). The Stokes Number for a 1.5 mm droplet and a particle with a sedimentation velocity of 5E-5 m/s is about 0.025 (using equation 9). The corresponding spray removal efficiency (using equation 10) is about 0.44 percent, about a factor of three less than the nominal 1.5 percent. However, for the 71st percentile value of sedimentation velocity (1E-4 m/s), the Stokes Number (for a 1.5 mm droplet) is about 0.05 (per equation 9), and the corresponding spray removal efficiency would be about 1.56 percent (equation 10). Thus, one may state that a particle exhibiting the 70th percentile sedimentation velocity from the adjusted distribution (i.e., about 9.8E-5 m/s) would experience an ε/D of 10 per meter for a 1.5 mm droplet. Thus the adjusted distribution appears to be somewhat (and conservatively) over-shifted in the direction of smaller, less dense particles relative to the distribution that would typify a spray removal efficiency of 1.5 percent. However, the downward shift is not excessive and it is conservative.

The distribution corresponding to the 1.5 mm droplet on Figure 3 should be used as input to the steam line deposition analysis. The median sedimentation velocity of 5E-5 m/s for that distribution represents a value that is about three percent of the original AEB-98-03 (Ref 4) median sedimentation velocity of 0.00117 m/s, and represents the 2.8th percentile of the original AEB-98-03 distribution. Moreover, the 5E-5 m/s sedimentation velocity value is already about one-half the minimum AEB-98-03 value of 1.17E-4 m/s (i.e., that corresponding to a particle diameter of 1.5 microns, a density of 3.25 g/cc, and shape factor of 1.77). Therefore, no further decrease in sedimentation velocity is required for downstream control volumes in the steam lines and main condenser.

To summarize, when sprays starts to operate one hour into the accident, the median value of the modified settling velocity distribution (i.e., 5E-5 m/s) will be used as the aerosol settling velocity in all three steam line control volumes (A, B1 and B2) as long as in the main condenser volume.

<u>6.5 Sprays in Operation (t>1hr): Calculation of the Aerosol Removal Coefficients in the Steam Lines and Main Condenser</u>

As shown in the previous section, it is appropriate (and conservative) to assume an aerosol settling velocity of 5E-5 m/s in the steam lines and main condenser when the drywell sprays are operating.

One may calculate removal coefficients in any control volume (referred to as "sedimentation lambdas") by using the following expression:

$$\lambda_{sed} = \frac{u_s \times S}{V} \qquad [12]$$

where u_s is the settling velocity of the particles, S is the settling area in the control volume, and V is the subject volume.

As far as the removal efficiency is concerned, it is obtained as follows:

$$\eta = \frac{\lambda_{sed}}{\lambda_{sed} + \lambda_{leak}} \qquad [13]$$

where λ_{leak} corresponds to the removal due to existence of a volumetric flow rate going out of the subject control volume, expressed in "volume per unit of time" (usually "per hour").

Volume A:

Inside Diam: 21.562 in

Length: 68.25 ft
Settling Area: 122.6 ft^2 (DxL)
Volume: 173.1 ft^3 (πxD^2/4)

Knowing that u_s = 5E-5 m/s = 0.59 ft/hr and that $\lambda_{leak\,A}$ = 1.76/hr, one obtains:

$$\lambda_{sed\,A} = 0.42\ /\ hr$$
$$\eta_A = 19.2\ \%$$

Volume B1:

The dimensions of the "B1" control volume are as follows:

Inside Diam: 23.647 in
Length: 17.6 ft
Settling Area: 34.7 ft^2 (DxL)
Volume: 53.7 ft^3 (πxD^2/4)

Knowing that u_s = 5E-5 m/s = 0.59 ft/hr and that $\lambda_{leak\,B1}$ = 0.56/hr, one obtains:

$$\lambda_{sed\,B1} = 0.38\ /\ hr$$
$$\eta_{B1} = 40.3\ \%$$

Volume B2:

The dimensions of the "B2" control volume are as follows:

Inside Diam: 21.562 in
Length: 68.25 ft
Settling Area: 122.6 ft^2 (DxL)
Volume: 173.1 ft^3 (πxD^2/4)

Knowing that u_s = 5E-5 m/s = 0.59 ft/hr and that $\lambda_{leak\,B2}$ = 0.88/hr, one obtains:

$$\lambda_{sed\,B2} = 0.42\ /\ hr$$
$$\eta_{B2} = 32.2\ \%$$

Main Condenser Volume:

With a main condenser volume of 122,400 ft^3 (see Section 6.3) and a sedimentation height in the main condenser of 8.3 meters (Item 7.9 of Ref 1), one calculates a sedimentation area of about 4,500 ft^2 (ratio of the volume to the sedimentation height).

Therefore, one has:

Settling Area: 4500 ft^2
Volume: 122,400 ft^3

Knowing that u_s = 5E-5 m/s = 0.59 ft/hr and that $\lambda_{leak\,A}$ = 1.96E-3/hr, one obtains:

$$\lambda_{sed\,A} = 0.022\ /\ hr$$
$$\eta_A = 91.8\ \%$$

6.6 Sprays Not Operating (t<1hr): Calculation of the Aerosol Settling velocities in the Steam Lines and Main Condenser

We showed earlier that the initial distribution shift toward small less dense slow-settling particles due to credit for sprays in the drywell was so dramatic that it was not necessary to modify the distribution further in the downstream volumes. However, the situation is different before spray actuation, i.e. before one hour accident time.

When sprays have not yet been activated, the AEB 98-03 distribution (Ref 4) can be used "as is" in the control volumes located directly downstream of the unsprayed drywell, i.e., the A and B1 control volumes. (The distribution was actually prepared for such a configuration). Consequently, the settling velocity to be used for the calculation of the removal lambdas and removal efficiencies in volumes A and B1 will be the median value of the distribution (1.17E-3 m/s) as described in Ref 4. This is the median sedimentation velocity of the drywell-to-steam lines leakage.

In volumes A and B1, sedimentation will occur. As a result, the leakage into the condenser (from A) and into B2 (from B1) will be characterized by a new distribution of sedimentation velocities.

To determine these new distributions, the three-step methodology described in Section 6.4 is followed. The calculation detailed thereafter shows how the distribution of sedimentation velocities entering B1 from the drywell is modified to obtain a new distribution and median value entering the B2 control volume downstream.

6.6.1 Step 1: Discretization of the AEB-98-03 Cumulative Distribution Function for Sedimentation Velocity

This Step is identical to that of Section 6.4.1, and no further details are needed at this point. The first five columns of the Appendix B spreadsheet that illustrates the method are identical to the first five columns of the Appendix A spreadsheet.

6.6.2 Step 2: Creating a Distribution of Sedimentation Removal Efficiency Consistent with the Distribution of Sedimentation Velocity

Consider the following for the B1 steam line control volume:

Using this same methodology, a removal efficiency can be calculated for each bin, the settling velocity to be used being the value corresponding to the bin center point. This is done in Column 6 of the Appendix B spreadsheet.

6.6.3 Step 3: Modifying the Sedimentation Velocity Bin Probabilities, Probability Density Function, and Cumulative Distribution Considering Sedimentation Removal

As one can see on the Appendix B spreadsheet, the distribution shift toward slow-settling particles is clear. The settling velocity of 3E-4 m/s which corresponded to the 15th percentile in the original distribution corresponds now to the 53th percentile. The original and modified cumulative distributions are compared on Figure 4.

To retrieve the exact median sedimentation velocity, the first 10 points or so of the modified cumulative distribution are fitted with an exponential growth curve similar to equation 11, with a = 0.804 and b = 3640.

The median sedimentation velocity of the leakage entering B2 was interpolated to be 2.7E-4 m/s, more than four times smaller than the median sedimentation velocity of the original distribution in B1.

6.6.4 Calculation of the aerosol sedimentation velocity in the main condenser

In the previous section, one explained that the sedimentation velocity to be used in the A and B1 control volume to calculate the removal efficiency was the median value of the original AEB 98-03 distribution, i.e., 1.17E-3 m/s. Subsequently, one calculated a new sedimentation velocity of 2.7E-4 m/s to be used in the B2 steam line control volume, located downstream of B1.

Downstream of A and B2 is the main condenser. Therefore, one needs to study how the settling velocity distributions in A and B2 would be modified by sedimentation to determine a new settling velocity to be used in the main condenser to calculate its removal efficiency.

Modified cumulative sedimentation velocity distributions for both leakage pathways to the condenser are shown in Column 9 of Appendix C and D. These distributions are fitted with exponential growth curves as done earlier (equation 11). For Column 9 of Appendix C, the exponential growth parameters "a" and "b" to be used for the curve fitting are a = 0.858 and b = 10513. As for Appendix D, one would use a = 0.793 and b = 2574.

The median sedimentation velocities to be used in the condenser were interpolated as follows:

For the leakage coming from the A control volume: u_{sedA} = 3.9E-4 m/s (see Appendix D)
For the leakage coming from the B2 control volume: u_{sedB2} = 8E-5 m/s (see Appendix C).

Of course, only one single value needs to be used, as the steam line leakage is assumed to be mixed in the main condenser and no distinction can be made as to what line each aerosol particle is coming from. Therefore, these two sedimentation velocities are averaged according to what fraction of the particles reaches the condenser through each of the two lines, based on the flow rates out and the removal efficiencies along the steam lines.

The calculation of the average will be as follows:

$$u_{sedcond} = \frac{Q_A(1-\eta_A)u_{sedA} + Q_{B_2}(1-\eta_{B_1})(1-\eta_{B_2})u_{sedB_2}}{Q_A(1-\eta_A) + Q_{B_2}(1-\eta_{B_1})(1-\eta_{B_2})} \quad [14]$$

where Q_A and Q_{B2} are the flow rates going out or A and B2, respectively,
u_{sedA} and u_{sedb2} are the median settling velocities of the aerosol leaking out of the two steam lines,
η_A, η_{B1} and η_{B2} are the aerosol removal efficiencies in A, B1 and B2, respectively.

The numerical calculation is performed in the next section.

6.7 Sprays Not Operating (t<1hr): Calculation of the Removal Coefficients in the Steam Lines and Main Condenser

Volume A:

Inside Diam:	21.562 in
Length:	68.25 ft
Settling Area:	122.6 ft^2 (DxL)
Volume:	173.1 ft^3 (πxD^2/4)

Knowing that u_s = 1.17E-3 m/s = 13.82 ft/hr and that $\lambda_{leak\ A}$ = 1.76/hr, one obtains:

$\lambda_{sed\ A}$ = 9.79 / hr
η_A = 84.7 %

Volume B1:

The dimensions of the "B1" control volume are as follows:

Inside Diam:	23.647 in
Length:	17.6 ft
Settling Area:	34.7 ft^2 (DxL)
Volume:	53.7 ft^3 (πxD^2/4)

Knowing that u_s = 1.17E-3 m/s = 13.82 ft/hr and that $\lambda_{leak\ B1}$ = 0.56/hr, one obtains:

$\lambda_{sed\ B1}$ = 8.93 / hr
η_{B1} = 94.1 %

Volume B2:

The dimensions of the "B2" control volume are as follows:

Inside Diam:	21.562 in
Length:	68.25 ft
Settling Area:	122.6 ft^2 (DxL)
Volume:	173.1 ft^3 (πxD^2/4)

Knowing that u_s = 2.7E-4 m/s = 3.19 ft/hr and that $\lambda_{leak\ B2}$ = 0.88/hr, one obtains:

$\lambda_{sed\ B2}$ = 2.26 / hr
η_{B2} = 71.9 %

Main Condenser Volume:

Per equation 14, the average settling velocity in the condenser is:

$$u_{sedcond} = \frac{304.4(1-0.848)(3.9E-4)+152.2(1-0.941)(1-0.720)(8E-5)}{304.4(1-0.848)+152.2(1-0.941)(1-0.720)} = 3.74E-4 m/s$$

Settling Area: 4500 ft^2 (from Section 6.5)
Volume: 122,400 ft^3 (from Section 6.3)

Knowing that u_s = 3.74E-4 m/s = 4.42 ft/hr and that $\lambda_{leak\ cond}$ = 1.96E-3/hr, one obtains:

$\lambda_{sed\ A}$ = 0.16 / hr
η_A = 98.8 %

6.8 Calculation of the Elemental Iodine Removal Coefficients in the Steam Lines and Main Condenser

The model used in the steam lines is the Bixler Model from NUREG/CR-6604 (Ref 6, Equation 29 p. 212).

[Note that the Cline correlation mentioned in Ref 6 was reviewed, and this review confirmed that the expression of the elemental iodine deposition velocity, U_{el}, contains an exponential, unlike what Ref 6 shows. Therefore, the following expression for elemental iodine deposition velocity, U_{el}, has been modified from Ref 6 to include the exponential.]

$$\eta_{el} = 1 - \exp\left(-\frac{U_{el} A_s}{100 Q}\right)$$

$$U_{el} = \exp\left(\frac{2809}{T} - 12.5\right)$$

Where: U_{el} = deposition velocity (cm/s)
Q = pipe gas flow (m^3/s)
A_s = total pipe surface area (m^2)
T = steam line wall temperature (K)

Volume A:

Parameters for the "A" control volume are as follows:
A_s = 385.3 ft^2 = 35.81 m^2 (πxDxL)
Q = 305.7 cfh = 2.40E-3 m^3/s
T = 561.4 K
U_{el} = 5.55E-4 cm/s

One obtains: η_{el} = 8 %

Volume B1:

Parameters for the "B1" control volume are as follows:
A_s = 108.6 ft^2 = 10.13 m^2 (πxDxL)
Q = 30.3 cfh = 2.38E-4 m^3/s

T = 561.4 K
U_{el} = 5.55E-4 cm/s

One obtains: η_{el} = 21%

Volume B2:

Parameters for the "B2" control volume are as follows:

A_s = 385.3 ft^2 = 35.81 m^2 (πxDxL)
Q = 152.9 cfh = 1.21E-3 m^3/s
T = 561.4 K
U_{el} = 5.55E-4 cm/s

One obtains: η_{el} = 15.2 %

The model used in the main condenser is taken from SRP 6.5.2 (Ref 7).

Per Ref 7, the removal coefficient λ_w for elemental iodine in the main condenser is obtained as follows:

$$\lambda_w = \frac{K_w A_w}{V} \qquad [15]$$

where K_w is the sedimentation velocity in the main condenser (K_w = 4.9 m/hr per Ref 7), A_w is the surface area for elemental iodine deposition in the main condenser, and V is the volume of the main condenser.

Sedim. Area: 4500 ft^2 (from Section 6.5)
Volume: 122,400 ft^3 (from Section 6.3)

Knowing that K_w = 4.9 m/hr = 16.07 ft/hr one obtains:

λ_w = 0.59 / hr

With $\lambda_{leak\ cond}$ = 1.96E-3/hr, one calculate an efficiency η_w using equation 13,

η_A = 99.7 %

One may notice that the elemental iodine removal efficiency in the condenser is greater than the corresponding removal efficiencies for particles before or after one hour accident time (respectively 91.8% and 98.8%).

The decision whether to use the particle removal efficiency or the elemental removal efficiency from SRP 6.5.2 when quantifying elemental iodine removal in the condenser needs to be based on:

1. Conservatism (i.e., the answer to the question "Which value is worse?"),
2. The surface area of the airborne aerosol compared to the surface area of the structures since airborne elemental iodine tends to adsorb on airborne particles and be removed with them.

In containment, before spray operation, particles are plentiful and are removed at a very limited rate (that of sedimentation). Therefore, it is correct and also conservative (since the rate is limited) to assume that elemental iodine will be removed at the same rate as particles.

In the condenser, the situation is different as there is very little particle airborne (due to efficient removal processes upstream). Thus, only a limited fraction of the airborne elemental iodine will be removed at the same rate as that of the airborne particles (i.e., at a very small rate), the rest being removed on the condenser surfaces, at the rate calculated using the SRP 6.5.2 model (i.e., at the substantially higher rate). However, this approach requires a calculation of the surface area of the airborne particles. Therefore, the more conservative and simpler approach that consists in assuming that all the elemental iodine would be removed at the rate of the particles was chosen. The removal efficiencies to be used are then 98.8% before one hour, and 91.8% thereafter.

η_A = 98.8 % before one hour accident time
η_A = 91.8 % after one hour accident time

6.9 Calculation of Combined Removal Efficiencies to be used in Dose Calculations

Having calculated removal efficiencies for each steam line control volume and the main condenser, one could be interested in retrieving some combined removal efficiencies to be used directly in a plant model for purpose of dose calculation. Indeed, it is typical not to credit any hold up in the steam lines which means that multiple steam lines are combined in one single junction from the primary containment to the main condenser, with a single filter to represent the removal efficiency. One could go one step further and include in that filter the removal efficiency of the main condenser downstream. This is the purpose of this section where combined removal efficiencies are calculated based on the flow rates through each line. Also presented in this section are corresponding removal efficiencies for the condenser bypass leakage.

Steam Line Leakage

Flow Path to Main Condenser through Steam Line A:

Volumetric flow rate out of A: 305.7 cfh
Removal Efficiency for Particles: 84.7% in A and 98.8% in Main Condenser (MC) before 1 hour, equivalent to 99.82% overall (=1-0.153x0.012)
19.2% in A, 91.8% in MC after 1 hour, equivalent to 93.37% overall
Removal Efficiency for Elem I: 8% in A, 98.8% in MC before 1 hour, equivalent to 98.90% overall
8% in A, 91.8% in MC after 1 hour, equivalent to 92.46% overall

Flow Path to Main Condenser through Steam Line B:

Volumetric flow rate out of B2: 152.9 cfh
Removal Efficiency for Particles: 94.1% in B1, 71.9% in B2, 98.8% in MC before 1 hour (99.98% overall)
40.3% in B1, 32.2% in B2, 91.8% in MC after 1 hour (96.68% overall)
Removal Efficiency for Elem I: 21% in B1, 15.2% in B2, 98.8% in MC before 1 hour (99.20% overall)
21% in B1, 15.2% in B2, 91.8% in MC after 1 hour (94.51% overall)

<u>Condenser Bypass Leakage</u>

Bypass of the main condenser may occur due to direct leakage from the steam lines to the HP turbine and then to the turbine building. Per Item 3.14 of Ref 1, this bypass leakage amounts to 0.5% of the steam line leakage. This bypass will experience removal in the steam lines, but not in the main condenser.

Flow Path to Turbine Building through Steam Line A:

Volumetric flow rate out of A: 1.53 cfh (0.005x305.7 cfh)
Removal Efficiency for Particles: 84.7% in A before 1 hour
19.2% in A after 1 hour
Removal Efficiency for Elem I: 8% in A before 1 hour
8% in A after 1 hour

Flow Path to Turbine Building through Steam Line B:

Volumetric flow rate out of B2: 0.76 cfh (0.005x152.9 cfh)
Removal Efficiency for Particles: 94.1% in B1, 71.9% in B2 before 1 hour (98.3% overall)
40.3% in B1, 32.2% in B2 after 1 hour (59.5% overall)
Removal Efficiency for Elem I: 21% in B1, 15.2% in B2 before 1 hour (33.0% overall)
21% in B1, 15.2% in B2 after 1 hour (33.0% overall)

7.0 Summary of Results

Two sets of results are presented below. The first set is the results from this revision of the calculation. The second set is the results from the original of the calculation. As noted in the revision log, if the efficiencies changed by less than one digit in the third significant figure as a result of Revision 1, the results of the original of this calculation may still be used. The key results of this calculation are summarized in the table below:

Revision 1

	Flow Rate (over 30 days)			Removal Efficiency for Particles		Removal Efficiency for Elemental Iodine	
	Out of DW	Out of A/B2	Out of MC	T < 1 hour	T > 1 hour	T < 1 hour	T > 1 hour
Steam Line Leakage (via MC)	78.1 cfh	456.3 cfh	239.3 cfh	99.9%	94.5%	99.0%	93.1%
MC Bypass (DW to TB)	0.4 cfh	2.29 cfh	N/A	89.2%	32.6%	16.3%	16.3%

Revision 0

	Flow Rate (over 30 days)			Removal Efficiency for Particles		Removal Efficiency for Elemental Iodine	
	Out of DW	Out of A/B2	Out of MC	T < 1 hour	T > 1 hour	T < 1 hour	T > 1 hour
Steam Line Leakage (via MC)	78.1 cfh	456.6* cfh	239.5* cfh	99.87%	94.45%	99.01%	93.10%
MC Bypass (DW to TB)	0.4 cfh	2.28 cfh	N/A	89.33%	32.70%	16.37%	16.37%

*Note that in the original calculation, these values conservatively (but unnecessarily) included the bypass. The values without bypass are 454.3 cfh and 238.3 cfh, respectively. 238.3 cfh appears in Reference 1 as Item 3.8 and is used in the dose calculation.

None of the removal efficiencies changed by more than one digit in the third significant figure; therefore, the originally calculated removal efficiencies remain acceptable. The same is true for the volumetric leak rates from the steam lines to the main condenser and for the condenser bypass (i.e., no change greater than one digit in the third significant figure). There was no change in the containment leakage through the MSIVs (as expected, based on the explanation provided in the revision log). Therefore, the flowrate and removal efficiency values taken from Revision 0 of this calculation remain as legitimate output used in further analysis.

8.0 Conclusions

This document presented a calculation of aerosol and elemental iodine removal efficiencies in the steam line and main condenser for purpose of Alternative Source Term dose calculations.

9.0 References

1. TVA Calculation ND-Q0999-980016, "Parameters Used In Dose Analyses, Revision 6.
2. NUREG/CR-5966, "A Simplified Model of Aerosol Removal by Containment Sprays", June 1993
3. Spraying Systems Co., Drawing 12135-6, September 12, 1967
4. AEB 98-03, "Assessment of Radiological Consequences for the Perry Pilot Plant Application Using the Revised (NUREG-1465) Source Term" Appendix A, 1998
5. Kress, T. S., "Review of the Status of Validation of the Computer Codes Used in the Severe Accident Source Term Reassessment Study (BMI-2104)", ORNL/TM-8842, April 1985
6. NUREG/CR-6604, "RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation", December 1997
7. NUREG-0800, Standard Review Plan, Section 6.5.2

Figure 1 - Probability Density Function and Cumulative Probability for Settling Velocity (Based on AEB-98-03 Curve Fit)

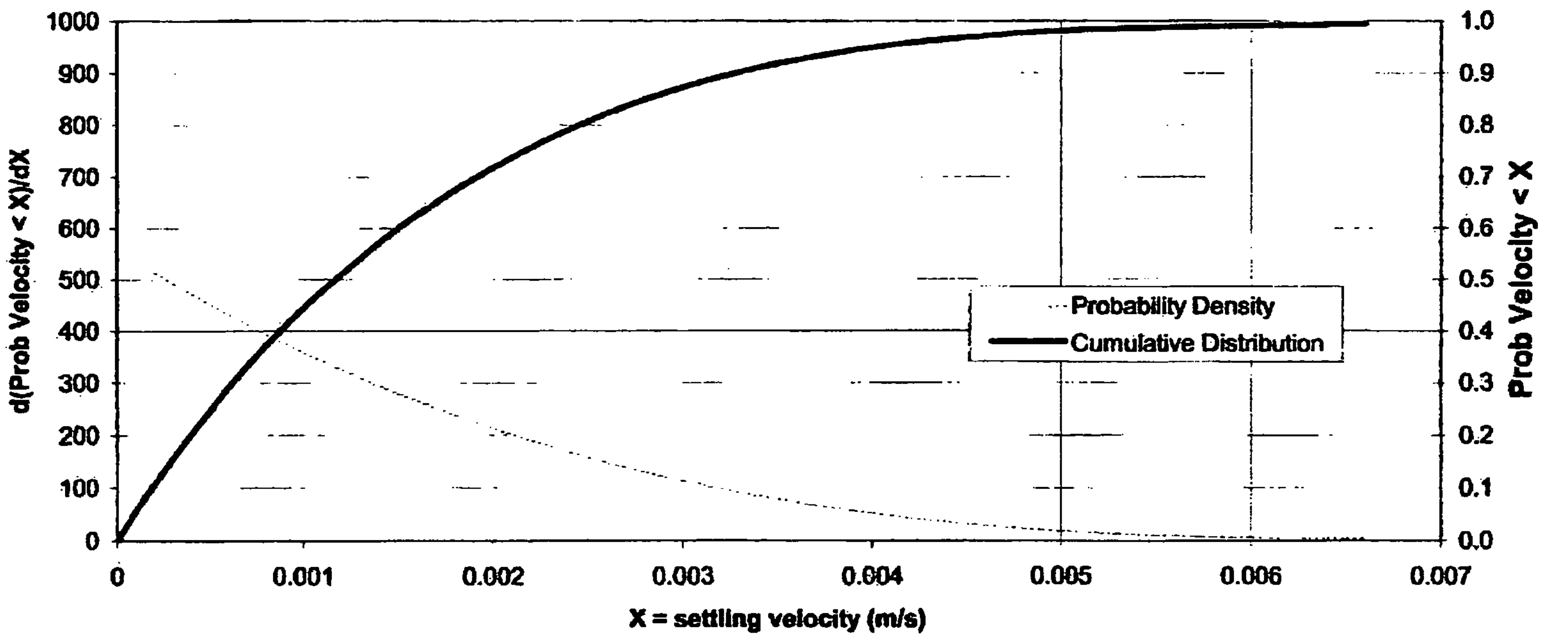


Figure 2 - Cumulative Probability for Stokes Number (Based on AEB-98-03 Curve Fit)

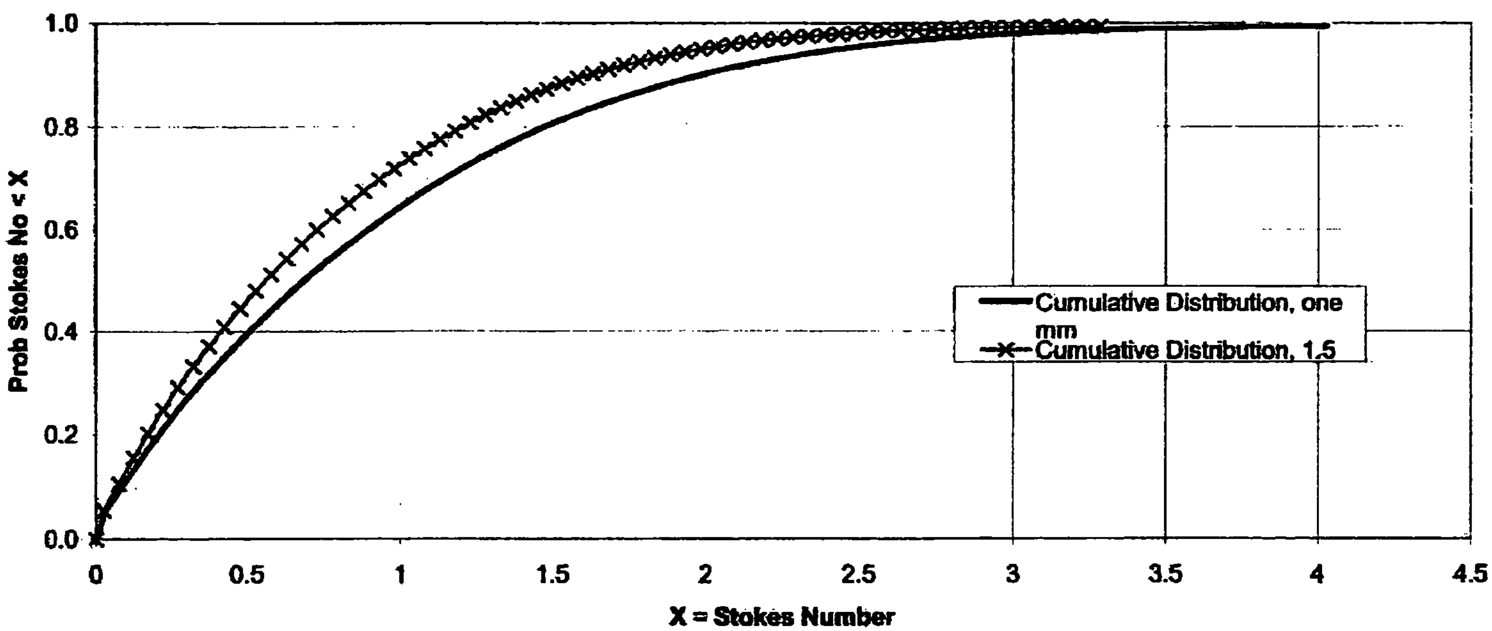


Figure 3 - Cumulative Probability for Settling Velocity (Based on AEB-98-03 Curve Fit - Adjusted for Bin Efficiency Ratio)

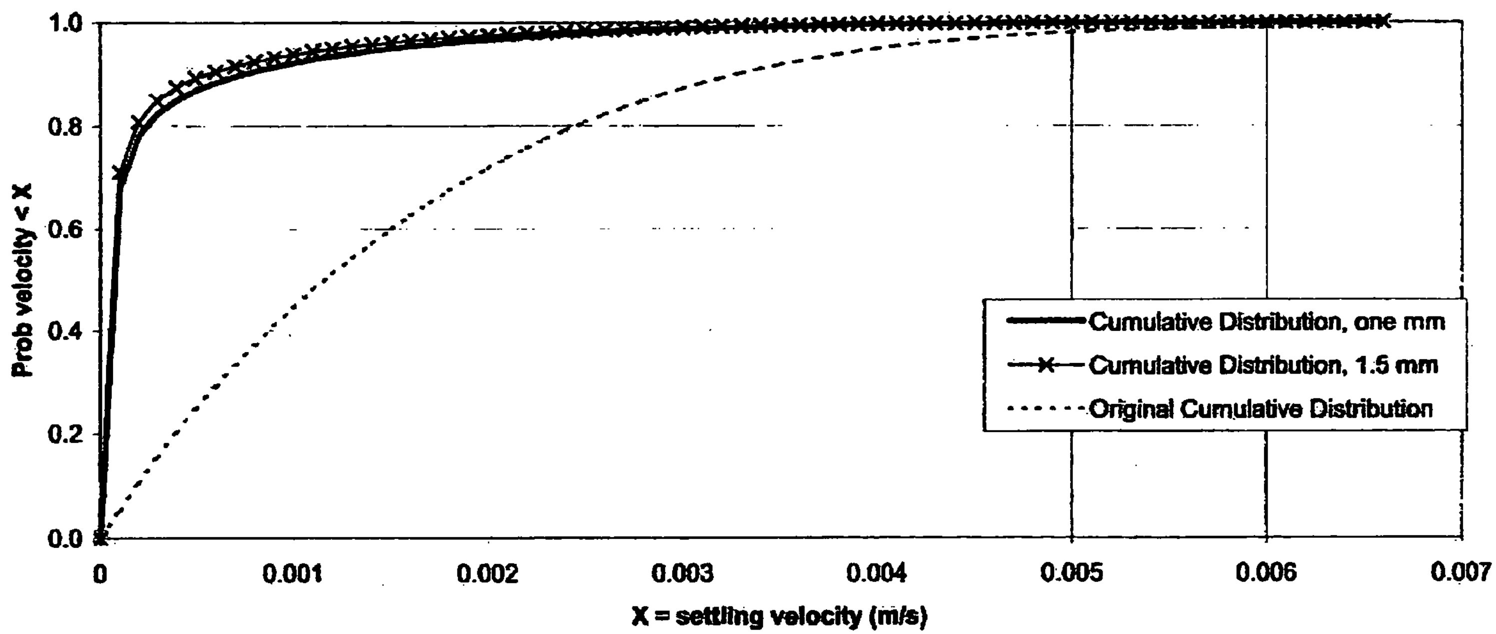
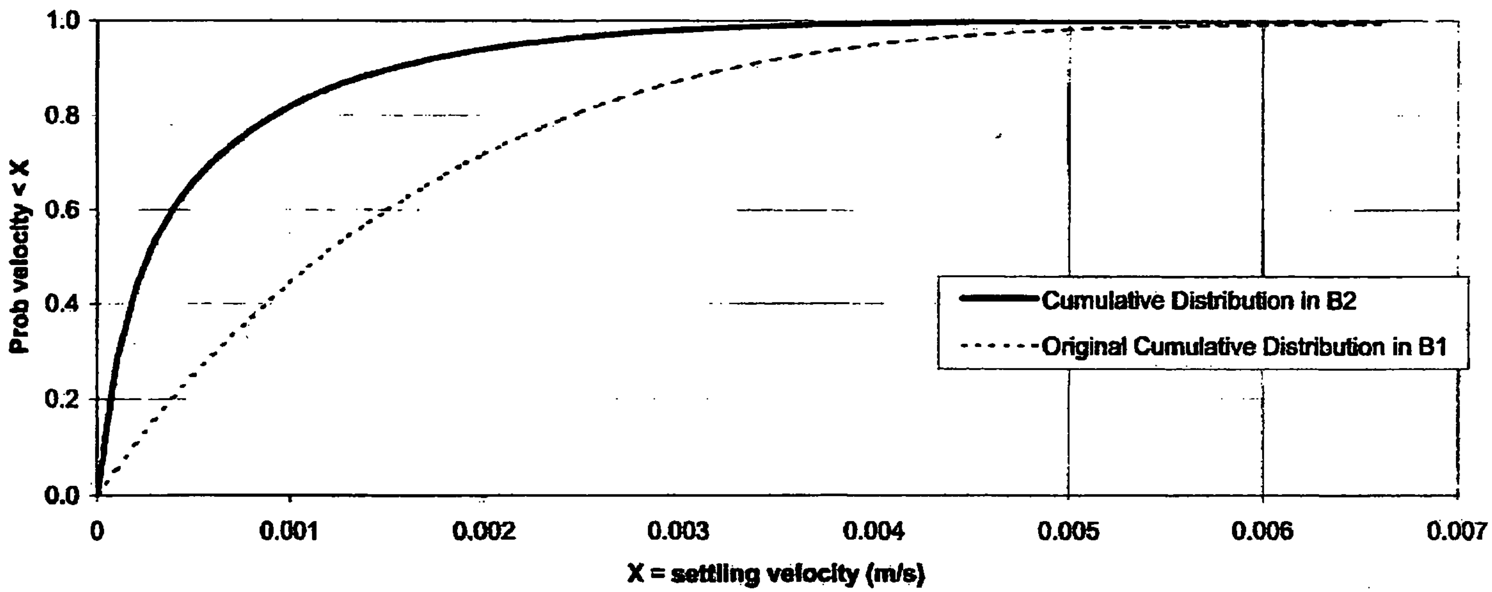


Figure 4 - Cumulative Probability for Settling Velocity in B2 Control Volume (Based on AEB-98-03 Curve Fit - Adjusted for Bin Efficiency Ratio)



Appendix A

Appendix B

Appendix C

[ ]

Appendix D

[ ]

[ ]

1.0 Purpose

The purpose of Appendix E is to determine the changes in steam line and main condenser leakage and bypass flows, and associated changes in aerosol and elemental iodine removal coefficients which are used in dose calculations. The existing AST dose calculation is contained in Appendix B of Reference E1, supported by information in NDQ099920010019 Revision 2 (considering the analyses involving the main steam line and condenser flows and removal coefficients, unsprayed case only) and reference E3 (input parameter data base).

2.0 Introduction

This update to the CR and offsite dose for the BFNP AST dose calculation is necessary due to changes in steam line and main condenser leakage and bypass flows which, in turn, result in changes in aerosol and elemental iodine removal coefficients in the steam lines and main condenser. There are two input changes being addressed: (1) the MSIV leak rate is being changed from 150 scfh total, 100 scfh maximum per line to 85 scfh total, 60 scfh maximum per line; and (2) the condenser bypass fraction (i.e., the fraction of total MSIV leakage that flows directly from the drain line tap location on the steam lines directly to the turbine building thus bypassing the main condenser) is being changed from the Appendix B bypass fraction of 0.5% to 51.1%. The Appendix B 99.5% flow fraction to the main condenser will thus become 48.9%. These changes will affect the aerosol and elemental iodine removal coefficients and the curie release to the environment through the main steam line and condenser leak paths, thus affecting the dose.

Aerosol and elemental iodine removal, due to sedimentation and diffusion respectively, are credited in the main steam lines and in the main condenser as part of the BFNP AST dose calculation. It is assumed that an inboard MSIV of one main steam line fails to close. Downstream of the outboard MSIV, about half of the steam line leakage is directed to the drain lines and does not reach the turbine stop valves. Therefore, in the case of the line with the failed MSIV, removal will be credited in one single volume from the outboard MSIV to the point where the drain line taps off to go to the condenser. The other three steam lines are assumed to be normally isolated (see Section 6.1). In these lines, removal will be credited in the inboard-to-outboard MSIV volumes and in the volumes from the outboard MSIVs to the points where the drain lines tap off. Finally, removal will be credited in the main condenser, where activity leaking out of the steam lines is collected.

Appendix E determines updated steam line, main condenser, and condenser bypass (turbine building) flows, and associated aerosol and elemental iodine removal coefficients (similar to what was done in NDQ099920010019 Revision 2).

3.0 Design Input Data

Design input data are taken from Reference E3, (item numbers provided below unless otherwise noted).

The data are as follows:

1. Reference pressure at BFN site: 14.4 psi (Item 8.4)
2. DW sprays assumed to start at t = 1 hour accident time (Item 9.1) (not used)
3. DW spray nozzle: 7G25 (Item 9.2) (not used)
4. MSIV leakage: 85 scfh total, 60 scfh max per line (Item 3.9 and 3.10)
5. MSIV leakage test pressure: Greater than or equal to 25 psig (Item 12.9)
6. Accident Conditions: P = 62.9 psia (48.5 psig), T = 295.2 F (Item 8.5)
7. Reference Pressure for Determination of Steam Line Temperature: 1050 psia (Item 8.2)

8. Volume from Inboard to Outboard MSIV: 53.7 cu ft (17.6 ft long from Item 7.2, 23.647" ID from Item 7.1)

9. Volume from Outboard MSIV to Drain Line Tap: 173.1 cu ft (68.25 ft long from Item 7.2, 21.562" ID from Item 7.1)

10. Condenser Leakage Bypass: 51.1%
    - Restricting flow area of ALT secondary pathway is the 0.1875 inch orifice. (Reference E6)
    - ALT pathway % flow area through 0.1875 inch orifice to the condenser = 48.9% (Reference E7)
    - Flow area bypassing the condenser = total % flow area - ALT pathway % flow area = 100% - 48.9% = 51.1%

11. Sedimentation Height in Main Condenser: 8.3 m = 27.2 ft (Item 7.9)

4.0 Assumptions

Assumption 1: Each steam line control volume is assumed to be well mixed (either the volume from the outboard MSIV to the point where the drain line taps - failed inboard MSIV - or the volumes from the inboard to the outboard MSIV and from the outboard MSIV to the point where the drain lines tap off – fully isolated lines).

Justification 1: The MSIV leakage flow is expected to be a plug flow, in other words, at a very low velocity with very little mixing. As a result, aerosols will experience removal processes with very long residence times as they travel along the entire length of the steam lines before reaching the point where the drain lines come off. This will significantly reduce the aerosol mass leaked to the environment. However, assuming that the MSIV leakage instantly mixes into the steam lines is a conservative assumption, as it will decrease the removal rates due to sedimentation. Insofar as the main condenser is concerned, assuming instantaneous mixing is conservative as it will reduce the aerosol concentration and particles won't interact as much as they could, if greater local concentrations corresponding to a more limited mixing were assumed.

5.0 Special Requirements / Limiting Conditions

There are no special requirements or limiting conditions in this calculation.

6.0 Computation and Analysis

Three steam lines are assumed to be intact up to the turbine stop valve, while the inboard MSIV is assumed to be failed open in one steam line (practically eliminating consideration of the section of the piping between the vessel and the outboard MSIV).

Sedimentation occurs in the intact steam lines from the vessel up to the turbine stop valves. However, only the piping between the inboard MSIV and the point where the drain line taps off to go to the main condenser is credited for removal of activity. This piping is divided into two adjacent volumes: (1) the volume between closed MSIVs, and (2) the volume between the outboard MSIV and the point where the drain lines tap off to go to the condenser.

As for the steam line with the failed open MSIV, sedimentation is being credited in one single piping volume, between the outboard MSIV and the point where the drain line taps off as it would be difficult to justify deposition in the section upstream of the outboard MSIV.

6.1 Leakage Rate into the Steam Lines

6.1.1 Mass Flow Rate

For the 85 scfh total MSIV leakage, it is assumed that about 70% of the total drywell to steam lines leakage enters the failed line, referred to as line "A" (60 maximum per line), and the remaining (about 30%) leaks into one intact line, referred to as line "B" (remaining 25 scfh out of the total of 85), which means that the two other intact lines ("C" and "D") are assumed to be leak tight.

The MSIV leakage partition is as follows:

Failed Line A	60 SCFH
Intact Line B	25 SCFH
Intact Line C	No Leakage
Intact Line D	No Leakage

Note that line B is made of two sub control volumes: (i) B1, inboard MSIV to outboard MSIV and (ii) B2, outboard MSIV to the point where the drain line taps off.

The case matrix for the aerosol removal analysis in the steam lines is then:

Case	Leakage	Volume where Aerosol Removal Occurs
A	60 SCFH	Outboard MSIV to Drain Line Tap
B:		
B1	25 SCFH	Inboard to Outboard MSIV
B2	25 SCFH	Outboard MSIV to Drain Line Tap

6.1.2 Volumetric Flow Rate

Since MSIV leakage is stated only in terms of mass flow rate, one needs to convert these SCFH values into volumetric flow rates (CFH) based on the actual conditions in the drywell.

The methodology used to perform this conversion is:

1. Determine an orifice size corresponding to MSIV leakage under test conditions,
2. Determine a volumetric leak rate per unit of orifice surface area under accident conditions,
3. Multiply the results from 1. and 2. to come up with a volumetric leak rate under accident conditions,
4. Compare this method with a more simplified method.

6.1.2.1 Step 1: Test Conditions

Considering the MSIV test conditions in the drywell, the medium is air at P=25 psig (Item 12.9 of Reference E3).

The critical pressure P_{cr}, function of the ratio of the specific heats for air (k), is expressed as:

$$P_{cr} = \mathrm{P} \times \left(\frac{2}{k+1}\right)^{\frac{k}{k-1}} \quad (1)$$

With P=25 psig (or 5674 psfa) per Item 12.9 of Reference E3 and k=1.4, P_{cr} = 2997 psfa. Since the test pressure is greater than the critical pressure, one can be assured that the volumetric flow through the leak orifice of the valve will remain constant for a constant temperature.

Noting "v" the specific volume of air at pressure P, one may calculate a mass flow per unit of surface area G as follows:

$$G = \sqrt{2 \times g_c \times \frac{k}{k-1} \times \frac{P}{v} \times \left(\left(\frac{P_{cr}}{P}\right)^{\frac{2}{k}} - \left(\frac{P_{cr}}{P}\right)^{\frac{k+1}{k}} \right)} \quad (2)$$

Numerically, with P = 5674 psfa, P_{cr}= 2997 psfa and v = 14.7/(0.075 x (14.4 + 25)) = 4.97 ft^3/lbm, equations (1) and (2) yield

$$G = \sqrt{2 \times 32.2 \times \frac{1.4}{1.4-1} \times \frac{5674}{4.97} \times \left(\left(\frac{2997}{5674}\right)^{\frac{2}{1.4}} - \left(\frac{2997}{5674}\right)^{\frac{1.4+1}{1.4}} \right)} = 131.2\ lbm/(s \times ft^2)$$

Now, considering that the MSIV leakage under test conditions totals 60 SCFH, or 60x0.075/3600 = 1.25E-3 lbm/s, one may determine an orifice size for the MSIV leakage dividing this mass flow by G calculated above. One obtains an area A_{60} such as:

$$A_{60} = 9.53E\text{-}6\ ft^2$$

Its corresponding diameter is: D_{60} = 0.106 cm

In like manner, the 25 scfh leakage in line B corresponds to 5.21E-4 lbm/s. Thus,

A_{25} = 3.97E-6 ft^2
D_{25} = 0.069 cm

6.1.2.2 Step 2: Accident Conditions

Under accident conditions, steam rather than air is assumed to be leaking out of the drywell (note that k for steam is 1.3). Per Item 8.5 of Reference E3, accident pressure is P = 48.5 psig (or 9058 psfa), and accident temperature is T = 295.2 F, which is the saturation temperature at 62.9 psia. Under these conditions, the specific volume of steam is v = 6.9 ft^3/lbm.

Using equation [1], one may calculate a critical pressure P_{cr} of 4943 psfa, showing that once again, the volumetric flow of steam through the leak orifice of the valve would remain constant for a constant temperature.

In like manner, per equation [2] one calculates a volumetric flow of steam per unit of surface area, and ends up with:

$$(v \times G)_{accident} = 946.6\ ft^3/ft^2\text{-}s$$

6.1.2.3 Step 3: Volumetric Flow Rate

Multiplying the steam volumetric flow per unit of surface area from Step 2 (946.6 ft^3/ft^2-s) with the leak areas (25 scfh and 60 scfh cases) calculated in Step 1, one obtains:

$$Q = A \times (v \times G)_{accident} \quad (3)$$

Numerically, equation (3) yields

Q_{60} = 9.53E-6 x 946.6 x 3600 = 32.5 cfh
Q_{25} = 3.97E-6 x 946.6 x 3600 = 13.5 cfh

6.1.2.4 Step 4: Simplified Method

To convert SCFH measured during a test of the MSIVs to a true volumetric flow, one may want to use a somewhat simpler method. This time, the steps are: (a) get volumetric flow of test by dividing SCFH times atmospheric pressure by absolute test pressure, (b) verify the test pressure to be above critical pressure (to establish that volumetric flow through the valve would remain constant for a constant temperature; i.e., the maximum temperature for the accident to be considered), and (c) convert volumetric flow of air (at test pressure and standard temperature) to steam (at test pressure and maximum temperature) by comparing sonic velocities.

1. The volumetric flow rate under test conditions is CFH_{test} = 60 SCFH x 14.7 / (25 + 14.4) = 22.4 cfh,
2. We already showed in Step 1 of the previous method that the test pressure is above the critical pressure,
3. The ratio of the sonic velocities is as follows (' is used to identify accident conditions in equation (4)):

$$\frac{v'_{sonic}}{v_{sonic}} = \frac{\sqrt{(k'-1)\frac{c'_p}{M'}T'}}{\sqrt{(k-1)\frac{c_p}{M}T_{standard}}} = \sqrt{\frac{(0.3)(8)(29)(755.2)}{(0.4)(7)(18)(530)}} = 1.403 \qquad (4)$$

One may now retrieve the volumetric flow rate under accident conditions, multiplying the result under (a) by this ratio. One finds:

$$Q_{60} = 22.4 \text{ x } 1.403 = 31.4 \text{ cfh}$$

In like manner,

$$Q_{25} = 13.1 \text{ cfh}$$

The results obtained with this simplified method are actually very close to that of the first method. Consequently, one chose to carry these results over to the next steps of the calculation.

The table below summarizes the SCFH to CFH conversion:

Volumetric Leak Rates in the Steam Lines

Steam Line	SCFH	CFH
A	60	31.4
B	25	13.1

6.2 Leakage Rate out of Each Steam Line Volume

Volume B1

The volume between the inboard and outboard MSIVs is 53.7 ft^3 (17.6 ft long, 23.647" inside diameter per Items 7.1 & 7.2 of Ref E3). In this space, the pressure is nearly that of the drywell (62.9 psia per Item 8.5 of Ref E3). The temperature is assumed to be equal to the saturation temperature in the reactor dome where the pressure is 1050 psia per Item 8.2 of Ref E3. The temperature is then 550.6 F, a conservative high value as the steam line temperature is expected to drop along the line as the pressure drops. Because of the temperature difference, the volumetric flow out of that space must be increased by the ratio of the sonic velocities for the two conditions, that is to say the square root of the ratio of the temperatures. One will find:

$$\text{Leak Rate (B1)} = 13.1 \text{ cfh x } [(460 + 550.6)/(460 + 295.2)]^{1/2} = 15.1 \text{ cfh}$$

= 0.28 vol/hour

Volumes A and B2

The volume between the outboard MSIV and the point where the drain line comes off is 173.1 ft3 (68.25 ft long, 21.562" inside diameter per Items 7.1 & 7.2 of Ref E3). In this space, the pressure is assumed to be atmospheric, with a temperature of 550.6 F (see previous paragraph). Therefore, one needs to apply a temperature and pressure correction to calculate the volumetric flow rates out of that space. One will find:

Leak Rate (A) = 31.4 cfh x (460 + 550.6)/(460 + 295.2) x (62.9 /14.4)
= 183.55 cfh
= 1.06 vol/hour

Leak Rate (B2) = 13.1 cfh x (460 + 550.6)/(460 + 295.2) x (62.9/ 14.4)
= 76.5 cfh
= 0.44 vol/hour

6.3 Leakage in and out of the Main Condenser Volume

The total mass flow rate entering the main condenser from the two upstream control volumes A and B2 is approximately the total MSIV tested leak rate (85 scfh), increased by the ratio of the accident pressure divided by the test pressure, i.e., 85 x (62.9/39.4) = 135.7 scfh and decreased by 51.1% to account for condenser bypass; i.e., to 66.4. scfh. Note that this supposes that the condenser is full of air.

In terms of volumetric flow entering the condenser, it amounts to 0.489 times the sum of the volumetric flows leaking out of the two steam lines, that is to say 0.489 x (183.55 + 76.5) = 127.2 cfh as calculated above.

In the condenser, the pressure is assumed to be atmospheric (as it is the case in the A and B2 steam line control volumes) and the temperature is assumed to be standard (compared to 550.6 F in the steam lines). Consequently, the volumetric flow rate going out of the main condenser equals the volumetric flow rate leaking out of the steam line volumes A and B2 but converted to standard temperature (i.e., multiplied by the ratio 530R/1010.6R). One obtains a volumetric flow rate of 66.7. cfh. This is good in agreement with what leaks in, as the leakage is close to the value of 66.4 scfh calculated above.

Note that the Main Condenser volume used in what follows is based on a fraction of the sum of the Main Condenser volume (136,000 ft^3 per Item 12.15 of Ref E3). For conservatism, only 90% of this entire volume is used, or 122,400 ft^3; and the entire Low Pressure Turbine free volume is ignored. Consequently, a flow rate of 66.4 cfh corresponds to a leakage of 5.4E-4 vol/hour.

6.4 Calculation of the Aerosol Settling velocities in the Steam Lines and Main Condenser

The subject analysis is based on the settling velocity distribution presented in the AEB-98-03 Appendix A document (Reference E4). This distribution represents the settling velocities of aerosols leaking in the steam lines from an unsprayed drywell.

[ ]

6.4.1 Step 1: Discretization of the AEB-98-03 Cumulative Distribution Function for Sedimentation Velocity

The cumulative distribution for sedimentation velocity seen on Figure A-1 of Ref E4 can be fitted with the following fourth order polynomial:

$$y = 0.000757419 + 547.22488x - 113835.58x^2 + 10532698x^3 - 3.63 \times 10^8 x^4 \quad (5)$$

As a check of this function, the following points from Ref 4 are confirmed:

Check	Vsed (m/s)	Calc'd %-tile
10^{th}	2.1E-04	0.110751332
40^{th}	8.1E-04	0.374763377
50^{th}	1.17E-03	0.501370443
60^{th}	1.48E-03	0.593708891

As can be seen, the calculated values are, at most, within a few percentile points of the actual percentile values.

Using this function, the spreadsheet presented in Table E-1 was prepared. In this spreadsheet, the first column is the sedimentation velocity in 1 E-4 m/s increments. The second column is the cumulative distribution of the sedimentation velocity calculated from the above expression in equation (5). The third is the average sedimentation velocity between the bin lower bound (previous row) and the bin upper bound (same row). The fourth column is the discrete portion of the distribution characterized by that average velocity. This is determined by subtracting the cumulative distribution value in the same row from the cumulative distribution value in the previous row. When divided by the bin sedimentation velocity increment (1 E-4 m/s), this difference becomes the slope of the cumulative distribution (i.e., the probability density function evaluated at that value of the sedimentation velocity). This is done in the fifth column, and this step completes the discretization of the sedimentation velocity cumulative distribution.

6.4.2 Step 2: Creating a Distribution of Sedimentation Removal Efficiency Consistent with the Distribution of Sedimentation Velocity

One may calculate removal coefficients in any control volume (referred to as "sedimentation lambdas") by using the following expression:

$$\lambda_{sed} = \frac{u_s \times S}{V} \quad (6)$$

where u_s is the settling velocity of the particles, S is the settling area in the control volume, and V is the subject volume.

As far as the removal efficiency is concerned, it is obtained as follows:

$$\eta = \frac{\lambda_{sed}}{\lambda_{sed} + \lambda_{leak}} \quad (7)$$

Where λ_{leak} corresponds to the removal due to existence of a volumetric flow rate going out of the subject control volume, expressed in "volume per unit of time" (usually "per hour"). If Q is the volumetric leak rate out of a subject control volume and V is the subject volume, λ_{leak} is equal to Q/V.

Consider the following for the B1 steam line control volume:

Using this same methodology, a removal efficiency can be calculated for each bin, the settling velocity to be used being the value corresponding to the bin center point. This is done in Column 6 of the Table E-1 spreadsheet.

6.4.3 Step 3: Modifying the Sedimentation Velocity Bin Probabilities, Probability Density Function, and Cumulative Distribution Considering Sedimentation Removal

As one can see on the Table E-1 spreadsheet, the distribution shift toward slow-settling particles is clear. The settling velocity of 4E-4 m/s which corresponded to the 20^{th} percentile in the original distribution corresponds now to the 65^{th} percentile.

To retrieve the exact median sedimentation velocity, the first 10 points or so of the modified cumulative distribution are fitted with a logarithmic growth curve:

$$y = a \times \ln(x) + b \qquad (8)$$

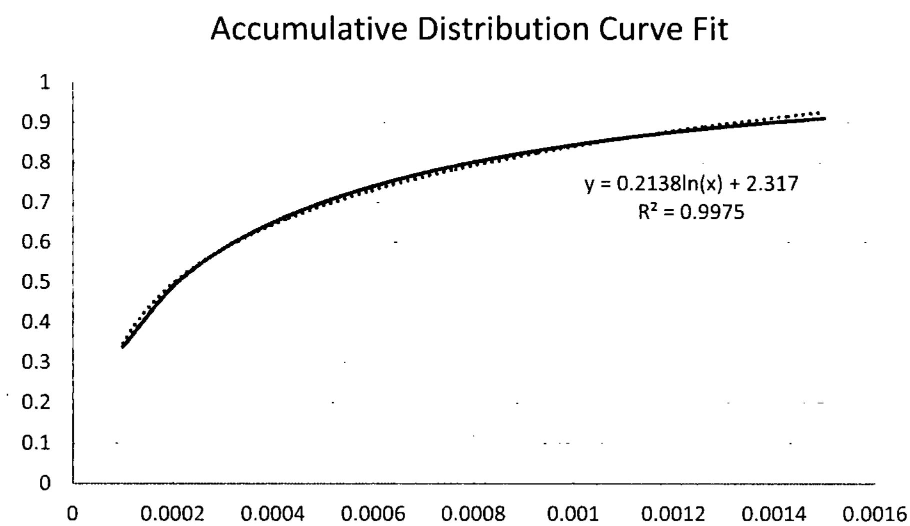
with a = 0.2138, b = 2.317, and R-Square = 0.9975 (as seen in figure below).

The median sedimentation velocity of the leakage entering B2 was interpolated to be 2.04E-4 m/s, about six times smaller than the median sedimentation velocity of the original distribution in B1.

6.4.4 Calculation of the aerosol sedimentation velocity in the main condenser

In the previous section, it was explained that the sedimentation velocity to be used in the A and B1 control volume to calculate the removal efficiency was the median value of the original AEB 98-03 distribution, i.e., 1.17E-3 m/s. Subsequently, a new sedimentation velocity of 2.04E-4 m/s was calculated to be used in the B2 steam line control volume, located downstream of B1.

Downstream of A and B2 is the main condenser. Therefore, one needs to study how the settling velocity distributions in A and B2 would be modified by sedimentation to determine a new settling velocity to be used in the main condenser to calculate its removal efficiency.



[ ]

Modified cumulative sedimentation velocity distributions for both leakage pathways to the condenser are shown in Column 9 of Table E-2 and Table E-3. These distributions are fitted with exponential growth curves as done earlier. For Column 9 of Table E-2, the logarithmic growth parameters "a" and "b" to be used for the curve fitting are a = 0.1573, b = 2.1389, and R-Square = 0.9717. As for Table E-3, one would use a = 0.2473, b = 2.495, and R-Square = 0.9984.

The median sedimentation velocities to be used in the condenser were interpolated as follows:

For the leakage coming from the A control volume: $u_{sed,A}$ =3.14E-4 m/s (see Table E-3)

For the leakage coming from the B2 control volume: $u_{sed,B2}$ =3.0E-5 m/s (see Table E-2).

Of course, only one single value needs to be used, as the steam line leakage is assumed to be mixed in the main condenser and no distinction can be made as to what line each aerosol particle is coming from. Therefore, these two sedimentation velocities are averaged according to what fraction of the particles reaches the condenser through each of the two lines, based on the flow rates out and the removal efficiencies along the steam lines.

The calculation of the average will be as follows:

$$u_{sed,cond} = \frac{Q_A(1-\eta_A)u_{sed,A}+Q_{B2}(1-\eta_{B1})(1-\eta_{B2})u_{sed,B2}}{Q_A(1-\eta_A)+Q_{B2}(1-\eta_{B1})(1-\eta_{B2})} \quad (9)$$

where Q_A and Q_{B2} are the flow rates going out or A and B2, respectively, $u_{sed,A}$ and $u_{sed,B2}$ are the median settling velocities of the aerosol leaking out of the two steam lines, η_A, η_{B1} and η_{B2} are the aerosol removal efficiencies in A, B1 and B2, respectively.

The numerical calculation is performed in the next section.

6.5 Calculation of the Removal Coefficients in the Steam Lines and Main Condenser

Volume A:

Inside Diam:	21.562 in
Length:	68.25 ft
Settling Area:	122.6 ft^2 (DxL)
Volume:	173.1 ft^3 (πxD^2/4xL)

Knowing that u_s= 1.17E-3 m/s = 13.82 ft/hr and that $\lambda_{leak,A}$ =1.06/hr, one obtains:

$\lambda_{sed,A}$ = 9.79/ hr

η_A = 90.2%

Volume B1:

Inside Diam:	23.647 in
Length:	17.6 ft
Settling Area:	34.7 ft^2 (DxL)
Volume:	53.7 ft^3 (πxD^2/4xL)

Knowing that u_s = 1.17E-3 m/s = 13.82 ft/hr and that $\lambda_{leak,B1}$ =0.28/hr, one obtains:

$\lambda_{sed,B1}$ = 8.93/ hr

η_{B1} = 96.9%

Volume B2:

Inside Diam:	21.562 in
Length:	68.25 ft
Settling Area:	122.6 ft^2 (DxL)
Volume:	173.1 ft^3 (πxD^2/4xL)

Knowing that u_s= 2.04E-4 m/s = 2.405 ft/hr and that $\lambda_{leak,B2}$ =0.44/hr, one obtains:

$\lambda_{sed,B2}$ = 8.93/ hr

η_{B2} = 96.9%

Main Condenser Volume:

Per equation (9), the average settling velocity in the condenser is:

$$u_{sed,cond} = \frac{183.55(1-0.902)3.14\times10^{-4} + 76.5(1-0.969)(1-0.794)3.0\times10^{-5}}{183.55(1-0.902) + 76.5(1-0.969)(1-0.794)} = 3.06\times10^{-4}$$

Settling Area: 4500 ft^2 (based on volume of 122,400 ft^3 and settling height of 27.2 ft)
Volume: 122,400 ft^3

Knowing that u_s = 3.06E-4 m/s = 3.61 ft/ hr and that $\lambda_{leak,Cond}$= 5.4E-4/hr, one obtains:

$\lambda_{sed,Cond}$ = 0.133/ hr
η_{Cond} =99.6%

6.6
Section Deleted.

6.7
Section Deleted.

6.8 Calculation of the Elemental Iodine Removal Coefficients in the Steam Lines and Main Condenser

The model used in the steam lines is the Bixler Model from NUREG/CR-6604 (Reference E5, Equation 29 p. 212).

[It is noted that the Cline correlation mentioned in Ref E5 was reviewed, and this review confirmed that the expression of the elemental iodine deposition velocity,U_{ei}, contains an exponential, which was apparently omitted from Ref E5 (otherwise the deposition velocities are negative). Therefore, the following expression for elemental iodine deposition velocity, U_{ei}, has been modified from Reference E5 to include the exponential. It is also noted that the units of U_{ei}, while not stated in Reference E5, are assumed to be cm/s with the factor of 100 in the denominator of the exponential in the expression for removal efficiency, η_{ei}, being a conversion to make the argument of the exponential dimensionless.]

$$\eta_{ei} = 1 - exp\left(-\frac{U_{ei}A_s}{100Q}\right)$$

$$U_{ei} = exp\left(\frac{2809}{T} - 12.5\right)$$

Where:
U_{ei}=deposition velocity (cm/s)
Q = pipe gas flow (m^3/s)
A_s= total pipe surface area (m^2)
T = steam line wall temperature (K)

Volume A:
Parameters for the "A" control volume are as follows:
A_s= 385.3 ft^2 = 35.81 m^2 (πxDxL)
Q = 183.55 cfh = 1.4E-03 m^3/s
T = 561.4 K
U_{ei}= 5.56E-4 cm/s

One obtains: η_{ei} = 12.9 %

Volume B1:
Parameters for the "B1" control volume are as follows:

A_s= 108.6 ft^2 = 10.13 m^2 (πxDxL)
Q = 15.1 cfh = 1.2E-4 m^3/s
T = 561.4 K
U_{ei}= 5.56E-4 cm/s

One obtains: η_{ei} = 37.7 %

Volume B2:
Parameters for the "B2" control volume are as follows:

A_s= 385.3 ft^2 = 35.81 m^2 (πxDxL)
Q = 76.5 cfh = 6.0E-04 m^3/s
T = 561.4 K
U_{ei}= 5.56E-4 cm/s

One obtains: η_{ei} = 28.2 %

The model used in the main condenser is taken from SRP 6.5.2 (Reference E2).

Per Reference E2, the removal coefficient λ_w for elemental iodine in the main condenser is obtained as follows:

$$\lambda_w = \frac{K_w A_w}{V} \quad (10)$$

where Kw is the sedimentation velocity in the main condenser (K_w = 4.9 m/hr per Reference E2), A_w is the surface area for elemental iodine deposition in the main condenser, and V is the volume of the main condenser.

Sedim. Area: 4500 ft^2
Volume: 122,400 ft^3

Knowing that K_w= 4.9 m/hr = 16.07 ft/hr one obtains from equation (10):

$$\lambda_w = 0.59/hr$$

With lambdas leak out of condenser, $\lambda_{leak,Cond}$, is calculated to be 5.4E-4/hr, one calculate an efficiency η_w using equation (7):

$$\eta_w = 99.9\%.$$

One may notice that the elemental iodine removal efficiency in the condenser is greater than the corresponding removal efficiencies for particles in the main condenser (99.6%).

The decision whether to use the particle removal efficiency or the elemental removal efficiency from SRP 6.5.2 when quantifying elemental iodine removal in the condenser needs to be based on:

1. Conservatism (i.e., the answer to the question "Which value is worse?"),

2. The surface area of the airborne aerosol compared to the surface area of the structures since airborne elemental iodine tends to adsorb on airborne particles and be removed with them.

In containment, particles are plentiful and are removed at a very limited rate (that of sedimentation). Therefore, it is correct and also conservative (since the rate is limited) to assume that elemental iodine will be removed at the same rate as particles.

In the condenser, the situation is different as there is very little particle airborne (due to efficient removal processes upstream). Thus, only a limited fraction of the airborne elemental iodine will be removed at the same rate as that of the airborne particles (i.e., at a very small rate), the rest being removed on the condenser surfaces, at the rate calculated using the SRP 6.5.2 model (i.e., at the substantially higher rate). However, this approach requires a calculation of the surface area of the airborne particles. Therefore, the more conservative and simpler approach consists in assuming that all the elemental iodine would be removed at the rate of the particles was chosen. The removal efficiency to be used is then 99.6%.

$$\eta_a = 99.6\%$$

6.9 Calculation of Combined Removal Efficiencies to be used in Dose Calculations

Having calculated removal efficiencies for each steam line control volume and the main condenser, one could be interested in retrieving some combined removal efficiencies to be used directly in a plant model for purpose of dose calculation. Indeed, it is typical not to credit any hold up in the steam lines which means that multiple steam lines are combined in one single junction from the primary containment to the main condenser, with a single filter to represent the removal efficiency. One could go one step further and include in that filter the removal efficiency of the main condenser downstream. This is the purpose of this section where combined removal efficiencies are calculated based on the flow rates through each line. Also presented in this section are corresponding removal efficiencies for the condenser bypass leakage.

Steam Line Leakage

Flow Path to Main Condenser through Steam Line A:

Volumetric flow rate out of A:	89.8 cfh (0.489x183.55 cfh)
Removal Efficiency for Particles:	90.2% in A and 99.6% in Main Condenser (MC), equivalent to 99.96% overall (=1-0.098x0.004)
Removal Efficiency for Elem I:	12.9% in A, 99.6% in MC, equivalent to 99.6% overall

Flow Path to Main Condenser through Steam Line B:

Volumetric flow rate out of B2:	37.4 cfh (0.489x76.5 cfh)
Removal Efficiency for Particles:	96.9 % in B1, 79.4% in B2, 99.6% in MC (99.997% overall)
Removal Efficiency for Elem I:	37.7 % in B1, 28.2% in B2, 99.6% in MC (99.8% overall)

Condenser Bypass Leakage

Bypass of the main condenser may occur due to direct leakage from the steam lines to the HP turbine and then to the turbine building. In the updated calculation, this bypass leakage amounts to 51.1% of the steam line leakage. This bypass will experience removal in the steam lines, but not in the main condenser.

Flow Path to Turbine Building through Steam Line A:

Volumetric flow rate out of A:	93.8 cfh (0.511x183.55 cfh)
Removal Efficiency for Particles:	90.2% in A
Removal Efficiency for Elem I:	12.9% in A

Flow Path to Turbine Building through Steam Line B:

Volumetric flow rate out of B2:	39.1 cfh (0.511x76.5 cfh)
Removal Efficiency for Particles:	96.9 % in B1, 79.4% in B2 (99.4% overall)
Removal Efficiency for Elem I:	37.7 % in B1, 28.2% in B2 (55.2% overall)

7.0 Summary of Results

	Flow Rate (over 30 days)			Removal Efficiency for Particulates	Removal Efficiency for Elemental I
	Out of DW (CFH)	Out of A/B2 (CFH)	Out of MC (CFH)		
Steam Line Leakage (via MC)	21.75 (78.1)	127.2 (456.3)	66.4 (239.3)	99.97% (99.9%)	99.70% (99.0%)
MC Bypass (DW to TB)	22.73 (0.4)	132.9 (2.29)	N/A	92.9% (89.2%)	25.3% (16.3%)

Note: Values in parentheses are from Revision 2 of this Calculation and are provided for comparison purposes only.

8.0 Conclusion:

This document presents a calculation of aerosol and elemental iodine removal efficiencies in the steam line and main condenser for the purposed of Alternative Source Term Dose Calculations

9.0 References:

E1. TVA Calculation NDQ0031920075, "Control Room and Offsite Doses Due to a LOCA," Revision 22. (For information only).

E2. NUREG-0800, Standard Review Plan, Section 6.5.2.

E3. TVA Calculation NDQ0999980016, "Parameters Used in Dose Analyses, Revision 8."

E4. AEB 98-03, "Assessment of Radiological Consequences for the Perry Pilot Plant Application Using the Revised (NUREG-1465) Source Term" Appendix A, 1998.

E5. NUREG/CR-6604, "RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation," December 1997.

E6. a. Drawing 1-47E801-1 "Mechanical Flow Diagram Main Steam"
b. Drawing 2-47E801-1 "Flow Diagram Main Steam"
c. Drawing 3-47E801-1"Flow Diagram Main Steam."

E7. MDQ001870126, Rev. 11, "Evaluation of MSSRV Inlet Piping and MS Drain Line Piping Size."

Table E-1

Table E-2

Calculation No. NDQ099920010019	Rev: 003	Plant: BFN	Page: E21
Subject: Ex-Containment Removal Coefficients for Alternative Source Term Analyses Appendix E	Prepared:	Date:	
	Checked:	Date	

Table E-3

Calculation No. NDQ099920010019	Rev: 003	Plant: BFN	Page: E23

Subject: Ex-Containment Removal Coefficients for Alternative Source Term Analyses Appendix E	Prepared:	Date:
	Checked:	Date

ATTACHMENT 7

NDQ0031920075
Control Room and Offsite Doses Due to a LOCA

QA Record

ORIGINAL

NPG CALCULATION COVERSHEET / CTS UPDATE

REV 0 EDMS/RIMS NO.	CTS TYPE:	EDMS TYPE:	EDMS ACCESSION NO (N/A for REV. 0)
R14920727107	Calculation	Calculations (nuclear)	R14 131029 104

Calc Title: Control Room and Offsite Doses Due to a LOCA

	ORG	PLANT	BRANCH	NUMBER	CUR REV	NEW REV
CALC ID	NUC	BFN	NTB	NDQ0031920075	021	022

CTS UPDATE ONLY ☐ (Verifier and Approval Signatures Not Required)

NO CTS CHANGES ☐ (For calc revision, CTS has been reviewed and no CTS changes required)

UNITS (check one)	SYSTEMS	UNIDS
☒ 0 ☐, 1 ☐, 2 ☐, 3 ☐	031	N/A

DCN,EDC,N/A	APPLICABLE DESIGN DOCUMENT(S)	CLASSIFICATION
N/A	N/A	EO

QUALITY RELATED?	SAFETY RELATED? (If yes, QR = yes)	UNVERIFIED ASSUMPTION	SPECIAL REQUIREMENTS AND/OR LIMITING CONDITIONS?	DESIGN OUTPUT ATTACHMENT?	SAR/TS and/or ISFSI SAR/CoC AFFECTED
Yes ☒ No ☐	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☒ No ☐	Yes ☒ No ☐

CALCULATION NUMBER REQUESTOR	PREPARING DISCIPLINE	VERIFICATION METHOD	NEW METHOD OF ANALYSIS
Name: PHONE:	N	Design Review	☐ Yes ☒ No

PREPARER (PRINT NAME AND SIGN)	DATE	CHECKER (PRINT NAME AND SIGN)	DATE
Jun Li By Direction Thomas R Haffey	10-17-13	Dave Leaver BY DIRECTION	10-17-13
VERIFIER (PRINT NAME AND SIGN)	**DATE**	**APPROVAL (PRINT NAME AND SIGN)**	**DATE**
Dave Leaver BY DIRECTION	10-17-13	KEVIN L. GROOM	10/22/2013

STATEMENT OF PROBLEM/ABSTRACT

This calculation determines the control room operator and offsite doses due to a Loss of Coolant Accident (LOCA). Two Methodologies are included in this calculation.

1) The main body of the calculation performs the radiological dose calculations using the guidance of Regulatory Guide 1.3. Source terms are associated with power uprate (3458 Mwt) using the ORIGEN computer code and multiplied by 102% per Regulatory Guide 1.3. The computer Code STP was used to determine the releases. The releases were used as input to the computer code COROD to determine the control room doses and the computer code FENCDOSE to determine the offsite doses. The doses associated with the 168 scfh total MSIV valve leakage was determined separately by GE and added to the results of this calculation. This methodology reflects the licensing basis prior to AST approval by the NRC for BFN. The results of this calculation show that the radiological dose limits of 10CFR50 Appendix A GDC 19 (control room dose) and 10CFR100 (offsite dose) are met for the LOCA.

2) Appendices B and C contain the radiological dose calculations based upon Alternative Source Term (AST) using the regulatory guidance of Regulatory Guide 1.183 for Units 1, 2 and 3. Source terms are associated with 102% of extended power uprate (3952 x 102% =4031 MWt) using the ORIGEN2 computer code. The computer code RADTRAD was used to determine the doses. The methodology reflects the current licensing basis since AST approval by the NRC for BFN has been obtained. The results of this analysis show that radiological dose limits of 10CFR50.67 are met for the LOCA. Appendix C provides independent review of Appendix B.

Appendices D and E represent the original analysis and independent review for AST. They are retained for historical purposes as well as providing references for the revised analysis. Appendix H is also retained since it applied the analyses of Appendices D and E to Unit 1. Appendices F &G evaluate the effect of alternate CREVS flows on the radiological dose results for methods 1 and 2 above, showing that regulatory criteria continue to be met for the applicable conditions.

Revision 22 adds Appendix I, which performs the AST analysis in Appendix B with a reduced MSIV leak rate and a reduced main condenser flow area fraction. The purpose of this is to calculate control room and offsite doses assuming that only the alternate leak treatment secondary flow path is available. Revision 22 also addresses PER 695918-001.

MICROFICHE/EFICHE Yes ☒ No ☐ FICHE NUMBER(S)

NPG CALCULATION COVERSHEET / CTS UPDATE

CALC ID	ORG	PLANT	BRANCH	NUMBER	REV
	NUC	BFN	NTB	NDQ0031920075	022

BLDG	ROOM	ELEV	COORD/AZIM	FIRM
NA	NA	NA	NA	WorleyParsons, Inc

CATEGORIES

KEY NOUNS (A-add, D-delete)

ACTION (A/D)	KEY NOUN	A/D	KEY NOUN

CROSS-REFERENCES (A-add, C-change, D-delete)

ACTION (A/C/D)	XREF CODE	XREF PLANT	XREF TYPE	XREF NUMBER	XREF REV
A	P	BFN	PER	695918-001	

CTS ONLY UPDATES:
Following are required only when making keyword/cross reference CTS updates and page 1 of form NEDP-2-1 is not included:

PREPARER (PRINT NAME AND SIGN)	DATE	CHECKER (PRINT NAME AND SIGN)	DATE
PREPARER PHONE NO.	EDMS ACCESSION NO. R14 131029 104		

TVAN CALCULATION RECORD OF REVISION	
CALCULATION IDENTIFIER NDQ0031920075	
Title	Control Room and Offsite Doses due to a LOCA
Revision No.	**DESCRIPTION OF REVISION**
0	Initial Issue
1	Pages changed: Coversheet, Rev Log, 5, 22, 23, 25, 28-30, 32-35, Attachment 3 (2 pages) Pages deleted: Abstract, 1-4, 6-21, 24, 26, 27, 31, 36-40, Attachment 3 (1 page), Attachment 2 (2 pages), Attachment 5 (1 page) Pages added: Abstract, 1-4, 6-21, 24, 26, 27, 31, 36-38, 38A, Classification & Categorization sheets (2), Independent Review Sheet, Attachment 9 (6 pages), Attachment 10 (7 pages), Attachment 3 (3 pages), Attachment 11 (5 pages)
2	Pages added: none Pages deleted: R0,1: Class & Cat Sheets (4), Ind. Reviews (2), 38, 38A (Page #'s only) Pages changed: Coversheet, Abstract, Rev Log, Classification Sheets, Ind. Review Form, 1, 7, 8, 9, 10, 15, 18, 19, 21, 23-37 Number of Pages in R2: 80 This revision was to change the reactor building's mixing volume and flow rates.
3	Added Attachment 12 - Calculation of doses due to stack leakage through 3 inch drain line. Pages added: Attachment 3 (6 pages), Rev Log (1 page) Classification & Categorization Sheets (2 pages), Independent Review (1 page) Pages deleted: None Pages changed: Coversheet, Abstract, Table of Contents (page 1 of calc)
4	Revised calculation to reflect DCN W17999 which installs automatic backdraft dampers in the offgas stack which reduced base of stack release to 5 cfm continuous. Increased scope of calculation to include Unit 3. See Sheets 7 + 8 for U1 restriction. Calc number updated to Unit 0, Unit 3 added to unit applicable. Pages added: Revision 4 Coversheet, Calc Classification and Categorization sheets (2), Independent Review sheet Pages deleted: None Pages changed: Revision 0 Coversheet, Coversheet Sheet 1 of 1, Pages 2, 3 thru 11, 13, 14, 16 thru 20, 21, 23 thru 34, 36, 37
5	Added cases for CREVs flow rate of 1500 cfm and 0 cfm. Pages added: Additional Rev Log Sheet, Calc Classification Sheets (2), Independent Review Sheet, Page 37A, Attachment 13 (59 pages) Pages deleted: None Pages changed: Coversheet, Coversheet Continuation Sht 1 of 1, Pages 8, 29, 34, 36
6	Evaluated 10 scfh leakage through hardened wetwell vent valves. Deleted Attachment 12 since DCN S24922 authorized the opening of the stack drain valves and demonstrated that no ground level radiological release would occur. Hardened wetwell vent installed by DCNs: W17337 common, W17491 U2, W17931 U3. Pages added: Attachment 14 (4 pages), Independent Review Sheet (1 page) Pages deleted: Calc Classification sheets for Revisions 2, 3 and 4, Attachment 12 (Total of 12 pages) Pages changed: Coversheet, Coversheet Continuation, Table of Contents, Shts 2, 5, 7, 15, 20, 21, 24, 36

TVAN CALCULATION RECORD OF REVISION	
CALCULATION IDENTIFIER NDQ0031920075	
Title	Control Room and Offsite Doses due to a LOCA
Revision No.	DESCRIPTION OF REVISION
7	This revision evaluated the dose to the control room from a base of stack release rate of 10 cfm for the duration of the accident (30 days). This dose was added to the model and a new total dose was calculated. Microfiche #TVA-F-A000038. Revision 7 contains a total of 161 pages Pages added: coversheet, abstract, revision log, calculation classification and categorization (2), independent review form, computer file storage information sheet, Appendix A (3 sheets) Pages deleted: none
8	Revision 8 was performed to incorporate new X/Q values and to include both east and west control room intakes in the calculation. The Hardened Wet Well Vent leakage of 10 cfh was modified to start later in the accident to simulate the finite travel time to the stack. The MSIV leakage component was eliminated from the analysis. Incorporated Appendix A into the text. This calculation is in support of UFSAR (section 14.6.3) change package RIMS# R92 980427 958, SA RIMS# R92 980427 959, and SE RIMS# R92 980427 960. Pages added: independent review, microfiche information sheet Pages changed: cover, calculation classification forms (2 pages), computer input storage information sheet, 1-4, 6, 8, 9, 12-15, 18, 19, 21-36 Pages deleted: p2 of abstract, classification forms, (R5, 2 pages), Appendix A, Attachments 8-11, Attachment 14 R8: 131 total pages
9	Revision 9 was performed to reincorporate the MSIV leakage, add ECCS leakage, changed the initial source terms from TID-14844 to the ORIGEN 1400 EFPD, 4.1 weight percent U-235 (GE11) fuel values as determined by GE at the 3458 MW power level, utilized new X/Q values based on ARCON96, and added the offsite dose to the calculation (includes changing the title of the calculation). Since the calculation was completely rewritten, no revision bars are used. Included in this calculation are cases for reduced CREVS flow (1500 cfm), and no CREVS flow (to bound delayed startup or no flow during switchover from one train to another). Preparation and checking of this calculation was initiated during NEDP-2 R0. Where possible NEDP-2 R1 forms have been incorporated. Otherwise, the calculation conforms to R0 specifications. This administrative action is acceptable: original signed by Peter G. Studer checker Pages added: all Pages deleted: all Pages changed: all R9: 34 total pages
10	Revision 10 is performed to correct a typographical error in the results section and coversheet. This was the only change in R10. Pages changed: 1, 2, 3, 30 Pages deleted: none Pages added: none

TVAN CALCULATION RECORD OF REVISION

CALCULATION IDENTIFIER NDQ0031920075

Title Control Room and Offsite Doses due to a LOCA

Revision No.	DESCRIPTION OF REVISION
11	Revision 11 is performed to increase the MSIV leakage from 11.5 scfh/valve to 200 scfh/valve (400 scfh maximum which equates to 100 scfh/valve average). Pages changed: 1-3, 6, 7, 9-11, 13, 16-18, 20-22, 24-31 Pages deleted: none Pages added: none Revision 11 contains 37 total pages
12	Revision 12 is performed to incorporate corrected MSIV leakage doses performed by GE at 168 scfh total leakage. This is part of corrective action of corrective action of Corp. PER 99-000069-000. Also, the control room top of stack X/Q values were changed (no longer ARCON96 methodology). This is part of corrective action of BFN PER 00-000813-000. All pages were renumbered, only text with changes will have a revision bar Pages changed 1a(old cover), 22, 3, 5-8, 10, 13-16, 18-20, 22-31 Pages added: 1 (new cover) Pages deleted: none R12: 38 total pages The UFSAR revision associated with this calculation cannot be issued until NRC approval of Tech Spec change 399 and implementation of DCNs T41019 (U3) and T41182 (U2).
13	Revision 13 is performed to include the GE generated 11.5 scfh/valve MSIV leakage dose values. This is done to show that the plant never exceeded the 10CFR100 and 10CFR50 App.A GDC 19 limits due to the X/Q errors described in BFN PER 00-000813-000 and in conjunction with power uprate. This revision does not change the revision 12 results for increased MSIV leakage and reflects how the plant is currently operating (March 2000). Pages added: 32-35 Pages deleted: none Pages changed: 1, 2, 3, 8, 30, 31 R13: 42 total pages
14	Revision 14 is performed to add top of stack release rates as design output for EOI input. Pages were renumbered, therefore only actual text changes are marked with revision bars. This revision supersedes ND-Q0065-920018. Pages added: Design Output Pages changed: 1, 2, 3, 4, 7, 29-32, 35 pages deleted: none R14: 47 total pages

TVAN CALCULATION RECORD OF REVISION	
CALCULATION IDENTIFIER NDQ0031920075	
Title	Control Room and Offsite Doses due to a LOCA
Revision No.	DESCRIPTION OF REVISION
15	Revision 15 is performed to add two source term analyses for the Alternative Source Term (AST): one with credit for drywell sprays [Appendix B (including B-1 through B-6), Appendix B Design Output, Appendix C (including (C-1 through C-4)] and one without credit for drywell sprays [Appendix D (including D-1 through D-6), Appendix D Design Output, Appendix E (including (E-1 through E-3)]. Pages changed: all, due to revised 2-page cover sheet and now 5-page record of revision Pages added: 46 through 229 Total pages this revision: 229 This calculation revision is part of the Alternative Source Term (AST) radiological dose determination methodology implementation consistent with the guidance and requirements presented in 10 CFR 50.67, 'Accident Source Term' and Regulatory Guide 1.183, 'Alternative Radiological Source Terms for Evaluating Design Basis Accidents At Nuclear Power Plants'. 10 CFR 50.67(b)(1) states in part 'A licensee who seeks to revise its current accident source term in design basis radiological consequence analyses shall apply for a license amendment under 50.90'. Therefore, this calculation revision is within the scope of 10 CFR 50.90 and not within the scope nor applicability of 10 CFR 50.59. FSAR Sections 1, 3, 4, 6, 7, 10, & 14 and the Technical Specifications have been reviewed for changes associated with this revision. This calculation revision reflects parameters, values, and methods associated with the implementation of AST. AST requires the approval of a license amendment by the NRC and will involve revisions to multiple sections of the FSAR and Technical Specifications. Incorporation of AST conditions into the FSAR and Technical Specifications will be accomplished as part of the implementation of the AST license amendment following NRC approval. original signed by D. Housley
16	Revision 16 is performed to examine the impact of CREVS flow with reduced control room makeup and unfiltered flows. This is in response to BFN PER 02-15729. The reduce control room flows are 1500 cfm or 2500 cfm for makeup flow, and 2000 cfm unfiltered flow. SAR section 14.6 has been reviewed by Don McCamy and this revision of the calculation does not affect the SAR. This revision does not change the design basis assumptions for in leakage (3717 CFM) or CREV flow (3000 CFM), but only evaluates the reduced flows for a specific condition. Tech Specs have been reviewed and determined not to be affected. Pages changed: 1, 2, 7-11, 40 Pages added: 230, 231 Pages deleted: none R16: 231 total pages

TVAN CALCULATION RECORD OF REVISION	
CALCULATION IDENTIFIER ND-Q0031-920075	
Title	Control Room and Offsite Doses Due to a LOCA
Revision No.	DESCRIPTION OF REVISION
16	Revision 16 is performed to examine the impact of CREVS flow with reduced control room makeup and unfiltered flows. This is in response to BFN PER 02-15729. The reduce control room flows are 1500 cfm or 2500 cfm for makeup flow, and 2000 cfm unfiltered flow. SAR section 14.6 has been reviewed by Don McCamy and this revision of the calculation does not affect the SAR. This revision does not change the design basis assumptions for in leakage (3717 CFM) or CREV flow (3000 CFM), but only evaluates the reduced flows for a specific condition. Tech Specs have been reviewed and determined not to be affected. Pages changed: 1, 2, 7-11, 40 Pages added: 230, 231 Pages deleted: none R16: 231 total pages
17	Revision 17 is performed to examine the impact of CREVS flow (varied control room makeup) with an unfiltered inleakage of 3717 cfm for the AST. Only the case without sprays (Appendix D) is examined, since the case with spray (Appendix B) would be less bounding. The impact is discussed in Appendix G. This revision also clarifies the closure time of the MSIVs and the impact on the DBA-LOCA dose analysis using the AST. Pages changed: 1, 2, 7, 8, 9, 48, 154, 162, 163, 167, 168, 172, 181, 183, 184 Pages added: 232, 233 Pages deleted: none R17: 233 total pages This calculation revision is part of the Alternative Source Term (AST) radiological dose determination methodology implementation consistent with the guidance and requirements presented in 10CFR50.67, 'Accident Source Term' and Regulatory Guide 1.183, 'Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Plants'. 10CFR50.67(b)(1) states in part 'A licensee who seeks to revise its current accident source term in design basis radiological consequence analyses shall apply for a license amendment under 50.90'. Therefore, this calculation revision is within the scope of 10CFR50.90 and not within the scope nor applicability of 10CFR50.59. FSAR Section 14.6 and the Technical Specifications have been reviewed for changes associated with this revision. This calculation revision reflects parameters/values associated with the implementation of Extended Power Uprate (EPU) and AST. EPU and AST require the approval of license amendments by the NRC and will involve revisions to multiple sections of the FSAR and Technical Specifications. Incorporation of EPU & AST conditions into the FSAR and Technical Specifications will be accomplished as part of the implementation of the license amendments following NRC approval. 1/21/03

TVAN CALCULATION RECORD OF REVISION	
CALCULATION IDENTIFIER NDQ0031920075	
Title	Control Room and Offsite Doses due to a LOCA
Revision No.	**DESCRIPTION OF REVISION**
17	Revision 17 is performed to examine the impact of CREVS flow (varied control room makeup) with an unfiltered inleakage of 3717 cfm for the AST. Only the case without sprays (Appendix D) is examined, since the case with spray (Appendix B) would be less bounding. The impact is discussed in Appendix G. This revision also clarifies the closure time of the MSIVs and the impact on the DBA-LOCA dose Analysis using the AST. Pages changed: 1, 2, 7, 8, 9, 48, 154, 162, 167, 168, 172, 181, 183, 184 Pageds added: 232, 233 Pages deleted: none R17: 233 total pages This calculation revision is part of the Alternative Source Term (AST) radiological dose determination methodology implementation consistent with the guidance and requirements presented in 10 CFR 50.67, 'Accident Source Term' and Regulatory Guide 1.183, 'Alternative Radiological Source Terms for Evaluating Design Basis Accidents At Nuclear Power Plants'. 10 CFR 50.67(b)(1) states in part 'A licensee who seeks to revise its current accident source term in design basis radiological consequence analyses shall apply for a license amendment under 50.90'. Therefore, this calculation revision is within the scope of 10 CFR 50.90 and not within the scope nor applicability of 10 CFR 50.59. FSAR Section 14.6 and the Technical Specifications have been reviewed for changes associated with this revision. This calculation revision reflects parameters, values, and methods associated with the implementation of Extended Power Uprate (EPU) and AST. EPU and AST require the approval of license amendments by the NRC and will involve revisions to multiple sections of the FSAR and Technical Specifications. Incorporation of EPU & AST conditions into the FSAR and Technical Specifications will be accomplished as part of the implementation of the license amendments following NRC approval. original signed by D. Housley
18	This revision includes editorial changes only. The coversheet abstract is re-written. The revision log is also re-formatted and the Description of Revision for Revision 15, which was inadvertently omitted from the revision log in the last revision, has been added. Pages changed: 1 through 7 Pages added: none Pages deleted: none R18: 233 total pages UFSAR Section 14.6 has been reviewed and this revision of the calculation does not affect the SAR. Technical Specifications has been reviewed and determined not to be affected.

<table>
<tr><th colspan="2">TVAN CALCULATION RECORD OF REVISION</th></tr>
<tr><td colspan="2">CALCULATION IDENTIFIER NDQ0031920075</td></tr>
<tr><td>Title</td><td>Control Room and Offsite Doses due to a LOCA</td></tr>
<tr><th>Revision No.</th><th>DESCRIPTION OF REVISION</th></tr>
<tr><td>19</td><td>This revision makes the calculation applicable to Unit 1 by adding Appendix H and incorporates the reference to ND-Q0999-980016, Revision 6 instead of to RIMS # R05020325113 for design input. This revision also corrects the reference for the effective condenser volume in Appendices B and D.

Pages Changed: 1, 2, 9, 47-51, 53, 59, 133, 152-155, 157, 163, 216
Pages Added: 234 to 241
Pages Deleted: none
R19: 241 total pages

FSAR Section 14.6 and the Technical Specifications have been reviewed for changes associated with this revision. This calculation revision reflects parameters, values and methods associated with the implementation of Extended Power Uprate (EPU) and AST. EPU and AST require the approval of license amendments by the NRC and will involve revisions to multiple sections of the FSAR and Technical Specifications. Incorporation of EPU & AST conditions into the FSAR and the Technical Specifications will be accomplished as a part of the implementation of the licensing amendments following NRC approval.</td></tr>
<tr><td>20</td><td>This revision determines the maximum increase in ESF Leakage allowable, while staying within the 10% of the existing margin by manipulating data from a previous RADTRAD analysis without sprays, (Appendix D). Dose contribution from ESF leakage was addressed in the CR, EAB, LPZ doses. Appendix I Design Output for a 300% increase in ESF Leakage (from 5 gpm to 20 gpm) was calculated from the data provided in Appendix D.

Pages Changed:
Pages Added: 242 to 246
Pages Deleted: none
R20: 246 total pages</td></tr>
<tr><td>21</td><td>Revision 21 Analysis was performed entirely by Polestar Applied Technology, Inc. TVA has endorsed this calculation by adding a new calculation cover sheet for use with EDC 69199A and has made editorial and administrative changes to the Polestar coversheet, revision log and Appendix B Design Output Sheet as required. No technical changes were made during this endorsement.

This revision replaces Appendices B and C which now serve as the licensing basis radiological dose calculations based upon Alternative Source Term (AST) using the regulatory guidance of Regulatory Guide 1.183 for Units 1, 2 and 3 and show that radiological dose limits of 10CFR50.67 are met for the LOCA. Appendix C provides independent review of Appendix B. The revised Appendix B is identical to the Appendix D (original AST) with the following exceptions: (1) no filter is credited for the Control Room makeup; (2) the stack bypass is increased from 10 to 20 cfm; (3) ESF is increased from 2.5 to 10 gpm (analyzed as 20 gpm); (4) the U1 Reactor Bldg volume is used rather than the U2/3 RB volumes (for conservatism); (5) the more limiting U1 Turbine Bldg Exhaust Release X/Qs are used.

Pages Changed: Pages 1, 2, 8, 9 and 46 onward. The following pages have page number changes only: 142-151, 153-169, 194-218, 220, 222-227, 231-244, 247-254
Pages Added: Pages 1A, 247-254
Pages Deleted: Appendix I (page numbers reused during renumbering)
R21: 255 total pages
Reviews of the SAR, ISFSI SAR, Tech Specs and ISFSI CoC are performed by EDC 69199A.</td></tr>
</table>

NPG CALCULATION RECORD OF REVISION	
CALCULATION IDENTIFIER NDQ0031920075	
Title	Control Room and Offsite Doses due to a LOCA
Revision No.	DESCRIPTION OF REVISION
022	Revision 22 adds Appendix I, which performs the AST analysis in Appendix B with a reduced MSIV leak rate and a reduced main condenser flow area fraction. The MSIV leak rate is being decreased from 100/150 SCFH to 60/85 SCFH and the main condenser flow area fraction is being reduced from 99.5% to 48.9%. The purpose of this is to calculate control room and offsite doses assuming that only the alternate leak treatment secondary flow path is available. Appendix I will be used to support a license amendment request. Revision 22 also addresses PER 695918-001. The following has been added to the ESF leakage description in Appendix B. (Clarification Statement: ESF leakage is conservatively assumed to be 20 GPM in the analysis. 20 GPM is validated by technical instruction (i.e. 0-TI-578) acceptance criteria of 10 GPM.) 10-18-13 SAR and ISFSI SAR have been reviewed by Thomas E. Hyde and this revision of the calculation does not impact the SAR or the ISFSI SAR. Tech Specs and ISFSI CoC have been reviewed and determined not to be impacted. Successor Calculations impacted by this revision NDQ000020020029 Dose Resulting From Shield Block Removal NDQ0000950017 Mild Environment Equipment Qualification Doses NDQ0000990011 Mission Dose To Restart Control Bay Chillers Following An Accident NDQ0031890035 Dose During A Mission On Outside The Main Control Room NDQ0031920117 Control Room Emergency Ventilation System (CREVS) Filter Dose NDQ0043900029 Post Accident Sampling System Doses NDQ0090950024 Dose To Personnel Handling WRGERMS Filter Pages added: 8a, 9a, Appendix I pages 255 - 448 Pages deleted: 1a Pages changed: 1, 2, 9, 10, 11, 46, 152 Total number of pages 450

NPG CALCULATION TABLE OF CONTENTS

Calculation Identifier: NDQ0031920075	Revision: 022

TABLE OF CONTENTS

NPG CALCULATION TABLE OF CONTENTS

Calculation Identifier: NDQ0031920075	Revision: 022

TABLE OF CONTENTS

TVAN COMPUTER INPUT FILE STORAGE INFORMATION SHEET			
Document NDQ0031920075	Rev. 022	Plant: BFN	
Subject: Control Room and Offsite Doses Due to a LOCA			
☐ Electronic storage of the input files for this calculation is not required. Comments:			
■ Input files for this calculation have been stored electronically and sufficient identifying information is provided below for each input file. (Any retrieved file requires re-verification of its contents before use.)			
The computer input for R8 is permanently stored in FILEKEEPER file # 301063 The computer input for R9 is permanently stored in FILEKEEPER file # 301864 The computer input for R11 is permanently stored in FILEKEEPER file # 302442 The computer input for R12 is permanently stored in FILEKEEPER file # 302723 The computer input and files for R22 is permanently stored in FILEKEEPER file # 322643			

TVA

TVAN COMPUTER OUTPUT
MICROFICHE INFORMATION SHEET

Document **ND-Q0031-920075**	Rev. 022	Plant: BFN

Subject:
Control Room and Offsite Doses Due to a LOCA

Microfiche Number	Description CR & offsite dose from stack base
R7:TVA-F-A000038 R8:TVA-F-A000050 R9:TVA-F-A000066 R11 :TVA-F-A000074 R12: TVA-F-A000076	

R12 output

Name	Code	Description Releases
N9275S12	STP	control room dose, stack base, west (U1 side) intake,3000 cfm CREVS
N975C12A	COROD	control room dose, stack base, east (U3 side) intake,3000 cfm CREVS
N975C12B	COROD	control room dose, stack top, west (U1) intake,3000 cfm CREVS
N975C12C	COROD	control room dose, stack top, east (U3) intake,3000 cfm CREVS
N975C12D	COROD	control room, base, west (151 side) intake, 1500 cfm CREVS
N975C12E	COROD	control room, base, east (U3 side) intake, 1500 cfm CREVS
N975C12F	COROD	control room, stack top, west (U1) intake, 1500 cfm CREVS
N975C12G	COROD	control room, stack top, east (U3) intake, 1500 cfm CREVS
N975C12H	COROD	control room, base, west (U1 side) intake, 0 cfm CREVS
N975C12I	COROD	control room, base, east (U3 side) intake, 0 cfm CREVS
N975C 12J	COROD	control room, stack top, west (U1) intake, 0 cfm CREVS
N975C12K	COROD	control room, stack top, east (U3) intake, 0 cfm CREVS
N975C12L	COROD	offsite dose, base of stack release
N975F12A	FENCDOSE	offsite dose, top of stack release
N975F12B	FENCDOSE	offsite dose, top of stack release, fumigation conditions
N975F12C	FENCDOSE	

R22: TVA-F-U002284

Name	Code	Description
StackBaseFinal.o0	RADTRAD	CR & offsite dose from stack base
StackTopFinal.o0	RADTRAD	CR & offsite dose from stack top
TBRoofFinal.o0	RADTARD	CR & offsite dose from TB roof
StackBase_ESF.o0	RADTRAD	CR & offsite dose from stack base, ESF System release
StackTop_ESF.o0	RADTRAD	CR & offsite dose from stack top, ESF System release
StackBase.out	STARDOSE	CR & offsite dose from stack base
StackTop.out	STARDOSE	CR & offsite dose from stack top
TBRoof.out	STARDOSE	CR & offsite dose from TB roof
StackTopFinal'.o0	RADTRAD	CR & offsite dose from stack top (fumigation)
StackTop_ESF'.o0	RADTRAD	CR & offsite dose from stack top, ESF System release (fumigation)
StackTop_ESF4EAB.o0	RADTRAD	CR & offsite dose from stack top, ESF System release (EAB)
StackTop4EAB.out	STARDOSE	CR & offsite dose from stack top (EAB)
StackTopFinal4EAB.o0	RADTRAD	CR & offsite dose from stack top (EAB)

Purpose

The purpose of this calculation is to determine the control room and offsite doses following a Regulatory Guide 1.3 (ref.1) Loss of Coolant Accident (LOCA). This calculation is being performed in order to demonstrate compliance with 10CFR50 App.A GDC 19 (control room operator dose) and 10CFR100 (offsite dose).

Introduction

Guidelines for determining the radiological consequences due to a design basis Loss of Coolant Accident (LOCA) for a boiling water reactor are presented in Regulatory Guide 1.3 (ref.1). These guidelines provide the bases for this analysis. The computer code STP (ref.3) is used to determine the activity released to the environs during the 30 days following the LOCA, the computer code COROD (ref.4) is used to determine the resulting control room doses, and the computer code FENCDOSE (ref.5) is used to determine the resulting offsite dose. The control room and offsite dose contribution due to MSIV leakage was determined independently by GE and is incorporated into this calculation. Revision 12 changes the MSIV leakage to 168 scfh total and changes the control room/top of stack X/Q values. Revision 14 is performed to provide the top of stack release rates as design output in order to provide input to Emergency Operating Instructions (EOIs). Inclusion of this information into this calculation allows this calculation to supersede ND-Q0065-920018.

This calculation also investigates the impact on the control room dose of reduced CREVS flow and no CREVS flow (such as might occur with delayed CREVS startup or switching trains).

Design Input

Core inventory of iodines and noble gasses are from ND-Q0999-980016 (ref.2). These are the source terms associated with Power Uprate, 24 month fuel cycles and high fuel discharge burnup using the ORIGEN computer code. The total burnup is 1400 EFPD with initial inventory of 4.1 weight percent U-235 (GE11 fuel) at the 3458 MW power level.

SGTS exhaust Flow: 24,750 cfm. This value is for 3 SGTS trains running. (ref.2)

Hardened Wetwell Valve (HWWV) Leakage: 10 scfh with a delay of 8 hours for the start of the leakage (ref.2)

Base of Stack Leakage: 10 cfm, (ref.2)

Control Room Makeup Flow Rate: 3000 cfm, (ref.2)

Control Room Unfiltered Inleakage: 3717 cfm, (ref.2)

Containment Atmospheric Dilution (CAD) System Flow Rate: 139 cfm for 24 hrs at 10 days, 20 days, 29 days, (ref.2)

MSIV leakage = 168 scfh total, this translates to a time dependent total flow for 4 valves of: (ref.2)

Time-hr	Total Leakage [cfh]
0.009576	72.47
0.01224	73.44
0.018288	73.93
0.018648	73.93
0.073056	66.26
0.154296	33.28
0.281904	25.79
0.884064	26.69
5.33472	27.85
11.14896	24.63
24	19.78
48	16.74
120	14.66
240	12.38
960	10.98
1440	10.39
2400	9.75

Turbine Roof Exhaust Rate: 144,000 cfm, (ref.2).

ECCS Leakage Into Reactor Building: 5 gpm, (ref.2)

Turbine Building Free Volume: 2,100,000 cuft, (ref.2)

Reactor Building + Refueling Floor Free Volume: U2/U3: 1,931,502 cuft, (ref.2). Note: Use of this volume is for when the SGTS is in operations since the SGTS takes suction from both the Reactor Building and the Refueling Floor Free Volume.

Control Room Free Volume: 210,000 cuft (includes U1, U2, and U3 since serviced by common HVAC, ref.2).

Drywell and Torus Free Volume: 283,00 cuft, (ref.2)

Condenser Volume: 125,000 cuft, (ref.2) (=2/3 for conservatism of sum of condenser, 136,000 cuft, and low pressure turbine, 51,000 cuft)

Stack Room Free Volume: 69120 cuft, (ref.2) Note: use 50% of this volume for incomplete mixing.

ECCS volume 141,260 cuft (ref.2)

SGTS Charcoal Filter Efficiency: 90% organic and inorganic iodine, (ref.2)

CREVS Charcoal Filter Efficiency: 90% organic and inorganic iodine, (ref.2)

Control Room Dimensions: 464.5' x 36.83' x 15.33', (ref.2)

Control Room Ceiling Thickness: 2.25' of concrete, (ref.2)

ECCS maximum water temperature: 177 °F (ref.7)

Control Room Occupancy Factors: 100% 0-24 hours, 60% 1-4 days, 40% 4-30 days, ref.2

Control Room Gamma Dose Due to Secondary Containment: 667.0 mrem (ref.16, includes occupancy factors)

Doses [rem] Due to 168 scfh total MSIV Leakage and released through the Turbine Building Roof Ventilation as determined by GE and based on ICRP-30 conversion factors, ref.20: control room: 2.16E-2 rem gamma, 0.219 rem beta, 54.9 rem thyroid.

2-hr EAB: 1.55E-4 rem gamma, 5.77E-5 rem beta, 2.48E-3 rem thyroid

30-day LPZ: 0.145 rem gamma, 0.144 rem beta, 38.0 rem thyroid

Note: these values are the maximum dose for the 4 lines. The dose is based on the same parameters as utilized in this analysis. The control room dose <u>does</u> <u>not</u> contain the factor of 2 described below and assumption #4. The doses include the 1.02 factor described in assumption #7. And based on power of 3458 MWt.

The doses (and other parameters) due to 11.5 scfh/MSIV valve leakage can be found in Appendix A.

The following are the X/Q values (ref.2) used in this analysis (all units in sec/m³). Note that these values **<u>do not</u>** include the factor of 2 allowed by the Standard Review Plan section 6.4 (ref.6, page 6.4-10). Since the intakes are on opposite side of the building, and the makeup flow is taken equally from each intake, the dilution due to the other intake will reduce the dose by a factor of 2 (see assumption #4 and also ref.2).

Control Room:

Top of Stack Release:

	Unit 1 (West)	Unit 3 (East)	
0-30 min:	3.40E-5	3.02E-5	(fumigation conditions)
30 min - 2 hr:	9.08E-13	1.41E-7	(non-fumigation)
2 hr - 8 hr:	3.41E-13	4.50E-8	
8 hr - 1 day:	2.09E-13	2.54E-8	
1 day - 4 day:	7.21E-14	7.36E-9	
4 day - 30 day:	1.57E-14	1.24E-9	

Base of Stack Release:

0-30 min:	2.00E-4	8.60E-5
30 min - 2 hr:	2.00E-4	8.60E-5
2 hr - 8 hr:	1.28E-4	6.46E-5
8 hr - 1 day:	5.72E-5	2.80E-5
1 day - 4 day:	4.05E-5	2.00E-5
4 day - 30 day:	3.09E-5	1.53E-5

Turbine Building Roof Ventilators Release:

0 - 2 hr:	1.20E-4	2.17E-4
2 hr - 8 hr:	9.96E-5	1.64E-4
8 hr - 1 day:	4.85E-5	7.89E-5
1 day - 4 day:	3.15E-5	4.33E-5
4 day - 30 day:	2.02E-5	3.35E-5

EAB (0-2 hr, 1465 m):

Top of Stack Fumigation Release (0-30 min): 2.35E-5
Top of Stack Release (30 min-2 hr): 1.19E-6
Base of Stack Release: 2.62E-4
Building Releases: 2.62E-4

LPZ (3200m):

	0-2 hr	2-8 hr	8-24 hr	1-4 day	4-30 day
Top of Stack Fumigation:	1.26E-5 (0-30 min)				
Top of Stack Release:	1.13E-6	5.75E-7	4.10E-7	1.97E-7	6.88E-8
Base of Stack Release:	1.31E-4	6.61E-5	4.69E-5	2.23E-5	7.96E-6
Building Releases:	1.31E-4	6.61E-5	4.69E-5	2.23E-5	7.96E-6

Assumptions

1. It is assumed that 100% of core noble gasses, and 25% core iodines are instantaneously released to the drywell atmosphere at the start of the accident. The iodines are comprised of 4% organic, 91% elemental, and 5% particulate. For the purposes of this calculation, the elemental and particulate are lumped together (96% of total iodine). It is assumed that 50% of the core iodines are instantaneously released to the ECCS water at the start of the accident.

Technical Justification: These are requirements of Regulatory Guide 1.3 and the Standard Review Plan, Section 15.6.5 Appendix B (ref.6).

2. The drywell leak rate is 2% volume per day for 30 days.

Technical Justification: Regulatory Guide 1.3 (ref.1) section C.1.e states that the primary containment should be assumed to leak at the leak rate incorporated in the technical specifications for the duration of the accident. BFN Technical Specifications 5.5.12 (ref.18) allows a leak rate of up to 2% per day at the maximum design basis pressure.

3. 10% of the iodine in the ECCS leakage is assumed to become airborne.

Technical Justification: Per the Standard Review Plan section 15.6.5 Appendix B (ref.6), if the ECCS water is less than 212 °F, then 10% of the iodine in solution goes airborne. The ECCS maximum water temperature is 177°F (ref.7).

4. The control room doses may be divided by 2.

Technical Justification: According to Ref.(6), page 6.4-10: "With dual air inlets placed on plant structures on opposite sides of potential radiation release points (e.g., containment building) and capable of functioning with an assumed single active failure in the inlet isolation system, the following considerations may be applied to the evaluation of the control room X/Qs:
(i) Dual inlet designs without manual or automatic selection control ... [use] ... least favorable inlet location to estimate X/Qs. The estimated values can be reduced by a factor of 2 to account for dilution effects..."
Therefore, since the new BFN CREVS design will function with a single active failure and the new air inlets are on opposite sides of the Turbine Building, the factor of 2 reduction in X/Q [Equivalent to dividing the doses by 2] is applied to the total dose

5. The dose from both the top and bottom of the stack released during 0-30.0 minute time frame may be divided by a factor of 1.7 in order to account for the use of the ICRP-30 conversion factors; the dose released during the 30.0 minute to 30 day time frame may be divided by a factor of 1.35.

Technical Justification: The complete justification for the division by 1.7 is given in Reference (21) where the iodine isotopic spectrum weighted conversion factor in the COROD code and the iodine isotopic spectrum weighted conversion factor given by ICRP-30 are in the ratio of 1.7 for the first 30 minutes of the accident. The I-131 isotope is largely going to dominate the long term iodine release because the I-131 half life is about 8 days as opposed to a maximum of less than one day for any of the other iodine isotopes. The iodine conversion factors were compared between COROD and the CRAC2 code (see References 22-24), which used an early version of the ICRP-30 conversion factors, and this comparison shown on page 10 of Ref.(35) indicates that I-131 has the lowest ratio of the conversion factors: that is 1.48E6/1.1E6 =1.35. Hence utilizing the 1.35 ratio is conservative for times greater than 30.0 minutes. Reference 35 information for ICRP factors is independent of which unit it is applied to.

6. The leakage from the primary containment (drywell) to secondary containment (reactor building) is assumed to mix instantaneously and uniformly in the combined reactor and refueling floor volume (1,931,502 cuft for U2/U3, 1,311,209 cuft for U1) prior to entering the SGTS.

Technical Justification: Based on the physical configuration of the plant and engineering judgment this assumption is reasonable. The total leakage from the drywell can be expected to occur from a large number of different penetrations located on various elevations and drywell perimeter positions. The leakage must then pass through the reactor building free volume in order to reach an SGTS intake duct. As such, mixing with some potion of the reactor building air must occur. Furthermore, SGTS also takes suction from the refuel floor. This effectively means that regardless of how much air actually leaks into the refuel zone, the multiple suction locations effectively dilutes the air inside the SGTS. The use of the combined volume therefore covers all potential leak locations and scenarios. For more on the various leak locations and flow splits, see calculation - MD-Q0065-920473 (ref.8).

7. All source terms must be multiplied by 1.02.

Technical Justification: Per Regulatory Guide 1.49 (ref.17), the reactor power at the time of the accident is 102%. The source terms from reference 2 are for 100% power. Since the iodines and noble gasses have relatively short half lives, utilizing a factor of 1.02 will not result in a significant overestimate of the isotopes as they will be in equilibrium at the end of cycle. Note: the GE MSIV doses already include this factor.

8. The receptor point location in the COROD model was taken at 76.97 feet, 18.42 ft, 6.0 ft.

Technical Justification: This is as close to the geometric center of the control room as a six foot tall individual may be expected to be. This would result in the worst case location for whole body dose to an individual who is 6 feet tall.

Special Requirements/Limiting Conditions

There are no special requirements or limiting conditions associated with this calculation.

Computations

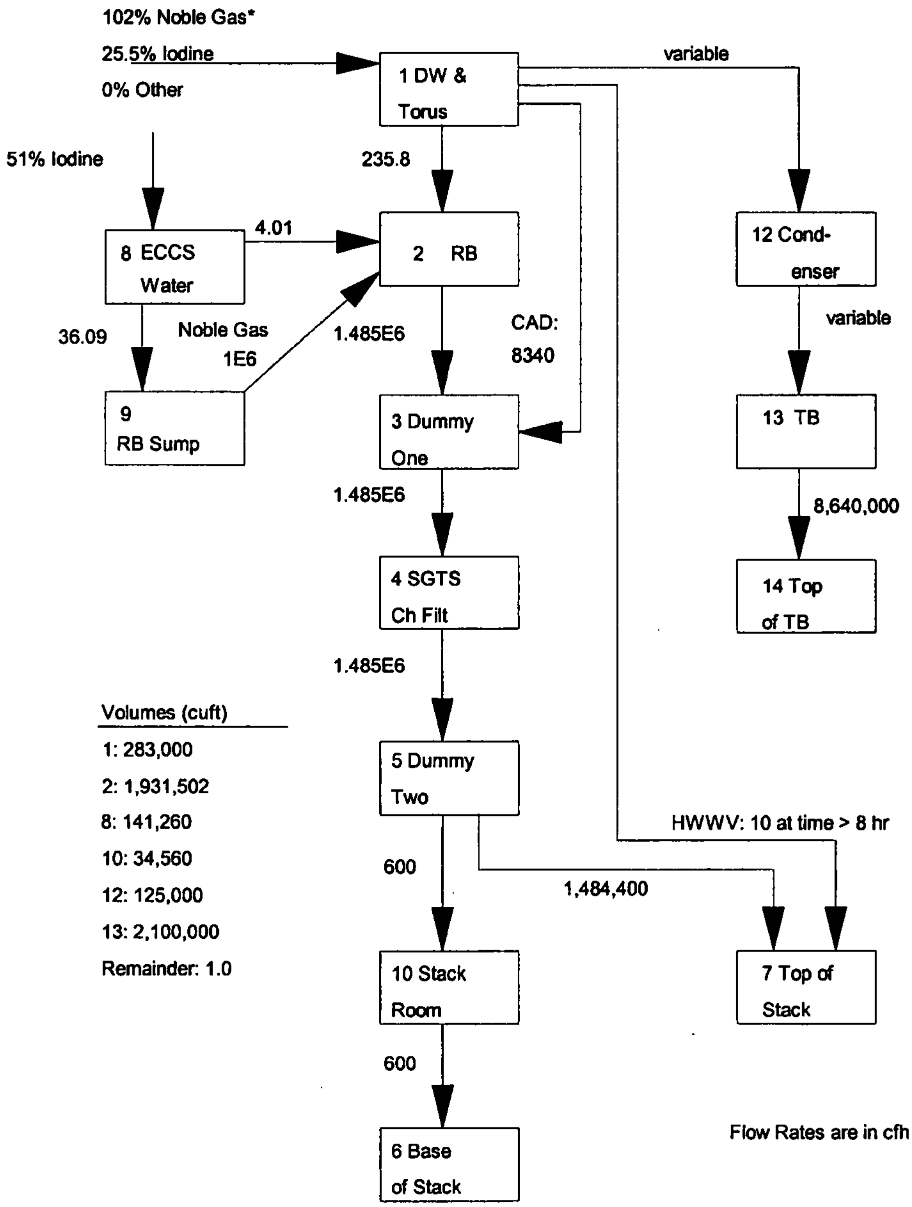
STP MODEL:

The STP (ref.3) model used determines the released activities from the top and base of the stack for the control room and offsite dose analyses is shown in Figure 1.In this model, the source term is released into the drywell and the ECCS water. These terms consist of 102% noble gasses (100*1.02), 25.5% iodines (25*1.02) in the drywell. 51% of the iodines (50%*1.02) is released into the ECCS. Note: previously Bromine was 51% release, however the Standard Review Plan only has Iodines as 50% (*1.02), with all others 1%(*1.02). Therefore, this calculation uses 1% (*1.02) for Bromine. The drywell leaks into the reactor building at the rate of 2%/day = 283,000 cuft*0.02/day*1day/24hr = 235.8 cuft/hr. The flow from the SGTS is split via a dummy volume with 10 cfm (600 cfh) going to the base of stack (through a stack room) and 24,750-10 = 24,740 cfm (1,484,400 cfh) directed to the top of the stack. The hardened wetwell vent (HWWV) valves (FCV-64-221, -222) provide a leakage path from the drywell to the top of stack of 10 cfh starting at 8 hours post LOCA. The ECCS water leaks into the reactor building at a rate of 5 gpm=60min/hr*5gpm/7.48cuft/gal=40.1cfh. Per assumption 3, 10% of this iodine (4.01 cfh) goes to the reactor building atmosphere and the remaining 90% (36.09 cfh)goes to the sump. Noble gasses evolving from the decay of iodine in the sump are transported to the reactor building atmosphere at an arbitrarily high value of 1E6 cfh. The exhaust components of the base of stack and top of stack are set to be Accumulator volumes where radioactive decay is suppressed. The flow from the containment to the main steam lines and the condensers is not used directly since the MSIV dose is determined by GE. However, the flow is included in this model in order to accurately account for the removal via the variable flow into the main steam lines and condensers and was directed into component 12 which was a combined volume. The same flow is directed to the turbine deck which is component 13. The exhaust flow out the top of the TB vents is 8,640,000 cfh. This is directed to component 14. These components are not used in the final results since the path is only to account for the removal via this path. The flows associated with this model are shown in Figure 2.

Figure 2
FLOWS IN STP MODEL

COMPONENTS	FLOW RATE
1→2	2%/day = 235.8 cfh
1→7	0 cfh t< 8hr; 10 cfh for t>8 hr
2→3	22,000 cfm = 1,485,000 cfh
3→4	22,000 cfm = 1,485,000 cfh
4→5	22,000 cfm = 1,485,000 cfh
5→7	22,000 - 10 = 21990 cfm = 1,484,400 cfh
5→10	10 cfm = 600 cfh
10→6	10 cfm = 600 cfh
1→3	139 cfm = 8340 cfh for 24 hour periods at 10, 20, and 29 days; 0 cfh for all other times
1→12	variable, see design input section
12→13	variable, see design input section
13→14	8,640,000 cfh
8→9	90% of 5gpm*60min/hr / 7.4805 gal/cuft = 36.09 cfh
8→2	10% of 5gpm*60min/hr / 7.4805 gal/cuft = 4.01 cfh
9→2	1E6 for noble gasses (arbitrarily high)

Figure 1: STP Model



* all sources multiplied by 1.02 per assumption #7

Figure 3: STP Input

```
//N9275S12 JOB 264360,9MBERG.BIN111,MSGLEVEL=1,MSGCLASS=T
//*MAIN ORG=LOCAL,CLASS=MB
//JCL JCLLIB ORDER=(APB.NEN.PS264460.PROCLIB)
//    EXEC STP,SOUT='*'
//GO.FT07F001 DD DSN=$KBI988.N9275S12.OUT,UNIT=ALLOC,
//    DCB=(RECFM=FB,LRECL=80,BLKSIZE=6160),SPACE=(TRK,(5,2),RLSE),
//    DISP=(NEW,CATLG,DELETE)
//*GO.FT07F001 DD DUMMY
//GO.FT01F001 DD *
NV= 14 MS= 1
//GO.FT11F001 DD *
NI= 22  NK= 3  NG= 21  NL= 3
   1I    131 1 9.9536E-07  10.0           10.0           10.0
   2I    132 1 8.4448E-05  10.0           10.0           10.0
   3I    133 1 9.2568E-06  10.0           10.0           10.0
   4I    134 1 2.1963E-04  10.0           10.0           10.0
   5I    135 1 2.9129E-05  10.0           10.0           10.0
   6I*   131 2 9.9536E-07  10.0           10.0           10.0
   7I*   132 2 8.4448E-05  10.0           10.0           10.0
   8I*   133 2 9.2568E-06  10.0           10.0           10.0
   9I*   134 2 2.1963E-04  10.0           10.0           10.0
  10I*   135 2 2.9129E-05  10.0           10.0           10.0
  11KRM   85 3 4.2978E-05  10.0           10.0           10.0
  12KR    85 3 2.0470E-09  119.8849E-06   10.0           10.0
  13KR    87 3 1.5141E-04  10.0           10.0           10.0
  14KR    88 3 6.8765E-05  10.0           10.0           10.0
  15KR    89 3 3.6328E-03  10.0           10.0           10.0
  16XEM 131 3 6.7414E-07  11.3039E-08    61.3039E-08    10.0
  17XEM 133 3 3.5656E-06  32.0365E-07    82.0365E-07    10.0
  18XE  133 3 1.5165E-06  39.0531E-06    89.0531E-06  173.5656E-06
  19XEM 135 3 7.3818E-04  54.8062E-06  104.8062E-06    10.0
  20XE  135 3 2.1043E-05  52.4322E-05  102.4322E-05  197.3818E-04
  21XE  137 3 3.0163E-03  10.0           10.0           10.0
  22XE  138 3 8.1528E-04  10.0           10.0           10.0
   0.050    0.100    0.150    0.200    0.300    0.400    0.500    0.600    0.800    1.000
   1.200    1.500    1.800    2.200    2.600    3.000    3.500    4.000    5.000    6.000
   7.500
   1I  1310.194149-2196-20     479-3167-1302+0267-3166-2567-10     0     0     0
0    0     0     0     0     0     0     0     723+0
   2I  1320.5140     0     353-3293-3668-2332-2926-2122+0153+1281+0715-1219+0668-2
548-1673-20     0     0     0     0     0     239+1
   3I  1330.4080     0     0     0     148-2894-3168-2472+0227-1554-1526-2505-10
0    0     0     0     0     0     0     0     135+1
   4I  1340.6100     0     831-2153-2603-2345-2396-1206+0189+0151+1196+0183+0128+0
110+0884-2229-20     0     0     0     0     265+1
   5I  1350.3680     0     260-4237-3160-1117-2223-1404-1127-1794-1409+0517+0405+0
389-1384-10     0     0     0     0     0     247+1
   6I* 1310.194149-2196-20     479-3167-1302+0267-3166-2567-10     0     0     0
0    0     0     0     0     0     0     0     723+0
   7I* 1320.5140     0     353-3293-3668-2332-2926-2122+0153+1281+0715-1219+0668-2
548-1673-20     0     0     0     0     0     239+1
   8I* 1330.4080     0     0     0     148-2894-3168-2472+0227-1554-1526-2505-10
0    0     0     0     0     0     0     0     135+1
   9I* 1340.6100     0     831-2153-2603-2345-2396-1206+0189+0151+1196+0183+0128+0
110+0884-2229-20     0     0     0     0     265+1
  10I* 1350.3680     0     260-4237-3160-1117-2223-1404-1127-1794-1409+0517+0405+0
389-1384-10     0     0     0     0     0     247+1
  11KRM 850.2530     0     390-3113+00     445-1496-40     732-40     0     0     0
0    0     0     0     0     0     0     0     732+0
  12KR  850.2510     0     0     0     0     0     0     221-20     0     0     0     0
0    0     0     0     0     0     0     0     514+0
  13KR  871.3240     0     0     0     0     0     199+00     128-1726-1135-1148-1440-1
604-1351+0956-2155-10     0     0     0     331+1
  14KR  880.3750     0     208-3568-1602-3116-1340-20     763-2131+0207-1717-1219+0
174+0126+1443-20     0     0     0     0     277+1
  15KR  891.2310     0     0     462-2500-1354-1677-1147+0974-1180+0113+0229+0325+0
152+0794-1155+0166+0233+0496-10     0     470+1
  16XEM1310.143343-20     0     328-20     0     0     0     0     0     0     0     0
0    0     0     0     0     0     0     0     164+0
  17XEM1330.190360-20     0     0     240-10     0     0     0     0     0     0     0
0    0     0     0     0     0     0     0     233+0
  18XE 1330.135148-1302-10     964-40     0     0     0     0     0     0     0     0
0    0     0     0     0     0     0     0     161+0
  19XEM1350.095840-30     0     0     0     0     0     428+00     0     0     0     0
```

```
0    0    0    0    0    0    0    0    527+0
  20XE 1350.317157-20    0    404-3226+0758-3131-20    162-1406-30    0    0
0    0    0    0    0    0    0    0    813+0
  21XE 1371.642981-40    0    0    0    709-3146+0535-30    877-2576-2331-2160-1
230-2264-2770-20    0    0    0    0    285+1
  22XE 1380.606103-20    0    769-2841-1259-1927-1680-2916-3251-1355-10    338+0
476+0894-10    0    0    0    0    0    250+1
//GO.FT21F001  DD *
1  'CORE INVENTORY (CURIES)/ORIGEN VALUES'
 1  9.0029+7    2  1.3008+8    3  1.8221+8    4  1.9978+8    5  1.7069+8
 6  3.7512+6    7  5.4200+6    8  7.5920+6    9  8.3240+6   10  7.1120+6
11  2.3510+7   12  1.3590+6   13  4.4810+7   14  6.3030+7   15  7.6530+7
16  1.0500+6   17  5.9560+6   18  1.8470+8   19  3.7610+7   20  6.6100+7
21  1.6550+8   22  1.5520+8
0
T
LOCA MODEL
NJ= 14  KCONC= 0
1 'DRYWELL & TORUS '
2 'REAC.BLDG/REFUEL'
3 'DUMMY1'
4 'CHARCOAL'
5 'DUMMY2'
6 'BASE OF STACK'
7 'TOP OF STACK'
8 'ECCS WATER'
9 'RB SUMP'
10 'STACK ROOMS'
11 'NOT USED'
12 'CONDENSERS'
13 'TURB BLDG'
14 'TB TOP'
-1
INITIAL ACTIVITY (INSTANTANEOUSLY RELEASED FROM THE CORE) IN COMPONENTS
G 1 1.0E-6  2 1.0E-6  3 1.0E-6  4 1.0E-6  5 1.0E-6
G 6 1.0E-6  7 1.0E-6  8 1.0E-6  9 1.0E-6  10 1.0E-6
G 11 1.0E-6  12 1.0E-6  13 1.0E-6  14 1.0E-6
V 1 283000 CUFT  2 1931502 CUFT  3 1.0  4 1.0  5 1.0 CUFT
V 6 1.0  7 1.0  8 141260 CUFT  9 1.0  10 34560 CUFT  11 1.0 CUFT
V 12 125000 CUFT  13 2100000 CUFT  14 1.0
S 1 1 1 0.255
S 1 1 2 0.255
S 1 1 3 1.02
S 1 8 1 0.51
S 1 8 2 0.51
F 1 2 0 235.8
F 1 3 0 0.0
F 1 7 0 0.0
F 1 12 0 72.47
F 2 3 0 1485000.
F 8 2 0 4.01
F 8 9 0 36.09
F 9 2 3 1E6
F 12 13 0 72.47
F 13 14 0 8640000.
A 6
A 7
A 14
N 6 0
N 7 0
N 14 0
U 3 4 5 1485000. 0.90 0.90 0.0
F 5 10 0 600.0
F 10 6 0 600.0
F 5 7 0 1484400.0
0.009576 HR
TIME TO 0.009576 HR
0.01224 HR
TIME TO 0.01224 HR
F 1 12 0 73.44
F 12 13 0 73.44
0.018288 HR
TIME TO 0.018288 HR
F 1 12 0 73.93
F 12 13 0 73.93
0.018648 HR
```

```
TIME TO 0.018648 HR
F 1 12 0 73.93
F 12 13 0 73.93
0.073056 HR
TIME TO 0.073056 HR
F 1 12 0 66.26
F 12 13 0 66.26
0.154296 HR
TIME TO 0.154296 HR
F 1 12 0 33.28
F 12 13 0 33.28
0.281904 HR
TIME TO 0.281904 HR
F 1 12 0 25.79
F 12 13 0 25.79
0.5 HR
TIME TO 0.5 HR (30 MIN)
F 1 12 0 26.69
F 12 13 0 26.69
N 6 0
N 7 0
N 14 0
P 2 0 6 7
0.884064 HR
TIME TO 0.884064 HR
1.0 HR
TIME TO 1.0 HOURS
F 1 12 0 27.85
F 12 13 0 27.85
2.000 HR
TIME TO 2.000 HR (2.0 HRS)
N 6 0
N 7 0
N 14 0
P 2 0 6 7
5.33472 HR
TIME TO 5.33472 HR
8.0 HR
TIME TO 8.0 HR
F 1 12 0 24.63
F 12 13 0 24.63
N 6 0
N 7 0
N 14 0
P 2 0 6 7
11.14896 HR
TIME TO 11.14896 HR
F 1 7 0 10.0
24.0 HR
TIME TO 24.0 HR (1 DAY)
F 1 12 0 19.78
F 12 13 0 19.78
N 6 0
N 7 0
N 14 0
P 2 0 6 7
48 HR
TIME TO 48 HR
F 1 12 0 16.74
F 12 13 0 16.74
96.0 HR
TIME TO 96.0 HR (4 DAYS)
F 1 12 0 14.66
F 12 13 0 14.66
N 6 0
N 7 0
N 14 0
P 2 0 6 7
120 HR
TIME TO 120 HR
240.0 HR
TIME TO 240.0 HR (10 DAYS)  CAD PURGE FLOW FOR 24 HRS BEGINS
F 1 12 0 12.38
F 12 13 0 12.38
264.0 HR
TIME TO 264.0 HR (11 DAYS)  TURN OFF CAD PURGE FLOW
```

```
F 1 12 0 10.98
F 12 13 0 10.98
F 1 3 0 8340.0
480.0 HR
TIME TO 480.0 HR (20 DAYS)  CAD PURGE FLOW FOR 24 HRS BEGINS
F 1 3 0 0.0
504.0 HR
TIME TO 504.0 HR (21 DAYS)  TURN OFF CAD PURGE FLOW
F 1 3 0 8340.0
696.0 HR
TIME TO 696.0 HR (29 DAYS)CAD PURGE FLOW FOR 24 HRS BEGINS
F 1 3 0 0.0
720.0 HR
TIME TO 720.0 HR (30 DAYS)  TURN OFF CAD PURGE FLOW
F 1 3 0 8340.0
P 2 0 6 7
T
T
```

FENCDOSE MODEL:

The STP output is used as input for the computer code FENCDOSE, which determines the 2 hour LPZ and 30 day LPZ dose. The 2 hr EAB dose is determined by scaling the 2 hr LPZ dose to the relative X/Q values or:

Top of Stack Release:

EAB Dose (2hr) = LPZ Dose (2hr)* $(X/Q_{2hr\ EAB})/(X/Q_{2\ hr\ LPZ})$
= LPZ Dose (2 hr) * 1.19E-6/1.13E-6
= LPZ Dose (2 hr) * 1.0531

Top of Stack Release - fumigation:

EAB Dose (2hr) = LPZ Dose (2hr)* $(X/Q_{2hr\ EAB})/(X/Q_{2\ hr\ LPZ})$
= LPZ Dose (2 hr) * 2.35E-5/1.26E-5
= LPZ Dose (2 hr) * 1.8651

Base of Stack Release:

EAB Dose (2hr) = LPZ Dose (2hr)* $(X/Q_{2hr\ EAB})/(X/Q_{2\ hr\ LPZ})$
= LPZ Dose (2 hr) * 2.62E-4/1.31E-4
= LPZ Dose (2 hr) * 2

Input for FENCDOSE, Base of Stack Releases:

```
//N975F12A JOB 264360,'9MBERG.BIN111',MSGCLASS=T
//*MAIN ORG=LOCAL,CLASS=SB
//JCL JCLLIB ORDER=(APB.NEN.PS264460.PROCLIB)
//STEP1 EXEC FENCDOSE,SOUT='*'
//GO.SYSIN DD *
1
I-131 I-132 I-133 I-134 I-135
I*-131 I*-132 I*-133 I*-134 I*-135
KRM-85 KR-85 KR-87 KR-88 KR-89
XEM-131 XEM-133 XE-133 XEM-135 XE-135 XE-137 XE-138
T
1.31E-4  6.61E-5  4.69E-5  2.23E-5  7.96E-6
LOCA MODEL
TIME TO 0.5 HR (30 MIN)
   -6  'BASE OF STACK                  ' $ TN=  0.5000E+00
         1 2.083E-04     2 2.692E-04    3 4.169E-04    4 3.458E-04    5 3.803E-04
         6 8.680E-06     7 1.122E-05    8 1.737E-05    9 1.441E-05   10 1.585E-05
        11 1.926E-03    12 1.179E-04   13 3.178E-03   14 4.988E-03   15 1.423E-04
        16 9.104E-05    17 5.149E-04   18 1.601E-02   19 1.806E-03   20 5.772E-03
        21 5.053E-04    22 4.716E-03
LOCA MODEL
TIME TO 2.000 HR (2.0 HRS)
   -6  'BASE OF STACK                  ' $ TN=  0.2000E+01
         1 1.005E-02     2 9.352E-03    3 1.947E-02    4 7.244E-03    5 1.641E-02
         6 4.189E-04     7 3.896E-04    8 8.111E-04    9 3.018E-04   10 6.836E-04
        11 7.864E-02    12 5.713E-03   13 8.555E-02   14 1.841E-01   15 5.636E-06
        16 4.404E-03    17 2.469E-02   18 7.727E-01   19 4.095E-02   20 2.792E-01
        21 4.700E-05    22 1.633E-02
LOCA MODEL
TIME TO 8.0 HR
   -6  'BASE OF STACK                  ' $ TN=  0.8000E+01
         1 3.031E-01     2 8.774E-02    3 5.177E-01    4 1.639E-02    5 3.254E-01
         6 1.263E-02     7 3.656E-03    8 2.157E-02    9 6.828E-04   10 1.356E-02
        11 1.281E+00    12 1.749E-01   13 3.710E-01   14 2.114E+00   15 1.562E-13
        16 1.340E-01    17 7.258E-01   18 2.332E+01   19 7.021E-01   20 7.937E+00
        21 3.486E-11    22 1.103E-03
LOCA MODEL
TIME TO 24.0 HR (1 DAY)
   -6  'BASE OF STACK                  ' $ TN=  0.2400E+02
         1 2.742E+00     2 5.311E-02    3 3.356E+00    4 5.318E-04    5 1.008E+00
         6 1.143E-01     7 2.213E-03    8 1.398E-01    9 2.216E-05   10 4.201E-02
        11 2.500E+00    12 1.648E+00   13 4.917E-02   14 1.930E+00   15 0.0
        16 1.246E+00    17 6.114E+00   18 2.110E+02   19 2.290E+00   20 4.815E+01
        21 0.0          22 1.319E-10
LOCA MODEL
TIME TO 96.0 HR (4 DAYS)
   -6  'BASE OF STACK                  ' $ TN=  0.9600E+02
         1 2.814E+01     2 9.506E-04    3 1.048E+01    4 4.468E-09    5 4.986E-01
         6 1.173E+00     7 3.960E-05    8 4.366E-01    9 1.862E-10   10 2.077E-02
        11 4.932E-01    12 1.994E+01   13 2.011E-05   14 8.379E-02   15 0.0
        16 1.433E+01    17 4.507E+01   18 2.076E+03   19 1.312E+00   20 6.632E+01
        21 0.0          22 0.0
LOCA MODEL
TIME TO 720.0 HR (30 DAYS)  TURN OFF CAD PURGE FLOW
   -6  'BASE OF STACK                  ' $ TN=  0.7200E+03
         1 2.416E+02     2 6.413E-13    3 1.718E+00    4 0.0          5 4.981E-04
         6 1.007E+01     7 2.672E-14    8 7.158E-02    9 0.0         10 2.075E-05
        11 1.438E-05    12 4.559E+02   13 4.079E-22   14 3.227E-09   15 0.0
        16 2.152E+02    17 6.986E+01   18 1.214E+04   19 2.110E-03   20 6.816E-01
        21 0.0          22 0.0
```

Input for FENCDOSE, Top of Stack Releases (30 min-30 day):

```
//N975F12B JOB 264360,'9MBERG.BIN111',MSGCLASS=T
//*MAIN ORG=LOCAL,CLASS=SB
//JCL JCLLIB ORDER=(APB.NEN.PS264460.PROCLIB)
//STEP1 EXEC FENCDOSE,SOUT='*'
//GO.SYSIN DD *
1
I-131 I-132 I-133 I-134 I-135
I*-131 I*-132 I*-133 I*-134 I*-135
KRM-85 KR-85 KR-87 KR-88 KR-89
XEM-131 XEM-133 XE-133 XEM-135 XE-135 XE-137 XE-138
T
1.13E-6  5.75E-7  4.10E-7  1.97E-7  6.88E-8
LOCA MODEL
TIME TO 0.5 HR (30 MIN)
   -7  'TOP OF STACK                    ' $ TN=  0.5000E+00
         1 0.000E+00    2 0.000E+00    3 0.000E+00    4 0.000E+00    5 0.000E+00
         6 0.000E+00    7 0.000E+00    8 0.000E+00    9 0.000E+00   10 0.000E+00
        11 0.000E+00   12 0.000E+00   13 0.000E+00   14 0.000E+00   15 0.000E+00
        16 0.000E+00   17 0.000E+00   18 0.000E+00   19 0.000E+00   20 0.000E+00
        21 0.000E+00   22 0.000E+00
LOCA MODEL
TIME TO 2.000 HR (2.0 HRS)
   -7  'TOP OF STACK                    ' $ TN=  0.2000E+01
         1 1.815E+03    2 1.765E+03    3 3.531E+03    4 1.476E+03    5 3.006E+03
         6 7.565E+01    7 7.354E+01    8 1.471E+02    9 6.150E+01   10 1.253E+02
        11 1.452E+04   12 1.031E+03   13 1.676E+04   14 3.446E+04   15 2.565E+00
        16 7.957E+02   17 4.473E+03   18 1.397E+05   19 2.011E+04   20 5.259E+04
        21 2.067E+01   22 4.660E+03
LOCA MODEL
TIME TO 8.0 HR
   -7  'TOP OF STACK                    ' $ TN=  0.8000E+01
         1 1.144E+04    2 4.098E+03    3 1.993E+04    4 1.038E+03    5 1.317E+04
         6 4.766E+02    7 1.708E+02    8 8.305E+02    9 4.325E+01   10 5.487E+02
        11 5.371E+04   12 6.582E+03   13 2.044E+04   14 9.480E+04   15 1.729E-08
        16 5.071E+03   17 2.782E+04   18 8.860E+05   19 2.624E+05   20 3.508E+05
        21 3.824E-06   22 1.050E+02
LOCA MODEL
TIME TO 24.0 HR (1 DAY)
   -7  'TOP OF STACK                    ' $ TN=  0.2400E+02
         1 4.252E+04    2 1.171E+03    3 5.414E+04    4 1.422E+01    5 1.792E+04
         6 1.772E+03    7 4.878E+01    8 2.256E+03    9 5.924E-01   10 7.464E+02
        11 3.534E+04   12 1.898E+04   13 9.213E+02   14 3.021E+04   15 0.0
        16 1.458E+04   17 7.357E+04   18 2.484E+06   19 7.993E+05   20 7.456E+05
        21 0.0         22 2.949E-06
LOCA MODEL
TIME TO 96.0 HR (4 DAYS)
   -7  'TOP OF STACK                    ' $ TN=  0.9600E+02
         1 1.578E+05    2 8.977E+00    3 6.795E+04    4 4.495E-05    5 4.041E+03
         6 6.575E+03    7 3.740E-01    8 2.831E+03    9 1.873E-06   10 1.684E+02
        11 3.194E+03   12 8.200E+04   13 1.482E-01   14 5.779E+02   15 0.0
        16 6.182E+04   17 2.037E+05   18 8.874E+06   19 4.539E+05   20 4.465E+05
        21 0.0         22 0.0
LOCA MODEL
TIME TO 720.0 HR (30 DAYS)  TURN OFF CAD PURGE FLOW
   -7  'TOP OF STACK                    ' $ TN=  0.7200E+03
         1 7.509E+05    2 2.624E-09    3 6.764E+03    4 0.0          5 1.994E+00
         6 3.129E+04    7 1.093E-10    8 2.818E+02    9 0.0         10 8.309E-02
        11 4.340E-02   12 1.174E+06   13 1.252E-18   14 9.823E-06   15 0.0
        16 5.973E+05   17 2.285E+05   18 3.570E+07   19 7.430E+02   20 2.046E+03
        21 0.0         22 0.0
```

Input for FENCDOSE, Top of Stack Releases - Fumigation (0-30 min):

```
//N975F12C JOB 264360,'9MBERG.BIN111',MSGCLASS=T
//*MAIN ORG=LOCAL,CLASS=SB
//JCL JCLLIB ORDER=(APB.NEN.PS264460.PROCLIB)
//STEP1 EXEC FENCDOSE,SOUT='*'
//GO.SYSIN DD *
1
I-131 I-132 I-133 I-134 I-135
I*-131 I*-132 I*-133 I*-134 I*-135
KRM-85 KR-85 KR-87 KR-88 KR-89
XEM-131 XEM-133 XE-133 XEM-135 XE-135 XE-137 XE-138
T
1.26E-5  5.75E-7  4.10E-7  1.97E-7  6.88E-8
LOCA MODEL
TIME TO 0.5 HR (30 MIN)
   -7  'TOP OF STACK                     ' $ TN=  0.5000E+00
         1 1.731E+02    2 2.268E+02    3 3.470E+02    4 2.981E+02    5 3.175E+02
         6 7.214E+00    7 9.450E+00    8 1.446E+01    9 1.242E+01   10 1.323E+01
        11 1.611E+03   12 9.798E+01   13 2.707E+03   14 4.192E+03   15 2.734E+02
        16 7.567E+01   17 4.283E+02   18 1.331E+04   19 1.915E+03   20 4.841E+03
        21 8.353E+02   22 4.556E+03
LOCA MODEL
TIME TO 2.000 HR (2.0 HRS)
   -7  'TOP OF STACK                     ' $ TN=  0.2000E+01
         1 0.000E+00    2 0.000E+00    3 0.000E+00    4 0.000E+00    5 0.000E+00
         6 0.000E+00    7 0.000E+00    8 0.000E+00    9 0.000E+00   10 0.000E+00
        11 0.000E+00   12 0.000E+00   13 0.000E+00   14 0.000E+00   15 0.000E+00
        16 0.000E+00   17 0.000E+00   18 0.000E+00   19 0.000E+00   20 0.000E+00
        21 0.000E+00   22 0.000E+00
LOCA MODEL
TIME TO 8.0 HR
   -7  'TOP OF STACK                     ' $ TN=  0.8000E+01
         1 0.000E+00    2 0.000E+00    3 0.000E+00    4 0.000E+00    5 0.000E+00
         6 0.000E+00    7 0.000E+00    8 0.000E+00    9 0.000E+00   10 0.000E+00
        11 0.000E+00   12 0.000E+00   13 0.000E+00   14 0.000E+00   15 0.000E+00
        16 0.000E+00   17 0.000E+00   18 0.000E+00   19 0.000E+00   20 0.000E+00
        21 0.000E+00   22 0.000E+00
LOCA MODEL
TIME TO 24.0 HR (1 DAY)
   -7  'TOP OF STACK                     ' $ TN=  0.2400E+02
         1 0.000E+00    2 0.000E+00    3 0.000E+00    4 0.000E+00    5 0.000E+00
         6 0.000E+00    7 0.000E+00    8 0.000E+00    9 0.000E+00   10 0.000E+00
        11 0.000E+00   12 0.000E+00   13 0.000E+00   14 0.000E+00   15 0.000E+00
        16 0.000E+00   17 0.000E+00   18 0.000E+00   19 0.000E+00   20 0.000E+00
        21 0.000E+00   22 0.000E+00
LOCA MODEL
TIME TO 96.0 HR (4 DAYS)
   -7  'TOP OF STACK                     ' $ TN=  0.9600E+02
         1 0.000E+00    2 0.000E+00    3 0.000E+00    4 0.000E+00    5 0.000E+00
         6 0.000E+00    7 0.000E+00    8 0.000E+00    9 0.000E+00   10 0.000E+00
        11 0.000E+00   12 0.000E+00   13 0.000E+00   14 0.000E+00   15 0.000E+00
        16 0.000E+00   17 0.000E+00   18 0.000E+00   19 0.000E+00   20 0.000E+00
        21 0.000E+00   22 0.000E+00
LOCA MODEL
TIME TO 720.0 HR (30 DAYS)  TURN OFF CAD PURGE FLOW
   -7  'TOP OF STACK                     ' $ TN=  0.7200E+03
         1 0.000E+00    2 0.000E+00    3 0.000E+00    4 0.000E+00    5 0.000E+00
         6 0.000E+00    7 0.000E+00    8 0.000E+00    9 0.000E+00   10 0.000E+00
        11 0.000E+00   12 0.000E+00   13 0.000E+00   14 0.000E+00   15 0.000E+00
        16 0.000E+00   17 0.000E+00   18 0.000E+00   19 0.000E+00   20 0.000E+00
        21 0.000E+00   22 0.000E+00
```

COROD MODEL:

The STP output is used as input for the computer code COROD, which determines the control room operator doses. The COROD model is the same as the revision 8 model and utilizes the following input parameters (see Design Input section):

X/Q values: see design input section
Makeup flow: 3000 cfm
Unfiltered bypass flow: 3717 cfm
Filter efficiency: 90% for iodines
Control Room Volume: 210,000 cuft
Recirculation Flow: 1E-15 (approximately 0)
Occupancy Factors: 100% 0-24 hrs, 60% 1-4 days, 40% 4-30 days
Control Room dimensions: 464'x36.83'x15.3'
Control Room ceiling thickness: 2.25' concrete
Dose point coordinates = 76.974'x18.4165'x6' (center of room, 6' up at head height)
# of increments: x-direction = 46, y-direction=9, z-direction = 4
Roof Flux Dose Lengths: 1000'x1000'x1000' (arbitrarily large)
# of intervals (roof flux): x-direction = 20y-direction=20 z-direction = 20
Coordinate of roof flux dose point: (500x500,-13.58')

The COROD model described above is for when the CREVS system is working with nominal parameters. The instrumentation of the CREVS may allow reduced makeup flow (1500 cfm). Other conditions may exist where the CREVS may not be running at all (for instance, delayed startup of the system, or during switchover from one train to another). Therefore several cases were run to study the impact of reduced flow (1500 cfm) and no flow (0 cfm). These cases used identical input as the nominal case above, except for the following changes to the makeup flow:

Reduced CREVS flow case:
Makeup flow: 1500 cfm
No CREVS flow case:
Makeup flow: 0.0 cfm

Figure 4: COROD INPUT "N9275C9A" U1/West Intake, Base of Stack Release

The following is for the nominal (3000 cfm) CREVS makeup flow. Two other cases were calculated for the base of stack U1/west: reduced flow of 1500 cfm (N9275C9E), and no flow (N9275C9I). The input variable changed for these extra cases on the following listing is printed in bold type.

```
//N975C12A JOB 264360,9MBERG.BIN111,MSGLEVEL=1,MSGCLASS=T
//*MAIN ORG=LOCAL,CLASS=SB
//JCL JCLLIB ORDER=(APB.NEN.PS264460.PROCLIB)
//STEP1 EXEC COROD,SOUT='*'
//GO.SYSIN DD *
NIT= 22    NR= 1    ITP= 6    FACT= 1.0
LOCA BASE OF STACK 0-30 DAY RELEASE,U1/WEST INTAKE
I 131 I 132 I 133 I 134 I 135
I* 131 I* 132 I* 133 I* 134 I* 135
KRM 85 KR 85 KR 87 KR 88 KR 89
XEM 131 XEM 133 XE 133 XEM 135 XE 135 XE 137 XE 138
   -6  'BASE OF STACK                  ' $ TN=  0.5000E+00
        1 2.083E-04    2 2.692E-04    3 4.169E-04    4 3.458E-04    5 3.803E-04
        6 8.680E-06    7 1.122E-05    8 1.737E-05    9 1.441E-05   10 1.585E-05
       11 1.926E-03   12 1.179E-04   13 3.178E-03   14 4.988E-03   15 1.423E-04
       16 9.104E-05   17 5.149E-04   18 1.601E-02   19 1.806E-03   20 5.772E-03
       21 5.053E-04   22 4.716E-03
   -6  'BASE OF STACK                  ' $ TN=  0.2000E+01
        1 1.005E-02    2 9.352E-03    3 1.947E-02    4 7.244E-03    5 1.641E-02
        6 4.189E-04    7 3.896E-04    8 8.111E-04    9 3.018E-04   10 6.836E-04
       11 7.864E-02   12 5.713E-03   13 8.555E-02   14 1.841E-01   15 5.636E-06
       16 4.404E-03   17 2.469E-02   18 7.727E-01   19 4.095E-02   20 2.792E-01
       21 4.700E-05   22 1.633E-02
   -6  'BASE OF STACK                  ' $ TN=  0.8000E+01
        1 3.031E-01    2 8.774E-02    3 5.177E-01    4 1.639E-02    5 3.254E-01
        6 1.263E-02    7 3.656E-03    8 2.157E-02    9 6.828E-04   10 1.356E-02
       11 1.281E+00   12 1.749E-01   13 3.710E-01   14 2.114E+00   15 1.562E-13
       16 1.340E-01   17 7.258E-01   18 2.332E+01   19 7.021E-01   20 7.937E+00
       21 3.486E-11   22 1.103E-03
   -6  'BASE OF STACK                  ' $ TN=  0.2400E+02
        1 2.742E+00    2 5.311E-02    3 3.356E+00    4 5.318E-04    5 1.008E+00
        6 1.143E-01    7 2.213E-03    8 1.398E-01    9 2.216E-05   10 4.201E-02
       11 2.500E+00   12 1.648E+00   13 4.917E-02   14 1.930E+00   15 0.0
       16 1.246E+00   17 6.114E+00   18 2.110E+02   19 2.290E+00   20 4.815E+01
       21 0.0         22 1.319E-10
   -6  'BASE OF STACK                  ' $ TN=  0.9600E+02
        1 2.814E+01    2 9.506E-04    3 1.048E+01    4 4.468E-09    5 4.986E-01
        6 1.173E+00    7 3.960E-05    8 4.366E-01    9 1.862E-10   10 2.077E-02
       11 4.932E-01   12 1.994E+01   13 2.011E-05   14 8.379E-02   15 0.0
       16 1.433E+01   17 4.507E+01   18 2.076E+03   19 1.312E+00   20 6.632E+01
       21 0.0         22 0.0
   -6  'BASE OF STACK                  ' $ TN=  0.7200E+03
        1 2.416E+02    2 6.413E-13    3 1.718E+00    4 0.0          5 4.981E-04
        6 1.007E+01    7 2.672E-14    8 7.158E-02    9 0.0         10 2.075E-05
       11 1.438E-05   12 4.559E+02   13 4.079E-22   14 3.227E-09   15 0.0
       16 2.152E+02   17 6.986E+01   18 1.214E+04   19 2.110E-03   20 6.816E-01
       21 0.0         22 0.0
2*2.00E-4 1.28-4 5.72-5 4.05-5 3.09-5
1800  5400  21600  57600  259200  2246400
3000.0 3717.0
0.90 1E-15 0.90 1E-15 210000.0 1E-15
100.0  60.0  40.0  1440.0  5760.0
153.948 36.833 15.33  46.0  9.0  4.0  76.974  18.4165 6.0  0.0
ROOFFLUX DOSE TO CONTROL ROOM PERSONNEL DUE TO SHINE THROUGH ROOF
1000.0  1000.0  1000.0  20.0  20.0  20.0  500.0  500.0  -13.58  2.25
/*
//
```

Figure 5: COROD INPUT "N9275C9B"
U3/East Intake, Base of Stack Release

The following is for the nominal (3000 cfm) CREVS makeup flow. Two other cases were calculated for the base of stack U3/east: reduced flow of 1500 cfm (N9275C9F), and no flow (N9275C9J). The input variable changed for these extra cases on the following listing is printed in bold type.

```
//N975C12B JOB 264360,9MBERG.BIN111,MSGLEVEL=1,MSGCLASS=T
//*MAIN ORG=LOCAL,CLASS=SB
//JCL JCLLIB ORDER=(APB.NEN.PS264460.PROCLIB)
//STEP1 EXEC COROD,SOUT='*'
//GO.SYSIN DD *
NIT= 22    NR= 1    ITP= 6    FACT= 1.0
LOCA BASE OF STACK 0-30 DAY RELEASE,U3/EAST INTAKE
I 131 I 132 I 133 I 134 I 135
I* 131 I* 132 I* 133 I* 134 I* 135
KRM 85 KR 85 KR 87 KR 88 KR 89
XEM 131 XEM 133 XE 133 XEM 135 XE 135 XE 137 XE 138
   -6  'BASE OF STACK                        ' $ TN=  0.5000E+00
         1 2.083E-04    2 2.692E-04    3 4.169E-04    4 3.458E-04    5 3.803E-04
         6 8.680E-06    7 1.122E-05    8 1.737E-05    9 1.441E-05   10 1.585E-05
        11 1.926E-03   12 1.179E-04   13 3.178E-03   14 4.988E-03   15 1.423E-04
        16 9.104E-05   17 5.149E-04   18 1.601E-02   19 1.806E-03   20 5.772E-03
        21 5.053E-04   22 4.716E-03
   -6  'BASE OF STACK                        ' $ TN=  0.2000E+01
         1 1.005E-02    2 9.352E-03    3 1.947E-02    4 7.244E-03    5 1.641E-02
         6 4.189E-04    7 3.896E-04    8 8.111E-04    9 3.018E-04   10 6.836E-04
        11 7.864E-02   12 5.713E-03   13 8.555E-02   14 1.841E-01   15 5.636E-06
        16 4.404E-03   17 2.469E-02   18 7.727E-01   19 4.095E-02   20 2.792E-01
        21 4.700E-05   22 1.633E-02
   -6  'BASE OF STACK                        ' $ TN=  0.8000E+01
         1 3.031E-01    2 8.774E-02    3 5.177E-01    4 1.639E-02    5 3.254E-01
         6 1.263E-02    7 3.656E-03    8 2.157E-02    9 6.828E-04   10 1.356E-02
        11 1.281E+00   12 1.749E-01   13 3.710E-01   14 2.114E+00   15 1.562E-13
        16 1.340E-01   17 7.258E-01   18 2.332E+01   19 7.021E-01   20 7.937E+00
        21 3.486E-11   22 1.103E-03
   -6  'BASE OF STACK                        ' $ TN=  0.2400E+02
         1 2.742E+00    2 5.311E-02    3 3.356E+00    4 5.318E-04    5 1.008E+00
         6 1.143E-01    7 2.213E-03    8 1.398E-01    9 2.216E-05   10 4.201E-02
        11 2.500E+00   12 1.648E+00   13 4.917E-02   14 1.930E+00   15 0.0
        16 1.246E+00   17 6.114E+00   18 2.110E+02   19 2.290E+00   20 4.815E+01
        21 0.0         22 1.319E-10
   -6  'BASE OF STACK                        ' $ TN=  0.9600E+02
         1 2.814E+01    2 9.506E-04    3 1.048E+01    4 4.468E-09    5 4.986E-01
         6 1.173E+00    7 3.960E-05    8 4.366E-01    9 1.862E-10   10 2.077E-02
        11 4.932E-01   12 1.994E+01   13 2.011E-05   14 8.379E-02   15 0.0
        16 1.433E+01   17 4.507E+01   18 2.076E+03   19 1.312E+00   20 6.632E+01
        21 0.0         22 0.0
   -6  'BASE OF STACK                        ' $ TN=  0.7200E+03
         1 2.416E+02    2 6.413E-13    3 1.718E+00    4 0.0          5 4.981E-04
         6 1.007E+01    7 2.672E-14    8 7.158E-02    9 0.0         10 2.075E-05
        11 1.438E-05   12 4.559E+02   13 4.079E-22   14 3.227E-09   15 0.0
        16 2.152E+02   17 6.986E+01   18 1.214E+04   19 2.110E-03   20 6.816E-01
21 0.0          22 0.0
2*8.60E-5 6.46-5 2.80-5 2.00-5 1.53E-5
1800  5400  21600  57600  259200  2246400
3000.0 3717.0
0.90 1E-15 0.90 1E-15 210000.0 1E-15
100.0  60.0  40.0  1440.0  5760.0
153.948 36.833 15.33  46.0  9.0  4.0  76.974  18.4165 6.0  0.0
ROOFFLUX DOSE TO CONTROL ROOM PERSONNEL DUE TO SHINE THROUGH ROOF
1000.0  1000.0  1000.0  20.0  20.0  20.0  500.0  500.0  -13.58  2.25
/*
//
```

U1/West Intake, Top of Stack Release

The following is for the nominal (3000 cfm) CREVS makeup flow. Two other cases were calculated for the top of stack U1/west: reduced flow of 1500 cfm (N9275C9G), and no flow (N9275C9K). The input variable changed for these extra cases on the following listing is printed in bold type.

```
//N975C12C JOB 264360,9MBERG.BIN111,MSGLEVEL=1,MSGCLASS=T
//*MAIN ORG=LOCAL,CLASS=SB
//JCL JCLLIB ORDER=(APB.NEN.PS264460.PROCLIB)
//STEP1 EXEC COROD,SOUT='*'
//GO.SYSIN DD *
NIT= 22   NR= 1   ITP= 6   FACT= 1.0
LOCA TOP OF STACK 0-30 DAY RELEASE,U1/WEST INTAKE
I 131 I 132 I 133 I 134 I 135
I* 131 I* 132 I* 133 I* 134 I* 135
KRM 85 KR 85 KR 87 KR 88 KR 89
XEM 131 XEM 133 XE 133 XEM 135 XE 135 XE 137 XE 138
-7  'TOP OF STACK                  ' $ TN=  0.5000E+00
         1 1.731E+02    2 2.268E+02    3 3.470E+02    4 2.981E+02    5 3.175E+02
         6 7.214E+00    7 9.450E+00    8 1.446E+01    9 1.242E+01   10 1.323E+01
        11 1.611E+03   12 9.798E+01   13 2.707E+03   14 4.192E+03   15 2.734E+02
        16 7.567E+01   17 4.283E+02   18 1.331E+04   19 1.915E+03   20 4.841E+03
        21 8.353E+02   22 4.556E+03
   -7  'TOP OF STACK                  ' $ TN=  0.2000E+01
         1 1.815E+03    2 1.765E+03    3 3.531E+03    4 1.476E+03    5 3.006E+03
         6 7.565E+01    7 7.354E+01    8 1.471E+02    9 6.150E+01   10 1.253E+02
        11 1.452E+04   12 1.031E+03   13 1.676E+04   14 3.446E+04   15 2.565E+00
        16 7.957E+02   17 4.473E+03   18 1.397E+05   19 2.011E+04   20 5.259E+04
        21 2.067E+01   22 4.660E+03
   -7  'TOP OF STACK                  ' $ TN=  0.8000E+01
         1 1.144E+04    2 4.098E+03    3 1.993E+04    4 1.038E+03    5 1.317E+04
         6 4.766E+02    7 1.708E+02    8 8.305E+02    9 4.325E+01   10 5.487E+02
        11 5.371E+04   12 6.582E+03   13 2.044E+04   14 9.480E+04   15 1.729E-08
        16 5.071E+03   17 2.782E+04   18 8.860E+05   19 2.624E+05   20 3.508E+05
        21 3.824E-06   22 1.050E+02
   -7  'TOP OF STACK                  ' $ TN=  0.2400E+02
         1 4.252E+04    2 1.171E+03    3 5.414E+04    4 1.422E+01    5 1.792E+04
         6 1.772E+03    7 4.878E+01    8 2.256E+03    9 5.924E-01   10 7.464E+02
        11 3.534E+04   12 1.898E+04   13 9.213E+02   14 3.021E+04   15 0.0
        16 1.458E+04   17 7.357E+04   18 2.484E+06   19 7.993E+05   20 7.456E+05
        21 0.0         22 2.949E-06
   -7  'TOP OF STACK                  ' $ TN=  0.9600E+02
         1 1.578E+05    2 8.977E+00    3 6.795E+04    4 4.495E-05    5 4.041E+03
         6 6.575E+03    7 3.740E-01    8 2.831E+03    9 1.873E-06   10 1.684E+02
        11 3.194E+03   12 8.200E+04   13 1.482E-01   14 5.779E+02   15 0.0
        16 6.182E+04   17 2.037E+05   18 8.874E+06   19 4.539E+05   20 4.465E+05
        21 0.0         22 0.0
   -7  'TOP OF STACK                  ' $ TN=  0.7200E+03
         1 7.509E+05    2 2.624E-09    3 6.764E+03    4 0.0          5 1.994E+00
         6 3.129E+04    7 1.093E-10    8 2.818E+02    9 0.0         10 8.309E-02
        11 4.340E-02   12 1.174E+06   13 1.252E-18   14 9.823E-06   15 0.0
        16 5.973E+05   17 2.285E+05   18 3.570E+07   19 7.430E+02   20 2.046E+03
        21 0.0         22 0.0
3.40E-5 9.08E-13  3.41E-13  2.09E-13  7.21E-14  1.57E-14
1800  5400  21600  57600  259200  2246400
3000.0 3717.0
0.90 1E-15 0.90 1E-15 210000.0 1E-15
100.0  60.0  40.0  1440.0  5760.0
153.948 36.833 15.33  46.0  9.0  4.0  76.974  18.4165 6.0  0.0
ROOFFLUX DOSE TO CONTROL ROOM PERSONNEL DUE TO SHINE THROUGH ROOF
1000.0  1000.0  1000.0  20.0  20.0  20.0  500.0  500.0  -13.58  2.25
/*
//
```

Figure 7: COROD INPUT "N9275C9D"
U3/East Intake, Top of Stack Release

The following is for the nominal (3000 cfm) CREVS makeup flow. Two other cases were calculated for the top of stack U3/east: reduced flow of 1500 cfm (N9275C9H), and no flow (N9275C9L). The input variable changed for these extra cases on the following listing is printed in bold type.

```
//N975C12D JOB 264360,9MBERG.BIN111,MSGLEVEL=1,MSGCLASS=T
//*MAIN ORG=LOCAL,CLASS=SB
//JCL JCLLIB ORDER=(APB.NEN.PS264460.PROCLIB)
//STEP1 EXEC COROD,SOUT='*'
//GO.SYSIN DD *
NIT= 22   NR= 1   ITP= 6   FACT= 1.0
LOCA TOP OF STACK 0-30 DAY RELEASE,U3/EAST INTAKE
I 131 I 132 I 133 I 134 I 135
I* 131 I* 132 I* 133 I* 134 I* 135
KRM 85 KR 85 KR 87 KR 88 KR 89
XEM 131 XEM 133 XE 133 XEM 135 XE 135 XE 137 XE 138
   -7  'TOP OF STACK                   ' $ TN=  0.5000E+00
        1 1.731E+02     2 2.268E+02     3 3.470E+02     4 2.981E+02     5 3.175E+02
        6 7.214E+00     7 9.450E+00     8 1.446E+01     9 1.242E+01    10 1.323E+01
       11 1.611E+03    12 9.798E+01    13 2.707E+03    14 4.192E+03    15 2.734E+02
       16 7.567E+01    17 4.283E+02    18 1.331E+04    19 1.915E+03    20 4.841E+03
       21 8.353E+02    22 4.556E+03
   -7  'TOP OF STACK                   ' $ TN=  0.2000E+01
        1 1.815E+03     2 1.765E+03     3 3.531E+03     4 1.476E+03     5 3.006E+03
        6 7.565E+01     7 7.354E+01     8 1.471E+02     9 6.150E+01    10 1.253E+02
       11 1.452E+04    12 1.031E+03    13 1.676E+04    14 3.446E+04    15 2.565E+00
       16 7.957E+02    17 4.473E+03    18 1.397E+05    19 2.011E+04    20 5.259E+04
       21 2.067E+01    22 4.660E+03
   -7  'TOP OF STACK                   ' $ TN=  0.8000E+01
        1 1.144E+04     2 4.098E+03     3 1.993E+04     4 1.038E+03     5 1.317E+04
        6 4.766E+02     7 1.708E+02     8 8.305E+02     9 4.325E+01    10 5.487E+02
       11 5.371E+04    12 6.582E+03    13 2.044E+04    14 9.480E+04    15 1.729E-08
       16 5.071E+03    17 2.782E+04    18 8.860E+05    19 2.624E+05    20 3.508E+05
       21 3.824E-06    22 1.050E+02
   -7  'TOP OF STACK                   ' $ TN=  0.2400E+02
        1 4.252E+04     2 1.171E+03     3 5.414E+04     4 1.422E+01     5 1.792E+04
        6 1.772E+03     7 4.878E+01     8 2.256E+03     9 5.924E-01    10 7.464E+02
       11 3.534E+04    12 1.898E+04    13 9.213E+02    14 3.021E+04    15 0.0
       16 1.458E+04    17 7.357E+04    18 2.484E+06    19 7.993E+05    20 7.456E+05
       21 0.0          22 2.949E-06
   -7  'TOP OF STACK                   ' $ TN=  0.9600E+02
        1 1.578E+05     2 8.977E+00     3 6.795E+04     4 4.495E-05     5 4.041E+03
        6 6.575E+03     7 3.740E-01     8 2.831E+03     9 1.873E-06    10 1.684E+02
       11 3.194E+03    12 8.200E+04    13 1.482E-01    14 5.779E+02    15 0.0
       16 6.182E+04    17 2.037E+05    18 8.874E+06    19 4.539E+05    20 4.465E+05
       21 0.0          22 0.0
   -7  'TOP OF STACK                   ' $ TN=  0.7200E+03
        1 7.509E+05     2 2.624E-09     3 6.764E+03     4 0.0           5 1.994E+00
        6 3.129E+04     7 1.093E-10     8 2.818E+02     9 0.0          10 8.309E-02
       11 4.340E-02    12 1.174E+06    13 1.252E-18    14 9.823E-06    15 0.0
       16 5.973E+05    17 2.285E+05    18 3.570E+07    19 7.430E+02    20 2.046E+03
       21 0.0          22 0.0
3.02E-5 1.41E-7 4.50E-8 2.54E-8 7.36E-8 1.24E-9
1800  5400  21600  57600  259200  2246400
3000.0 3717.0
0.90 1E-15 0.90 1E-15 210000.0 1E-15
100.0  60.0  40.0  1440.0  5760.0
153.948 36.833 15.33  46.0  9.0  4.0  76.974  18.4165 6.0  0.0
ROOFFLUX DOSE TO CONTROL ROOM PERSONNEL DUE TO SHINE THROUGH ROOF
1000.0  1000.0  1000.0  20.0  20.0  20.0  500.0  500.0  -13.58  2.25
/*
//
```

The thyroid doses determined by COROD are based on ICRP-2 methodology. The following table converts the ICRP-2 doses to the ICRP-30 values, utilizing the appropriate occupancy factors (100% 0-24 hrs, 60% 1-4 day, 40% 4-30 day, ref.2).

3000 cfm CREVS intake flow

	0-.5 HR	.5-2 HR	2-8 HR	8-24 HR	1-4 DAY	4-30 DAY	Total
	mrem	mrem	mrem	mrem	mrem	mrem	rem
U1 B/S	8.369E-03	7.444E-01	1.790E+01	3.397E+01	2.673E+02	1.597E+03	
OF	1	1	1	1	0.6	0.4	
DOSE	0.008369	0.7444	17.9	33.97	160.38	638.8	0.852
DCF	1.7	1.35	1.35	1.35	1.35	1.35	
DOSE	0.004922941	0.551407407	13.25925926	25.16296296	118.8	473.185185	**0.6309637**
U1 T/S	1.184E+03	1.976E+03	1.120E+02	2.484E-03	2.777E-03	2.540E-03	
OF	1	1	1	1	0.6	0.4	
DOSE	1184	1976	112	0.002484	0.0016662	0.001016	3.272
DCF	1.7	1.35	1.35	1.35	1.35	1.35	
DOSE	696.4705882	1463.703704	82.96296296	0.00184	0.001234222	0.00075259	**2.243**

	0-.5 HR	.5-2 HR	2-8 HR	8-24 HR	1-4 DAY	4-30 DAY	Total
U3 B/S	3.599E-03	3.201E-01	9.007E+00	1.664E+01	1.320E+02	7.910E+02	
OF	1	1	1	1	0.6	0.4	
DOSE	0.003599	0.3201	9.007	16.64	79.2	316.4	0.422
DCF	1.7	1.35	1.35	1.35	1.35	1.35	
DOSE	0.002117059	0.237111111	6.671851852	12.32592593	58.66666667	234.37037	**0.312**
U3 T/S	1.052E+03	1.848E+03	3.798E+02	2.423E+02	2.759E+03	2.191E+02	
OF	1	1	1	1	0.6	0.4	
DOSE	1052	1848	379.8	242.3	1655.4	87.64	5.265
DCF	1.7	1.35	1.35	1.35	1.35	1.35	
DOSE	618.8235294	1368.888889	281.3333333	179.4814815	1226.222222	64.9185185	**3.740**

* OF= Occupancy Factor = 1.0 for 0-24 hr, 0.6 for 1-4 day, 0.4 for 4-30 day
** DCF = ICRP-30 Dose Conversion Factor = 1.7 for 0-0.5 hr, 1.35 for 0.5 hr-30 day

1500 cfm CREVS intake
1500 cfm

	0-.5 HR	.5-2 HR	2-8 HR	8-24 HR	1-4 DAY	4-30 DAY	Total
	mrem	mrem	mrem	mrem	mrem	mrem	rem
U1 B/S	8.569E-03	8.261E-01	2.164E+01	4.192E+01	3.308E+02	1.979E+03	
OF	1	1	1	1	0.6	0.4	
DOSE	0.008569	0.8261	21.64	41.92	198.48	791.6	1.054
DCF	1.7	1.35	1.35	1.35	1.35	1.35	
DOSE	0.005040588	0.611925926	16.02962963	31.05185185	147.0222222	586.37037	**0.781091**
U1 T/S	1.213E+03	2.535E+03	2.884E+02	1.924E-02	3.461E-03	3.153E-03	
OF	1	1	1	1	0.6	0.4	
DOSE	1213	2535	288.4	0.01924	0.0020766	0.0012612	4.036
DCF	1.7	1.35	1.35	1.35	1.35	1.35	
DOSE	713.5294118	1877.777778	213.6296296	0.014251852	0.001538222	0.00093422	**2.805**

	0-.5 HR	.5-2 HR	2-8 HR	8-24 HR	1-4 DAY	4-30 DAY	Total
U3 B/S	3.685E-03	3.552E-01	1.088E+01	2.054E+01	1.634E+02	9.800E+02	
OF	1	1	1	1	0.6	0.4	
DOSE	0.003685	0.3552	10.88	20.54	98.04	392	0.522
DCF	1.7	1.35	1.35	1.35	1.35	1.35	
DOSE	0.002167647	0.263111111	8.059259259	15.21481481	72.62222222	290.37037	**0.387**
U3 T/S	1.077E+03	2.355E+03	6.066E+02	3.009E+02	3.413E+03	2.784E+02	
OF	1	1	1	1	0.6	0.4	
DOSE	1077	2355	606.6	300.9	2047.8	111.36	**6.499**
DCF	1.7	1.35	1.35	1.35	1.35	1.35	
DOSE	633.5294118	1744.444444	449.3333333	222.8888889	1516.888889	82.4888889	4.650

0 cfm CREVS intake

	0-.5 HR	.5-2 HR	2-8 HR	8-24 HR	1-4 DAY	4-30 DAY	Total
	mrem	mrem	mrem	mrem	mrem	mrem	rem
U1 B/S	8.780E-03	9.301E-01	2.783E+01	5.612E+01	4.452E+02	2.668E+03	
OF	1	1	1	1	0.6	0.4	
DOSE	0.00878	0.9301	27.83	56.12	267.12	1067.2	1.419
DCF	1.7	1.35	1.35	1.35	1.35	1.35	
DOSE	0.005164706	0.688962963	20.61481481	41.57037037	197.8666667	790.518519	**1.0512645**
U1 T/S	1.243E+03	3.349E+03	8.079E+02	6.202E-01	4.716E-03	4.265E-03	
OF	1	1	1	1	0.6	0.4	
DOSE	1243	3349	807.9	0.6202	0.0028296	0.001706	5.401
DCF	1.7	1.35	1.35	1.35	1.35	1.35	
DOSE	731.1764706	2480.740741	598.4444444	0.459407407	0.002096	0.0012637	**3.811**

	0-.5 HR	.5-2 HR	2-8 HR	8-24 HR	1-4 DAY	4-30 DAY	Total
U3 B/S	3.776E-03	4.000E-01	1.398E+01	2.751E+01	2.198E+02	1.321E+03	
OF	1	1	1	1	0.6	0.4	
DOSE	0.003776	0.4	13.98	27.51	131.88	528.4	0.702
DCF	1.7	1.35	1.35	1.35	1.35	1.35	
DOSE	0.002221176	0.296296296	10.35555556	20.37777778	97.68888889	391.407407	**0.520**
U3 T/S	1.104E+03	3.090E+03	1.192E+03	4.079E+02	4.587E+03	3.922E+02	
OF	1	1	1	1	0.6	0.4	
DOSE	1104	3090	1192	407.9	2752.2	156.88	8.703
DCF	1.7	1.35	1.35	1.35	1.35	1.35	
DOSE	649.4117647	2288.888889	882.962963	302.1481481	2038.666667	116.207407	**6.278**

The releases from the top of the stack for a LOCA are (from the STP output):

Curies Released From Top of Stack

NUCLIDE	0-0.5 hr	0.5-2 hr	2-8 hr	8-24 hr	24-48 hr	48-96 hr
I 131	1.731E+02	1.815E+03	1.144E+04	4.252E+04	5.833E+04	1.578E+05
I 132	2.268E+02	1.765E+03	4.098E+03	1.171E+03	8.971E+00	8.977E+00
I 133	3.470E+02	3.531E+03	1.993E+04	5.414E+04	4.160E+04	6.795E+04
I 134	2.981E+02	1.476E+03	1.038E+03	1.422E+01	4.495E-05	4.495E-05
I 135	3.175E+02	3.006E+03	1.317E+04	1.792E+04	3.724E+03	4.041E+03
I* 131	7.214E+00	7.565E+01	4.766E+02	1.772E+03	2.431E+03	6.575E+03
I* 132	9.450E+00	7.354E+01	1.708E+02	4.878E+01	3.738E-01	3.740E-01
I* 133	1.446E+01	1.471E+02	8.305E+02	2.256E+03	1.733E+03	2.831E+03
I* 134	1.242E+01	6.150E+01	4.325E+01	5.924E-01	1.873E-06	1.873E-06
I* 135	1.323E+01	1.253E+02	5.487E+02	7.464E+02	1.551E+02	1.684E+02
KRM 85	1.611E+03	1.452E+04	5.371E+04	3.534E+04	3.118E+03	3.194E+03
KR 85	9.798E+01	1.031E+03	6.582E+03	1.898E+04	2.795E+04	8.200E+04
KR 87	2.707E+03	1.676E+04	2.044E+04	9.213E+02	1.482E-01	1.482E-01
KR 88	4.192E+03	3.446E+04	9.480E+04	3.021E+04	5.765E+02	5.779E+02
KR 89	2.734E+02	2.565E+00	1.729E-08	0.000E+00	0.000E+00	0.000E+00
XEM 131	7.567E+01	7.957E+02	5.071E+03	1.458E+04	2.132E+04	6.182E+04
XEM 133	4.283E+02	4.473E+03	2.782E+04	7.357E+04	8.912E+04	2.037E+05
XE 133	1.331E+04	1.397E+05	8.860E+05	2.484E+06	3.385E+06	8.874E+06
XEM 135	1.915E+03	2.011E+04	2.624E+05	7.993E+05	3.917E+05	4.539E+05
XE 135	4.841E+03	5.259E+04	3.508E+05	7.456E+05	3.685E+05	4.465E+05
XE 137	8.353E+02	2.067E+01	3.824E-06	0.000E+00	0.000E+00	0.000E+00
XE 138	4.556E+03	4.660E+03	1.050E+02	2.949E-06	1.832E-27	0.000E+00
Total Iodine	1.419E+03	1.208E+04	5.175E+04	1.206E+05	1.080E+05	2.394E+05
Total NG	3.484E+04	2.892E+05	1.708E+06	4.202E+06	4.287E+06	1.013E+07
Grand Total	3.626E+04	3.012E+05	1.760E+06	4.323E+06	4.395E+06	1.036E+07

* = organic iodine

Curies Released From Top of Stack

NUCLIDE	96-120 hr	120-240 hr	240-480 hr	480-960 hr
I 131	4.227E+04	1.973E+05	6.602E+05	7.509E+05
I 132	2.623E-09	2.624E-09	2.624E-09	2.624E-09
I 133	3.541E+03	6.278E+03	6.764E+03	6.764E+03
I 134	1.759E-31	0.000E+00	0.000E+00	0.000E+00
I 135	1.837E+00	1.994E+00	1.994E+00	1.994E+00
I* 131	1.761E+03	8.220E+03	2.751E+04	3.129E+04
I* 132	1.093E-10	1.093E-10	1.093E-10	1.093E-10
I* 133	1.476E+02	2.616E+02	2.818E+02	2.818E+02
I* 134	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I* 135	7.653E-02	8.309E-02	8.309E-02	8.309E-02
KRM 85	4.237E-02	4.340E-02	4.340E-02	4.340E-02
KR 85	2.614E+04	1.485E+05	8.218E+05	1.174E+06
KR 87	1.252E-18	1.252E-18	1.252E-18	1.252E-18
KR 88	9.798E-06	9.823E-06	9.823E-06	9.823E-06
KR 89	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XEM 131	1.912E+04	1.030E+05	4.716E+05	5.973E+05
XEM 133	3.480E+04	1.065E+05	2.263E+05	2.285E+05
XE 133	2.182E+06	9.250E+06	3.288E+07	3.570E+07
XEM 135	6.700E+02	7.430E+02	7.430E+02	7.430E+02
XE 135	1.724E+03	2.046E+03	2.046E+03	2.046E+03
XE 137	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE 138	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Iodine	4.772E+04	2.121E+05	6.948E+05	7.892E+05
Total NG	2.265E+06	9.611E+06	3.440E+07	3.770E+07
Grand Total	2.313E+06	9.823E+06	3.510E+07	3.849E+07

* = organic iodine* = organic iodine

Revision 14 is performed to provide the top of stack release rates as design output in order to provide input to Emergency Operating Instructions (EOIs). This information supersedes that found in ND-Q0065-920018. Note that these releases are not the only releases from the plant. The major contributor to the control room dose and offsite dose is the MSIV leakage. However, if the 168 scfh MSIV leakage is not exceeded, and the bottom of stack leakage is less than 10 cfm, then the following top of stack release rates provide an indication when control room/offsite doses may be exceeded. The control room doses as determined in this calculation are very close to the limits. Therefore, if the top of stack releases are less than following, it can be reasonably assured that the control room and offsite doses will not exceed regulatory limits. The following is the release rate (μCi/sec) from the top of the stack:

Curies Release Rate (μCi/sec) From Top of Stack

NUCLIDE	0-0.5	0.5-2	2-8	8-24	24-48	48-96
I 131	9.617E+04	3.361E+05	5.296E+05	7.382E+05	6.751E+05	9.132E+05
I 132	1.260E+05	3.269E+05	1.897E+05	2.033E+04	1.038E+02	5.195E+01
I 133	1.928E+05	6.539E+05	9.227E+05	9.399E+05	4.815E+05	3.932E+05
I 134	1.656E+05	2.733E+05	4.806E+04	2.469E+02	5.203E-04	2.601E-04
I 135	1.764E+05	5.567E+05	6.097E+05	3.111E+05	4.310E+04	2.339E+04
I* 131	4.008E+03	1.401E+04	2.206E+04	3.076E+04	2.814E+04	3.805E+04
I* 132	5.250E+03	1.362E+04	7.907E+03	8.469E+02	4.326E+00	2.164E+00
I* 133	8.033E+03	2.724E+04	3.845E+04	3.917E+04	2.006E+04	1.638E+04
I* 134	6.900E+03	1.139E+04	2.002E+03	1.028E+01	2.168E-05	1.084E-05
I* 135	7.350E+03	2.320E+04	2.540E+04	1.296E+04	1.795E+03	9.745E+02
KRM 85	8.950E+05	2.689E+06	2.487E+06	6.135E+05	3.609E+04	1.848E+04
KR 85	5.443E+04	1.909E+05	3.047E+05	3.295E+05	3.235E+05	4.745E+05
KR 87	1.504E+06	3.104E+06	9.463E+05	1.599E+04	1.715E+00	8.576E-01
KR 88	2.329E+06	6.381E+06	4.389E+06	5.245E+05	6.672E+03	3.344E+03
KR 89	1.519E+05	4.750E+02	8.005E-07	0.000E+00	0.000E+00	0.000E+00
XEM 131	4.204E+04	1.474E+05	2.348E+05	2.531E+05	2.468E+05	3.578E+05
XEM 133	2.379E+05	8.283E+05	1.288E+06	1.277E+06	1.031E+06	1.179E+06
XE 133	7.394E+06	2.587E+07	4.102E+07	4.313E+07	3.918E+07	5.135E+07
XEM 135	1.064E+06	3.724E+06	1.215E+07	1.388E+07	4.534E+06	2.627E+06
XE 135	2.689E+06	9.739E+06	1.624E+07	1.294E+07	4.265E+06	2.584E+06
XE 137	4.641E+05	3.828E+03	1.770E-04	0.000E+00	0.000E+00	0.000E+00
XE 138	2.531E+06	8.630E+05	4.861E+03	5.120E-05	2.120E-26	0.000E+00
Total Iodine	7.885E+05	2.236E+06	2.396E+06	2.094E+06	1.250E+06	1.385E+06
Total NG	1.936E+07	5.354E+07	7.906E+07	7.296E+07	4.962E+07	5.860E+07
Grand Total	2.015E+07	5.578E+07	8.146E+07	7.505E+07	5.087E+07	5.998E+07

* = organic iodine

Curies Release Rate (µCi/sec) From Top of Stack

NUCLIDE	96-120	120-240	240-480	480-960
I 131	4.892E+05	4.567E+05	5.094E+05	4.345E+05
I 132	3.036E-08	6.074E-09	2.025E-09	1.519E-09
I 133	4.098E+04	1.453E+04	5.219E+03	3.914E+03
I 134	2.036E-30	0.000E+00	0.000E+00	0.000E+00
I 135	2.126E+01	4.616E+00	1.539E+00	1.154E+00
I* 131	2.038E+04	1.903E+04	2.123E+04	1.811E+04
I* 132	1.265E-09	2.530E-10	8.434E-11	6.325E-11
I* 133	1.708E+03	6.056E+02	2.174E+02	1.631E+02
I* 134	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I* 135	8.858E-01	1.923E-01	6.411E-02	4.808E-02
KRM 85	4.904E-01	1.005E-01	3.349E-02	2.512E-02
KR 85	3.025E+05	3.438E+05	6.341E+05	6.794E+05
KR 87	1.449E-17	2.898E-18	9.660E-19	7.245E-19
KR 88	1.134E-04	2.274E-05	7.579E-06	5.685E-06
KR 89	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XEM 131	2.213E+05	2.384E+05	3.639E+05	3.457E+05
XEM 133	4.028E+05	2.465E+05	1.746E+05	1.322E+05
XE 133	2.525E+07	2.141E+07	2.537E+07	2.066E+07
XEM 135	7.755E+03	1.720E+03	5.733E+02	4.300E+02
XE 135	1.995E+04	4.736E+03	1.579E+03	1.184E+03
XE 137	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE 138	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Iodine	5.523E+05	4.909E+05	5.361E+05	4.567E+05
Total NG	2.621E+07	2.225E+07	2.655E+07	2.182E+07
Grand Total	2.676E+07	2.274E+07	2.708E+07	2.228E+07

* = organic iodine

Results

The results (in rem) are presented below. The control room results are divided by 2 to account for the dual intakes (see assumption #8). Note that fumigation is included in the top of stack contribution for the control room, whereas the offsite dose it is a separate component. The control room doses due to MSIV leakage as determined by GE were based on 3000 cfm. To scale the GE results for 1500 cfm and 0.0 cfm CREVS flow, the following scaling factor is applied: (GE MSIV dose)*(x cfmbase dose+ x cfmtop dose)/(3000 cfmbase dose+3000 cfmtop dose) where "x' variable is either 1500 or 0 cfm. The total gamma dose includes 0.667 rem due to shine from secondary containment (this 0.667 rem is not divided by two).

case=3000 cfm makeup flow

CR U1	base	top	MSIV	Total	Total/2
Gamma	9.800E-04	7.200E-03	2.160E-02	6.968E-01	6.819E-01
Beta	7.862E-03	7.592E-02	2.190E-01	3.028E-01	1.514E-01
Thyroid	6.310E-01	2.243E+00	5.490E+01	5.777E+01	2.889E+01

CR U3	base	top	MSIV	Total	Total/2
Gamma	4.847E-04	9.344E-03	2.160E-02	6.984E-01	6.827E-01
Beta	3.888E-03	9.234E-02	2.190E-01	3.152E-01	1.576E-01
Thyroid	3.123E-01	3.740E+00	5.490E+01	5.895E+01	2.948E+01

case=1500 cfm makeup flow

CR U1	base	top	MSIV	Total	Total/2
Gamma	9.821E-04	7.019E-03	2.113E-02	6.961E-01	6.816E-01
Beta	7.879E-03	7.283E-02	2.110E-01	2.917E-01	1.458E-01
Thyroid	7.811E-01	2.805E+00	6.850E+01	7.209E+01	3.604E+01

CR U3	base	top	MSIV	Total	Total/2
Gamma	4.857E-04	9.170E-03	2.122E-02	6.979E-01	6.824E-01
Beta	3.897E-03	8.952E-02	2.126E-01	3.060E-01	1.530E-01
Thyroid	3.865E-01	4.650E+00	6.823E+01	7.327E+01	3.664E+01

case = 0 cfm makeup flow

CR U1	base	top	MSIV	Total	Total/2
Gamma	9.861E-04	6.788E-03	2.053E-02	6.953E-01	6.812E-01
Beta	7.911E-03	6.869E-02	2.002E-01	2.768E-01	1.384E-01
Thyroid	1.051E+00	3.811E+00	9.287E+01	9.774E+01	4.887E+01

CR U3	base	top	MSIV	Total	Total/2
Gamma	4.877E-04	8.950E-03	2.074E-02	6.972E-01	6.821E-01
Beta	3.912E-03	8.577E-02	2.041E-01	2.938E-01	1.469E-01
Thyroid	5.201E-01	6.278E+00	9.211E+01	9.891E+01	4.946E+01

* Total = base+top+MSIV+0.667 for gamma; = base+top+MSIV for beta,Thyroid

** Total/2=(base+top+MSIV)/2+0.667 for gamma; =(base+top+MSIV)/2 for beta,Thyroid

Offsite	Gamma Base	Top	Fumigation	MSIV	Total
30-day LPZ	2.594E-03	2.660E-01	6.793E-02	1.450E-01	4.815E-01
2-hr LPZ	2.272E-05	3.762E-02	6.793E-02		1.056E-01
2-hr EAB	4.544E-05	3.962E-02	1.267E-01	1.550E-04	1.665E-01

Offsite	Beta Base	Top	Fumigation		Total
30-day LPZ	5.745E-03	2.928E-01	4.138E-02	1.440E-01	4.839E-01
2-hr LPZ	1.379E-05	2.216E-02	4.138E-02		6.355E-02
2-hr EAB	2.758E-05	2.334E-02	7.718E-02	5.770E-05	1.006E-01

Offsite	Inhalation Base	Top	Fumigation		Total
30-day LPZ	1.002E+00	4.490E+01	2.067E+00	3.800E+01	8.597E+01
2-hr LPZ	1.228E-03	1.880E+00	2.067E+00		3.948E+00
2-hr EAB	2.456E-03	1.980E+00	3.855E+00	2.480E-03	5.840E+00

The following tables present the Control Room and Offsite doses with the 11.5 scfh/MSIV valve leakage. The MSIV values are taken from Appendix A. Note that the results are based on ICRP-2 conversion factors:

case=3000 cfm makeup flow, 11.5 scfh/MSIV valve leakage

CR U1	base	top	MSIV	Total	Total/2
Gamma	9.800E-04	7.200E-03	1.093E-03	6.763E-01	6.716E-01
Beta	7.862E-03	7.592E-02	1.122E-02	9.500E-02	4.750E-02
Thyroid	6.310E-01	2.243E+00	3.200E+00	6.074E+00	3.037E+00

CR U3	base	top	MSIV	Total	Total/2
Gamma	4.847E-04	9.344E-03	1.629E-03	6.785E-01	6.727E-01
Beta	3.888E-03	9.234E-02	1.671E-02	1.129E-01	5.647E-02
Thyroid	3.123E-01	3.740E+00	4.756E+00	8.808E+00	4.404E+00

	Offsite	Gamma			
	Base	Top	Fumigation	MSIV	Total
30-day LPZ	2.594E-03	2.660E-01	6.793E-02	9.106E-03	3.456E-01
2-hr LPZ	2.272E-05	3.762E-02	6.793E-02		1.056E-01
2-hr EAB	4.544E-05	3.962E-02	1.267E-01	1.165E-06	1.664E-01

	Offsite	Beta			
	Base	Top	Fumigation		Total
30-day LPZ	5.745E-03	2.928E-01	4.138E-02	9.127E-03	3.491E-01
2-hr LPZ	1.379E-05	2.216E-02	4.138E-02		6.355E-02
2-hr EAB	2.758E-05	2.334E-02	7.718E-02	4.329E-07	1.005E-01

	Offsite	Inhalation			
	Base	Top	Fumigation		Total
30-day LPZ	1.002E+00	4.490E+01	2.067E+00	2.736E+00	5.071E+01
2-hr LPZ	1.228E-03	1.880E+00	2.067E+00		3.948E+00
2-hr EAB	2.456E-03	1.980E+00	3.855E+00	3.154E-05	5.837E+00

The following table gives the summary of the results for normal operation of the CREVS system (3000 cfm intake) of this calculation:

Summary of Results (11.5 scfh/MSIV valve leakage, ICRP-2 conversion factors) [rem]

	Control Room	2-hr EAB Offsite	30-day LPZ Offsite
Thyroid	4.404	5.837	50.71
Gamma	0.6727	0.1664	0.3456
Beta	0.05647	0.1005	0.3491

Summary of Results (168 scfh MSIV leakage total, ICRP-30 conversion factors) [rem]

	Control Room	2-hr EAB Offsite	30-day LPZ Offsite
Thyroid	29.48	5.840	85.97
Gamma	0.6827	0.1665	0.4815
Beta	0.1576	0.1006	0.4839

If CREVS flow is reduced to 1500 cfm, the control room doses will increase as much as a factor of 1.24. When there is no CREVS flow, the control room doses will increase as much as a factor of 1.68.

Conclusions

With either 11.5 scfh/MSIV valve leakage, or 168 scfh MSIV total valve leakage, the control room doses are below the 10CFR50 App. A GDC 19 limits of 5 rem gamma, 30 rem beta, and 30 rem Inhalation. The offsite doses are below the 10CFR100 limits of 25 rem gamma, 300 rem beta, and 300 rem Inhalation.

This calculation also determined that for reduced CREVS flow (1500 cfm due to instrumentation) or no CREVS flow for the duration of the accident, the doses exceeded the GDC 19 limits. The no CREVS flow case was for the entire accident and therefore bounds cases for no flow during switchover from one train to another, and for delayed startup. This calculation supersedes calculation ND-Q2031-920088 (ref.19, which concluded that a 10 minute delayed startup of the CREVS results in an insignificant increase in doses). ND-Q2031-920088 was superceded because the X/Q values and other input data were out of date, however, the conclusions for the insignificant increase in doses for 10 minute delay startup will still be valid. Nevertheless, this calculation shows that charcoal filters are required long term in the CREVS system.

The calculation has determined that the MSIV leakage may be increased from 11.5 scfh/valve to 168 scfh total.

References

1. Regulatory Guide 1.3 R2 "Assumptions Used For Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident For Boiling Water Reactors"
2. ND-Q0999-980016 R3 "Parameters Used in Dose Analyses"
3. Computer Code STP R6, code I.D. 262165
4. Computer Code COROD R3, code I.D. 262347
5. Computer Code FENCDOSE, code I.D. 262358
6. NUREG-0800 "Standard Review Plan"
7. Design Criteria BFN-50-C-7103, Attachment E
8. MD-Q0066-920473 R1 "Estimated Mixing Volume and SGTS Flow During a Design Basis Accident on Unit 2 With the Equipment Hatches Removed"
9. not used
10. not used
11. not used
12. not used
13. Letter from A.L.Jenkins to J.L.Kamphouse "Browns Ferry Control Room Dose Calculations in Accordance with the BWROG Radiological Dose Methodology (11.5 SCFH per Steam Line) Revision 1" dated August 28, 1992 with attachment: "Browns Ferry Nuclear Plant Calculation of LOCA Doses to the Control Room From MSIV Leakage" DRF A00-04146 Section C, Performed by GE Nuclear Energy, August 1992 RIMS#R92 920904 001
14. not used
15. not used
16. ND-Q0000-890013 R3 "Post-LOCA Control Room Gamma Dose From Secondary Containment and Core Spray Piping"
17. Regulatory Guide 1.49 "Power Levels of Water-Cooled Nuclear Power Reactors"
18. BFN Technical Specification 5.5.12 Amendments 234 (U1), 253 (U2), and 214 (U3)
19. ND-Q2031-920088 R1 "CREVS 10 Minute Delayed Start" (not used as design input)
20. Letter # NSA 99-513 from Gregory J. Porter (GE) to Tennessee Valley Authority, Dated December 31, 1999, "Transmittal of Revised Browns Ferry MSIV Leakage Pathway Radiological Dose Calculations Per GE Proposal 523-1JQ06-ER2" RIMS# B44 000106 001
21. ND-Q2031-910015 R0 "Control Room LOCA Doses - CREVS Modifications" RIMS# B22 910904 104
22. NUREG-1169 "Resolution of Generic Issue C-8" by J.N.Ridgely and M.L.Wohl, USNRC, (1986)
23. ICRP, 1977 Recommendations of the International Commission on Radiological Protection. International Commission on Radiological Protection, Publication 26, Pergamon Press, Oxford, England
24. ICRP, 1979 Limits for Intakes of Radionuclides by Workers. International Commission on Radiological Protection, Publication 30, Part 1, Pergamon Press, New York, New York
25. ND-Q0065-920018 R2 "Maximum Release Rates From the Top of the Stack Post LOCA" note: this is not used as design input. It is being superseded by this calculation (ND-Q0031-920075 R14).

Appendix A: GE Generated 11.5 scfh/MSIV Valve Leakage Doses

Doses [rem] Due to 11.5 scfh/MSIV valve Leakage and released through the Turbine Building Roof Ventilation as determined by GE, ref.13. Note, these values are based on different X/Q values than the current design of the plant and therefore will have to be modified. Only the non-zero values are reported (CR= control room, DL= drain line, org= organic, resus= resuspended, NG= noble gas) :

control room MSIV doses:

	gamma	thyroid	beta
CR DL			
2 hr	9.390E-12	4.781E-08	4.355E-11
4 hr	2.884E-10	2.012E-06	1.473E-09
1 day	3.277E-08	5.942E-04	2.145E-07
30 day	1.046E-07	4.266E-03	6.480E-07
CR NG DL			
2 hr	2.514E-08	0.000E+00	1.746E-07
4 hr	7.698E-07	0.000E+00	5.220E-06
1 day	9.473E-05	0.000E+00	9.112E-04
30 day	6.106E-03	0.000E+00	6.417E-02
CR DL org			
2 hr	8.911E-10	4.538E-06	4.133E-09
4 hr	2.738E-08	1.910E-04	1.399E-07
1 day	4.182E-06	7.851E-02	2.755E-05
30 day	1.556E-04	9.692E+00	8.585E-04
CR org resus			
2 hr	9.112E-11	6.125E-06	4.838E-10
4 hr	7.899E-10	5.310E-05	4.194E-09
1 day	1.959E-07	1.317E-02	1.040E-06
30 day	1.378E-04	9.264E+00	7.317E-04
total 2 hr	2.613E-08	1.071E-05	1.793E-07
total 4 hr	7.983E-07	2.461E-04	5.366E-06
total 1day	9.914E-05	9.227E-02	9.400E-04
total 30 day	6.400E-03	1.896E+01	6.576E-02

EAB offsite MSIV doses:

	gamma	thyroid	beta
offsite DL			
0-2 hr	6.690E-10	1.819E-07	1.669E-10
offsite NG DL			
0-2 hr	1.054E-06	0.000E+00	3.996E-07
offsite org DL			
0-2 hr	6.310E-08	1.716E-05	1.574E-08
off resus			
0-2 hr	3.252E-09	1.301E-05	1.027E-09
total	1.121E-06	3.035E-05	4.165E-07

LPZ offsite MSIV doses:

	gamma	thyroid	beta
offsite DL			
0-2 hr	3.222E-10	8.764E-08	8.041E-11
2-4 hr	3.109E-09	1.140E-06	8.509E-10
4 hr-1day	1.741E-07	9.251E-05	6.287E-08
1-30day	4.194E-07	5.556E-04	1.513E-07
offsite NG DL			
0-2 hr	5.107E-07	0.000E+00	1.936E-07
2-4 hr	4.789E-06	0.000E+00	1.828E-06
4 hr-1day	2.021E-04	0.000E+00	1.602E-04
1-30day	5.747E-03	0.000E+00	6.311E-03
offsite org DL			
0-2 hr	3.058E-08	8.317E-06	7.631E-09
2-4 hr	2.956E-07	1.084E-04	8.090E-08
4 hr-1day	2.222E-05	1.211E-02	8.109E-06
1-30day	4.368E-04	1.029E+00	1.447E-04
offsite org resus			
0-2 hr	1.590E-09	6.358E-06	5.022E-10
2-4 hr	7.324E-09	2.929E-05	2.313E-09
4 hr-1day	9.556E-07	2.015E-03	3.018E-07
1-30day	3.550E-04	9.487E-01	1.121E-04
total 2 hr	5.432E-07	1.476E-05	2.018E-07
total 4 hr	5.095E-06	1.388E-04	1.912E-06
total 1 day	2.254E-04	1.422E-02	1.687E-04
total 30 day	6.539E-03	1.978E+00	6.568E-03

The following X/Q values were used by GE in the MSIV leakage contribution. **These are <u>not</u> used in this analysis except for scaling the doses to the updated plant X/Q values shown below:**

	GE CR X/Q	GE EAB X/Q	GE LPZ X/Q
0-2 hr	3.480E-04	2.700E-4	1.320E-04
2-8 hr	2.940E-04		6.020E-05
8 hr-1day	2.530E-04		4.070E-05
1-4 day	2.010E-04		1.730E-05
4-30 day	1.440E-04		5.100E-06

Scaling of GE MSIV Results to Current X/Q and Power Levels:

The control room and offsite doses as determined by GE due to the MSIV leakage were based on out of date X/Q values. This section scales the doses to current X/Q values by dividing each incremental dose by the X/Q used by GE and multiplying by the current X/Q. Also, the GE values need to be scaled upward by factors of 1.05 (for power uprate from 3293 to 3458 MWt) and 1.02 (per Regulatory Guide 1.49). The GE time increments do not correspond to the same ones traditionally used by TVA. For scaling purposes, one should not use a weighted average X/Q for application to a dose extending over two time periods (such as a period of 4 hour to 1day instead of 2-8 hours and 8hrs - 1 day) because the GE results may not be linear with respect to time. For conservatism, use the highest X/Q value for cases where the GE dose covers more than one time period. The GE results are in units of rem:

Control Room:

	Gamma	Thyroid	Beta
total 2 hr	2.613E-08	1.071E-05	1.793E-07
total 4 hr	7.983E-07	2.461E-04	5.366E-06
total 1day	9.914E-05	9.227E-02	9.400E-04
total 30 day	6.400E-03	1.896E+01	6.576E-02

The above values are cumulative total. To properly account for the X/Q at the appropriate time interval, the dose during each time period was determined to be

increment	Gamma	Thyroid	Beta
0-2	2.613E-08	1.071E-05	1.793E-07
2-4	7.721E-07	2.354E-04	5.186E-06
4-1day	9.834E-05	9.203E-02	9.346E-04
1-30day	6.300E-03	1.887E+01	6.482E-02
checksum	6.400E-03	1.896E+01	6.576E-02

	GE X/Q	U1 Turb Bldg	U1 ratio	U3 Turb Bldg	U3 ratio	use ratio for these time periods
0-2	3.480E-04	1.200E-04	3.448E-01	2.170E-04	6.236E-01	0-2
2-8	2.940E-04	9.960E-05	3.388E-01	1.640E-04	5.578E-01	2-4,4-1day
8-1day	2.530E-04	4.850E-05	1.917E-01	7.890E-05	3.119E-01	
1-4day	2.010E-04	3.150E-05	1.567E-01	4.330E-05	2.154E-01	1-30day (Unit 1)
4-30day	1.440E-04	2.020E-05	1.403E-01	3.350E-05	2.326E-01	1-30day (Unit 3)

GE results (delta) modified by Turbine Building X/Q

increment	U1 gamma	U1 thyroid	U1 beta	U3 gamma	U3 thyroid	U3 beta
0-2	9.011E-09	3.693E-06	6.181E-08	1.629E-08	6.679E-06	1.118E-07
2-4	2.616E-07	7.975E-05	1.757E-06	4.307E-07	1.313E-04	2.893E-06
4-1day	3.332E-05	3.118E-02	3.166E-04	5.486E-05	5.134E-02	5.214E-04
1-30day	9.874E-04	2.957E+00	1.016E-02	1.466E-03	4.389E+00	1.508E-02
total CR	**1.021E-03**	**2.988E+00**	**1.048E-02**	**1.521E-03**	**4.441E+00**	**1.560E-02**
scaled dose	**1.093E-03**	**3.200E+00**	**1.122E-02**	**1.629E-03**	**4.756E+00**	**1.671E-02**

* scaled by multiplying by 1.05 and 1.02

EAB offsite doses (non-zero):

	gamma	thyroid	beta
total	1.121E-06	3.035E-05	4.165E-07

increment	GE X/Q	new X/Q	ratio
0-2	2.700E-04	2.620E-04	9.704E-01

EAB GE results modified by new X/Q

increment	gamma	thyroid	beta
0-2	1.088E-06	2.945E-05	4.042E-07
scaled dose*	**1.165E-06**	**3.154E-05**	**4.329E-07**

* = scaled by multiplying by 1.05 and 1.02

LPZ offsite doses (non-zero):

	gamma	thyroid	beta
total 2hr	5.432E-07	1.476E-05	2.018E-07
total 4 hr	5.095E-06	1.388E-04	1.912E-06
total 1 day	2.254E-04	1.422E-02	1.687E-04
total 30 day	6.539E-03	1.978E+00	6.568E-03

increment			
0-2 hr	5.432E-07	1.476E-05	2.018E-07
2-4 hr	4.552E-06	1.241E-04	1.710E-06
4 hr-1day	2.204E-04	1.408E-02	1.668E-04
1-30 day	6.314E-03	1.964E+00	6.399E-03
checksum	6.539E-03	1.978E+00	6.568E-03

increment	GE X/Q	new X/Q	ratio
0-2 hr	1.320E-04	1.310E-04	9.924E-01
2-4 hr	6.020E-05	6.610E-05	1.098E+00
4 hr-1day	4.070E-05	6.610E-05	1.624E+00
1-30 day	1.730E-05	2.230E-05	1.289E+00

GE results modified by new X/Q

increment	gamma	thyroid	beta
0-2 hr	5.391E-07	1.465E-05	2.003E-07
2-4 hr	4.998E-06	1.362E-04	1.878E-06
4 hr-1day	3.579E-04	2.286E-02	2.708E-04
1-30 day	8.139E-03	2.532E+00	8.249E-03
total LPZ	8.502E-03	2.555E+00	8.522E-03
scaled dose*	**9.106E-03**	**2.736E+00**	**9.127E-03**

· = scaled by multiplying by 1.05 and 1.02

Design Output
(page left blank)

Appendix B
Application of the Alternative Source Term (AST) to TVA/BFN LOCA Analysis
Using RADTRAD, without Credit for Drywell Sprays but with
No CREV Filtration Credit, Increased Stack Bypass, Increased ESF Leakage, and U1 Applicability

Approach

The Design Input and Methods used for Appendix B are *identical* to those of Appendix D, EXCEPT for the following:

- Credit for the control room envelope ventilation system (CREVS) was removed, i.e. the entire 6717cfm make up flow into the control room from the environment is unfiltered. (Junction 14 in the Appendix D Plant Model Description)
- The allowable SGTS flow bypassing the stack (Junction 7 in the Appendix D Plant Model Description) was increased from 10cfm to 20 cfm
- ESF leakage was increased from 2.5gpm (analyzed as 5 gpm) to 10 gpm (analyzed as 20 gpm), (Junction 4 in Appendix D Plant Model Description). (Clarification Statement: ESF leakage is conservatively assumed to be 20 GPM in the analysis. 20 GPM is validated by technical instruction (i.e. 0-TI-578) acceptance criteria of 10 GPM.)
- The Reactor Building volume for Unit 1is used rather than the Reactor Building Volume 2/3 (1.311E6ft3 vs 1.932E6ft3 respectively, see Item 3.4 of Reference D-2) because the smaller reactor volume was found to be more limiting, i.e. a smaller volume would give less holdup.
- Use of the Unit 1 Turbine Building X/Qs. Two sets of control room X/Qs for the Turbine building releases appear in the main body of Reference D-2. One is for the "Turbine Building Roof Ventilators" (applicable to all units), while the second is for the "Turbine Building Exhaust Release" which is calculated for each unit uniquely. For Units 2/3, the roof ventilator set bounds the exhaust release set, but that is not true for Unit 1. Therefore, the impact of increasing the Turbine Building release X/Qs for Unit 1 is included in this appendix. The increase as compared to the Appendix D roof ventilator values is as follows:

	Turbine Building Roof Ventilators (sec/m^3)	Turbine Building Exhaust Release (sec/m^3)
0 - 2 hr:	2.17E-4	3.22E-4
2 hr - 8 hr:	1.64E-4	2.77E-4
8 hr - 1 day:	7.89E-5	1.31E-4
1 day - 4 day	4.33E-5	7.91E-5
4 day - 30 day:	3.35E-5	6.10E-5

RADTRAD Analysis

Matrix of RADTRAD Runs

The table below summarizes the characteristics of each of the five RADTRAD runs performed for this analysis.

RADTRAD Cases					
Run#	Release Pathways to the Environment	PSF File	NIF File	DCF File	RFT File
B1	Base of Stack Release (activity in DW)	Stackbase.psf	Bfn.nif	Fgr11&12.inp	Bfn.rft
B2	Top of Stack Release (activity in DW)	Stacktop.psf	Bfn.nif	Fgr11&12.inp	Bfn.rft
B3	TB Roof Release (activity in DW)	TBroof.psf	Bfn.nif	Fgr11&12.inp	Bfn.rft
B4	Base of Stack Release (iodine ESF activity in SP)	Stackbase_esf.psf	Bfnesf.nif	Fgr11&12.inp	Bfn.rft
B5	Top of Stack Release (iodine ESF activity in SP)	Stacktop_esf.psf	Bfnesf.nif	Fgr11&12.inp	Bfn.rft

The TEDE value for the control room and offsite will be obtained by adding up the doses of each of these five RADTRAD runs.

Fumigation Time Interval

As discussed in Appendix D, in order to retrieve the most conservative dose, the half-hour period when fumigation is occurring must correspond to the time interval when the control room dose accumulation rate is maximum. In order to know about this time interval, two additional RADTRAD runs with the Top of Stack Release active (Runs B2 and B5) were rerun with the fumigation X/Q applied from start to finish (these new runs are numbered B2' and B5'). The control room dose accumulation rates were retrieved as a function of time, added to one another at each time step so that the peak control room dose accumulation rate could be obtained.

The Appendix B4 spreadsheet shows a peak at about 3.75 hours. Thus, the fumigation X/Q was used in Runs B2 and B5 from t = 3.5 to t = 4.0 hours accident time. Note that this time period is the same as the period in Appendix D.

Maximum Two-Hour EAB TEDE

For a fixed X/Q, the maximum two-hour EAB dose of one complete set of five runs is not the sum of the five maximum two-hour EAB doses of each of the five runs. To determine the maximum two-hour EAB dose a spreadsheet (Appendix B5) was used to add up the EAB TEDE at each time step for each of the five runs while holding the X/Q constant at an arbitrary value. This provided a basis to retrieve the maximum two-hour dose period. Unlike Appendix D5, however, the EAB dose is not taken from Appendix B5. In this appendix, the five cases were rerun with the maximum two-hour EAB dose period specified, and the doses were taken from the runs.

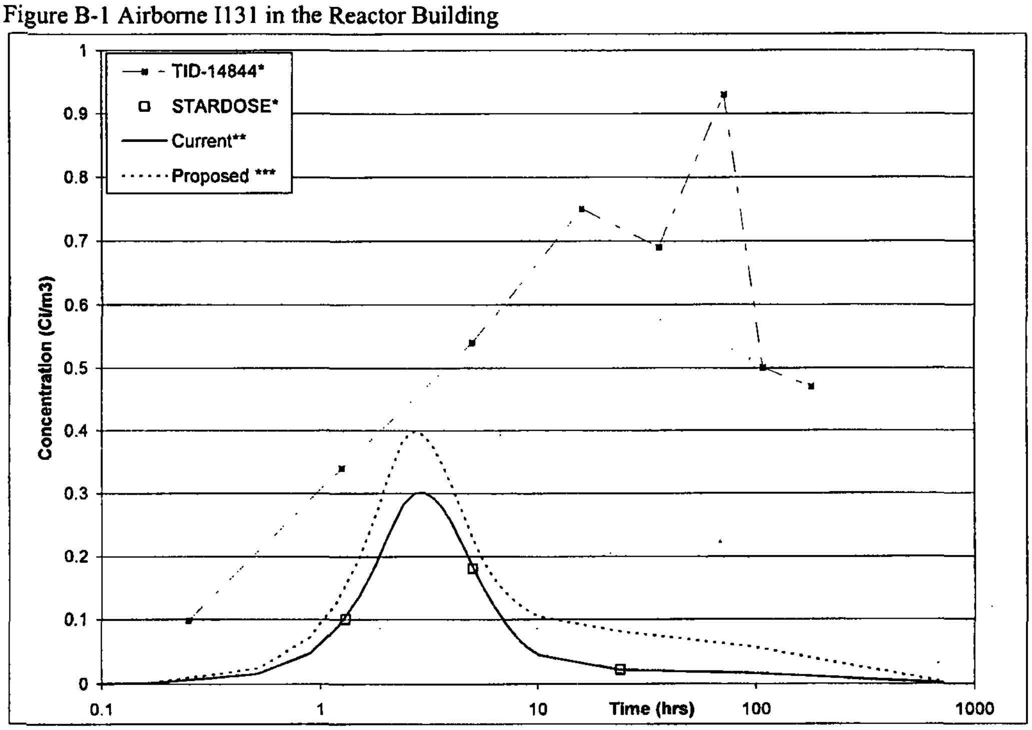
Documentation of Runs

- Appendix B1: Seven main input files (.PSF) - runs B1, B2, B2', B3, B4, B5, B5'
- Appendix B2: Four secondary input files - two .NIF, one .RFT, one .INP
- Appendix B3: Five output excerpts are shown – runs B1, B2, B3, B4, B5
- Appendix B4: Fumigation Spreadsheet
- Appendix B5: Max 2-hour EAB TEDE Spreadsheet

Secondary Containment Shine Dose Justification

The external shine dose of 0.762 rem used to obtain the CR TEDE was taken from TVA Calculation ND-Q0000-890013, "Post-LOCA Control Room Gamma Dose from Secondary Containment and Core Spray Piping" (Reference D-8). In that reference, the AST airborne activity (I131 is used as an example here) calculated using STARDOSE (see Appendices C and E) was compared to the existing TID-14844 basis to justify using that dose. That comparison is seen in the first two plots of Figure B-1 below.

Figure B-1 Airborne I131 in the Reactor Building



* From Appendix 2-4 of Reference D-8
** With 5 gpm ESF Leakage, and using the Reactor Building Volume for Units 2/3 (1.932E6 ft^3)
*** Using all the changes proposed in this Appendix B

Data from this appendix (Runs B2 and B5) were used to generate the "proposed" plot of Figure B-2. The corresponding RADTRAD runs from Appendix D are the "current" plot (note how these data line up almost exactly with the STARDOSE data from Reference D-8, as one would expect). The airborne activity corresponding to the "proposed" dose of this appendix, which includes the five modifications outlined in the Approach section, above, is still well below the reference airborne activity from Reference D-8; and therefore, the proposed use of 0.762 rem for the gamma shine dose from secondary containment and core spray piping in this appendix is acceptable.

Results

In the table below, the CR TEDE reflects a 50% reduction allowed per SRP 6.4. Therefore, these CR doses are half of those documented in Appendix B3.

RADTRAD(3) Results

Run #	Release Pathway	30-d CR TEDE (rem)	Max 2-h EAB TEDE (rem)	30-d LPZ TEDE (rem)
B1	Base of Stack	1.27E-2	2.72E-2(1)	2.28E-2
B2	Top of Stack	3.58E-1	7.91E-1(1)	5.92E-1
B3	TB Roof	2.24E-1	7.76E-2(1)	3.02E-1
B4	ESF (ECCS) - Base of Stack	8.93E-2	2.24E-2(1)	9.38E-2
B5	ESF (ECCS) – Top of Stack	4.91E-1	7.95E-1(1)	1.37E+0
Ref D-8	External Shine	7.62E-1	0(2)	0(2)
Total	All Pathways	1.94E+0	1.71E+0(1)	2.38E+0

(1) Worst 2-hour period was found from Appendix B5 (i.e., from t = 2 to t = 4 hours). The EAB X/Q was set to zero for all other times. Therefore, these are not necessarily the limiting EAB doses for any particular run, but the sum does represent the limiting 2-hour EAB dose.
(2) Not applicable for offsite dose
(3) Shine from Reference D-8 – Not calculated with RADTRAD (justified above)

References are from Appendix D

Appendix B1
RADTRAD Main Input Files

RUN B1 – STACKBASE.PSF

```
Radtrad 3.02 1/5/2000
 Base of Stack Release
Nuclide Inventory File:
 C:\[Pathname]\BFN.nif
 Plant Power Level:
  4.0310E+03
 Compartments:
   9
 Compartment 1:
DW
   3
  1.5900E+05
   0
   0
   0
   1
   0
 Compartment 2:
Torus
   3
  1.1940E+05
   0
   0
   0
   0
   0
 Compartment 3:
RB
   3
  1.3110E+06
   0
   0
   0
   0
   0
 Compartment 4:
SR
   3
  3.4560E+04
   0
   0
   0
   0
   0
 Compartment 5:
Condenser
   3
  1.2240E+05
   0
   0
   0
   0
   0
 Compartment 6:
TB
   3
  1.0000E+00
   0
   0
   0
   0
   0
 Compartment 7:
Dummy
   3
  1.0000E+06
   0
   0
   0
   0
   0
Compartment 8:
CR
   1
  2.1000E+05
   0
   0
   0
   0
   0
Compartment 9:
Environment
   2
  0.0000E+00
   0
   0
   0
   0
   0
Pathways:
 15
Pathway 1:
DW to Torus
   1
   2
   2
Pathway 2:
Torus to DW
   2
   1
   2
Pathway 3:
DW to RB
   1
   3
   2
Pathway 4:
Torus to RB
   2
   3
   2
Pathway 5:
RB to SR
   3
   4
   2
Pathway 6:
Torus to  SR
   2
   4
   2
Pathway 7:
Torus to Dummy
   2
   7
   2
```

Appendix B1
RADTRAD Main Input Files

RUN B1 – STACKBASE.PSF

```
Radtrad 3.02 1/5/2000
 Base of Stack Release
Nuclide Inventory File:
 C:\[Pathname]\BFN.nif
 Plant Power Level:
  4.0310E+03
 Compartments:
   9
 Compartment 1:
 DW
   3
  1.5900E+05
   0
   0
   0
   1
   0
 Compartment 2:
 Torus
   3
  1.1940E+05
   0
   0
   0
   0
   0
 Compartment 3:
 RB
   3
  1.3110E+06
   0
   0
   0
   0
   0
 Compartment 4:
 SR
   3
  3.4560E+04
   0
   0
   0
   0
   0
 Compartment 5:
 Condenser
   3
  1.2240E+05
   0
   0
   0
   0
   0
 Compartment 6:
 TB
   3
  1.0000E+00
   0
   0
   0
   0
   0
 Compartment 7:
 Dummy
   3
  1.0000E+06
   0
   0
   0
   0
   0
 Compartment 8:
 CR
   1
  2.1000E+05
   0
   0
   0
   0
   0
 Compartment 9:
 Environment
   2
  0.0000E+00
   0
   0
   0
   0
   0
 Pathways:
  15
 Pathway 1:
 DW to Torus
   1
   2
   2
 Pathway 2:
 Torus to DW
   2
   1
   2
 Pathway 3:
 DW to RB
   1
   3
   2
 Pathway 4:
 Torus to RB
   2
   3
   2
 Pathway 5:
 RB to SR
   3
   4
   2
 Pathway 6:
 Torus to  SR
   2
   4
   2
 Pathway 7:
 Torus to Dummy
   2
   7
   2
```

```
Pathway 8:
SR to Environment
  4
  9
  2
Pathway 9:
SR to Dummy
  4
  7
  2
Pathway 10:
DW to Condenser
  1
  5
  2
Pathway 11:
DW to TB
  1
  6
  2
Pathway 12:
Condenser to TB
  5
  6
  2
Pathway 13:
TB to Dummy
  6
  7
  2
Pathway 14:
Environment to CR
  9
  8
  2
Pathway 15:
CR to Environment
  8
  9
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
C:\ [Pathname]\Fgr11&12.inp
C:\ [Pathname]\BFN.rft
  0.0000E+00
  1
  9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  9
Compartment 1:
  0
  1
  0
  0
  0
  0
  0
  1
 10
  0.0000E+00   0.0000E+00
  3.3000E-02   7.5000E-01
  5.3300E-01   3.7000E-01
  2.0330E+00   1.0600E+00
  5.0330E+00   6.4000E-01
  8.3670E+00   5.6000E-01
  1.2033E+01   5.3000E-01
  1.9478E+01   5.1000E-01
  2.4033E+01   0.0000E+00
  7.2000E+02   0.0000E+00
  1
 10
  0.0000E+00   0.0000E+00
  3.3000E-02   7.5000E-01
  5.3300E-01   3.7000E-01
  2.0330E+00   1.0600E+00
  5.0330E+00   6.4000E-01
  8.3670E+00   5.6000E-01
  1.2033E+01   5.3000E-01
  1.9478E+01   5.1000E-01
  2.4033E+01   0.0000E+00
  7.2000E+02   0.0000E+00
Compartment 2:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 3:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 4:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 5:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 6:
  0
  1
  0
  0
  0
  0
  0
```

```
 0
 0
Compartment 7:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 8:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 9:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Pathways:
15
Pathway 1:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 2.0330E+00   1.1940E+05   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 2:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 2.0330E+00   1.1940E+05   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 3:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   2.2080E+00   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   1.6580E+00   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   2.4750E+04   9.0000E+01   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 6:
 3
 0
 0
 0
 0
 1
 7
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 2.4000E+02   1.3900E+02   9.0000E+01   0.0000E+00
0.0000E+00
 2.6400E+02   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
```

```
   4.8000E+02   1.3900E+02   9.0000E+01   0.0000E+00
0.0000E+00
   5.0400E+02   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
   6.9600E+02   1.3900E+02   9.0000E+01   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 7:
   0
   0
   0
   0
   0
   1
   3
   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
   8.0000E+00   1.6700E-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
 Pathway 8:
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   2.0000E+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
 Pathway 9:
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   2.4740E+04   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 10:
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   1.3000E+00   9.9870E+01   9.9010E+01
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 11:
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   6.7000E-03   8.9330E+01   1.6370E+01
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 12:
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   3.9700E+00   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 13:
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   1.0000E+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 14:
   0
   0
   0
   0
   0
   1
   3
   0.0000E+00   6.7170E+03   0.0000E+00   0.0000E+00
0.0000E+00
   1.6700E-01   6.7170E+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 15:
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   6.7170E+03   1.0000E+02   1.0000E+02
1.0000E+02
   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:
 Control_Room
   8
   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
 Location 2:
 EAB
   9
   1
   4
   0.0000E+00   0.0000E+00
   2.0000E+00   2.6200E-04
   4.0000E+00   0.0000E+00
   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:
 LPZ
   9
   1
   6
   0.0000E+00   1.3100E-04
   2.0000E+00   6.6100E-05
   8.0000E+00   4.6900E-05
   2.4000E+01   2.2300E-05
   9.6000E+01   7.9600E-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
 Effective Volume Location:
   1
   6
   0.0000E+00   2.0000E-04
   2.0000E+00   1.2800E-04
   8.0000E+00   5.7200E-05
   2.4000E+01   4.0500E-05
   9.6000E+01   3.0900E-05
   7.2000E+02   0.0000E+00
 Simulation Parameters:
   4
   0.0000E+00   1.0000E-01
   8.0000E+00   1.0000E+00
   2.4000E+01   2.4000E+01
   7.2000E+02   0.0000E+00
 Output Filename:
 C:\ [Pathname]\B1_Final_Stackbase.o0
   1
   1
   1
   1
   1
 End of Scenario File
```

RUN B2 – STACKTOP.PSF

```
Radtrad 3.02 1/5/2000
 Top of Stack Release
 Nuclide Inventory File:
 c:\[Pathname]\bfn.nif
 Plant Power Level:
  4.0310E+03
 Compartments:
   9
 Compartment 1:
 DW
   3
  1.5900E+05
   0
   0
   0
   1
   0
 Compartment 2:
 Torus
   3
  1.1940E+05
   0
   0
   0
```

```
  0
  0
Compartment 3:
RB
  3
 1.3110E+06
  0
  0
  0
  0
  0
Compartment 4:
SR
  3
 3.4560E+04
  0
  0
  0
  0
  0
Compartment 5:
Condenser
  3
 1.2240E+05
  0
  0
  0
  0
  0
Compartment 6:
TB
  3
 1.0000E+00
  0
  0
  0
  0
  0
Compartment 7:
Dummy
  3
 1.0000E+06
  0
  0
  0
  0
  0
Compartment 8:
CR
  1
 2.1000E+05
  0
  0
  0
  0
  0
Compartment 9:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Pathways:
 15
Pathway 1:
DW to Torus
  1
  2
  2
Pathway 2:
Torus to DW
  2
  1
  2
Pathway 3:
DW to RB
  1
  3
  2
Pathway 4:
Torus to RB
  2
  3
  2
Pathway 5:
RB to SR
  3
  4
  2
Pathway 6:
Torus to  SR
  2
  4
  2
Pathway 7:
Torus to Environment
  2
  9
  2
Pathway 8:
SR to Dummy
  4
  7
  2
Pathway 9:
SR to Environment
  4
  9
  2
Pathway 10:
DW to Condenser
  1
  5
  2
Pathway 11:
DW to TB
  1
  6
  2
Pathway 12:
Condenser to TB
  5
  6
  2
Pathway 13:
TB to Dummy
  6
  7
  2
Pathway 14:
Environment to CR
  9
  8
  2
Pathway 15:
CR to Environment
  8
  9
  2
```

```
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\ [Pathname]\fgr11&12.inp
c:\ [Pathname]\bfn.rft
  0.0000E+00
  1
  9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  9
Compartment 1:
  0
  1
  0
  0
  0
  0
  0
  1
 10
  0.0000E+00   0.0000E+00
  3.3000E-02   7.5000E-01
  5.3300E-01   3.7000E-01
  2.0330E+00   1.0600E+00
  5.0330E+00   6.4000E-01
  8.3670E+00   5.6000E-01
  1.2033E+01   5.3000E-01
  1.9478E+01   5.1000E-01
  2.4033E+01   0.0000E+00
  7.2000E+02   0.0000E+00
  1
 10
  0.0000E+00   0.0000E+00
  3.3000E-02   7.5000E-01
  5.3300E-01   3.7000E-01
  2.0330E+00   1.0600E+00
  5.0330E+00   6.4000E-01
  8.3670E+00   5.6000E-01
  1.2033E+01   5.3000E-01
  1.9478E+01   5.1000E-01
  2.4033E+01   0.0000E+00
  7.2000E+02   0.0000E+00
Compartment 2:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 3:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 4:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 5:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 6:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 7:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 8:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 9:
  1
  1
  0
  0
  0
  0
  0
  0
Pathways:
 15
Pathway 1:
  0
  0
  0
  0
  0
```

```
  1
  3
  0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
  2.0330E+00   1.1940E+05   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 2:
  0
  0
  0
  0
  0
  1
  3
  0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
  2.0330E+00   1.1940E+05   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 3:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   2.2080E+00   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   1.6580E+00   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   2.4750E+04   9.0000E+01   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 6:
  3
  0
  0
  0
  0
  1
  7
  0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
  2.4000E+02   1.3900E+02   9.0000E+01   0.0000E+00
0.0000E+00
  2.6400E+02   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
  4.8000E+02   1.3900E+02   9.0000E+01   0.0000E+00
0.0000E+00
  5.0400E+02   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
  6.9600E+02   1.3900E+02   9.0000E+01   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 7:
  0
  0
  0
  0
  0
  1
  3
  0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
  8.0000E+00   1.6700E-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
 Pathway 8:
  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
Pathway 9:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   2.4740E+04   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 10:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   1.3000E+00   9.9870E+01   9.9010E+01
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 11:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   6.7000E-03   8.9330E+01   1.6370E+01
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 12:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   3.9700E+00   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 13:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   1.0000E+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 14:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   6.7170E+03   0.0000E+00   0.0000E+00
0.0000E+00
 1.6700E-01   6.7170E+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 15:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   6.7170E+03   1.0000E+02   1.0000E+02
1.0000E+02
 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:
Control_Room
  8
  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
Location 2:
EAB
  9
  1
  5
  0.0000E+00   0.0000E+00
  2.0000E+00   1.1900E-06
  3.5000E+00   2.3500E-05
  4.0000E+00   0.0000E+00
  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:
LPZ
  9
  1
  8
  0.0000E+00   1.1300E-06
  2.0000E+00   5.7500E-07
  3.5000E+00   1.2600E-05
  4.0000E+00   5.7500E-07
  8.0000E+00   4.1000E-07
  2.4000E+01   1.9700E-07
  9.6000E+01   6.8800E-08
  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
Effective Volume Location:
  1
  8
  0.0000E+00   1.4100E-07
  2.0000E+00   4.5000E-08
  3.5000E+00   3.4000E-05
  4.0000E+00   4.5000E-08
  8.0000E+00   2.5400E-08
  2.4000E+01   7.3600E-09
  9.6000E+01   1.2400E-09
  7.2000E+02   0.0000E+00
Simulation Parameters:
  4
  0.0000E+00   1.0000E-01
  8.0000E+00   1.0000E+00
  2.4000E+01   2.4000E+01
  7.2000E+02   0.0000E+00
Output Filename:
C:\ [Pathname]\B2_Final_Stacktop.o0
  1
  1
  1
  1
  1
End of Scenario File
```

RUN B2' – STACKTOP_FUMIGATION.PSF

```
Radtrad 3.02 1/5/2000
 Top of Stack Release-CR Fumigation
 Nuclide Inventory File:
 c:\[Pathname]\bfn.nif
 Plant Power Level:
  4.0310E+03
 Compartments:
  9
 Compartment 1:
 DW
  3
  1.5900E+05
  0
  0
  0
  1
  0
 Compartment 2:
 Torus
  3
  1.1940E+05
  0
  0
  0
  0
  0
 Compartment 3:
 RB
  3
  1.3110E+06
  0
  0
  0
  0
  0
 Compartment 4:
 SR
  3
  3.4560E+04
  0
  0
  0
  0
  0
 Compartment 5:
 Condenser
  3
  1.2240E+05
  0
  0
  0
  0
  0
 Compartment 6:
 TB
  3
  1.0000E+00
  0
```

```
  0
  0
  0
  0
Compartment 7:
Dummy
  3
 1.0000E+06
  0
  0
  0
  0
  0
Compartment 8:
CR
  1
 2.1000E+05
  0
  0
  0
  0
  0
Compartment 9:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Pathways:
 15
Pathway 1:
DW to Torus
  1
  2
  2
Pathway 2:
Torus to DW
  2
  1
  2
Pathway 3:
DW to RB
  1
  3
  2
Pathway 4:
Torus to RB
  2
  3
  2
Pathway 5:
RB to SR
  3
  4
  2
Pathway 6:
Torus to  SR
  2
  4
  2
Pathway 7:
Torus to Environment
  2
  9
  2
Pathway 8:
SR to Dummy
  4
  7
  2
Pathway 9:
SR to Environment
  4
  9
  2
Pathway 10:
DW to Condenser
  1
  5
  2
Pathway 11:
DW to TB
  1
  6
  2
Pathway 12:
Condenser to TB
  5
  6
  2
Pathway 13:
TB to Dummy
  6
  7
  2
Pathway 14:
Environment to CR
  9
  8
  2
Pathway 15:
CR to Environment
  8
  9
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\ [Pathname]\fgr11&12.inp
c:\ [Pathname]\bfn.rft
  0.0000E+00
  1
  9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  9
Compartment 1:
  0
  1
  0
  0
  0
  0
  0
  1
 10
  0.0000E+00   0.0000E+00
  3.3000E-02   7.5000E-01
```

```
  5.3300E-01   3.7000E-01
  2.0330E+00   1.0600E+00
  5.0330E+00   6.4000E-01
  8.3670E+00   5.6000E-01
  1.2033E+01   5.3000E-01
  1.9478E+01   5.1000E-01
  2.4033E+01   0.0000E+00
  7.2000E+02   0.0000E+00
  1
 10
  0.0000E+00   0.0000E+00
  3.3000E-02   7.5000E-01
  5.3300E-01   3.7000E-01
  2.0330E+00   1.0600E+00
  5.0330E+00   6.4000E-01
  8.3670E+00   5.6000E-01
  1.2033E+01   5.3000E-01
  1.9478E+01   5.1000E-01
  2.4033E+01   0.0000E+00
  7.2000E+02   0.0000E+00
Compartment 2:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 3:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 4:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 5:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 6:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 7:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 8:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 9:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Pathways:
 15
Pathway 1:
  0
  0
  0
  0
  0
  1
  3
    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
    2.0330E+00   1.1940E+05   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 2:
  0
  0
  0
  0
  0
  1
  3
    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
    2.0330E+00   1.1940E+05   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 3:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   2.2080E+00   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   1.6580E+00   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   2.4750E+04   9.0000E+01   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 6:
 3
 0
 0
 0
 0
 1
 7
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 2.4000E+02   1.3900E+02   9.0000E+01   0.0000E+00
0.0000E+00
 2.6400E+02   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 4.8000E+02   1.3900E+02   9.0000E+01   0.0000E+00
0.0000E+00
 5.0400E+02   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 6.9600E+02   1.3900E+02   9.0000E+01   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 7:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 8.0000E+00   1.6700E-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
Pathway 8:
 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
Pathway 9:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   2.4740E+04   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 10:
 0
 0
```

```
  0
  0
  0
  1
  2
  0.0000E+00   1.3000E+00   9.9870E+01   9.9010E+01
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 11:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   6.7000E-03   8.9330E+01   1.6370E+01
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 12:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   3.9700E+00   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 13:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   1.0000E+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 14:
  0
  0
  0
  0
  0
  1
  3
  0.0000E+00   6.7170E+03   0.0000E+00   0.0000E+00
0.0000E+00
  1.6700E-01   6.7170E+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 15:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   6.7170E+03   1.0000E+02   1.0000E+02
1.0000E+02
  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:
 Control_Room
  8
  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
 Location 2:
 EAB
  9
  1
  4
  0.0000E+00   1.1900E-06
  4.2000E+00   2.3500E-05
  4.7000E+00   1.1900E-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:
 LPZ
  9
```

```
 1
 8
 0.0000E+00   1.1300E-06
 2.0000E+00   5.7500E-07
 4.2000E+00   1.2600E-05
 4.7000E+00   5.7500E-07
 8.0000E+00   4.1000E-07
 2.4000E+01   1.9700E-07
 9.6000E+01   6.8800E-08
 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
Effective Volume Location:
 1
 2
 0.0000E+00   3.4000E-05
 7.2000E+02   0.0000E+00
Simulation Parameters:
 4
 0.0000E+00   1.0000E-01
 8.0000E+00   1.0000E+00
 2.4000E+01   2.4000E+01
 7.2000E+02   0.0000E+00
Output Filename:
C:\ [Pathname]\B2'_Stacktop_Fumigation.o0
 1
 1
 1
 1
 1
End of Scenario File
```

RUN B3 – TBROOF.PSF

```
Radtrad 3.02 1/5/2000

 Nuclide Inventory File:
 c:\[Pathname]\bfn.nif
 Plant Power Level:
  4.0310E+03
 Compartments:
  9
 Compartment 1:
 DW
  3
  1.5900E+05
  0
  0
  0
  1
  0
 Compartment 2:
 Torus
  3
  1.1940E+05
  0
  0
  0
  0
  0
 Compartment 3:
 RB
  3
  1.3110E+06
  0
  0
  0
  0
  0
 Compartment 4:
 SR
  3
  3.4560E+04
  0
  0
  0
  0
  0
 Compartment 5:
 Condenser
  3
  1.2240E+05
  0
  0
  0
  0
  0
 Compartment 6:
 TB
  3
  1.0000E+00
  0
  0
  0
  0
  0
 Compartment 7:
 Dummy
  3
  1.0000E+06
  0
  0
  0
  0
  0
 Compartment 8:
 CR
  1
  2.1000E+05
  0
  0
  0
  0
  0
 Compartment 9:
 Environment
  2
  0.0000E+00
  0
  0
  0
  0
  0
 Pathways:
  15
 Pathway 1:
 DW to Torus
  1
  2
  2
 Pathway 2:
 Torus to DW
```

```
  2
  1
  2
Pathway 3:
DW to RB
  1
  3
  2
Pathway 4:
Torus to RB
  2
  3
  2
Pathway 5:
RB to SR
  3
  4
  2
Pathway 6:
Torus to  SR
  2
  4
  2
Pathway 7:
Torus to Dummy
  2
  7
  2
Pathway 8:
SR to Dummy
  4
  7
  2
Pathway 9:
SR to Dummy
  4
  7
  2
Pathway 10:
DW to Condenser
  1
  5
  2
Pathway 11:
DW to TB
  1
  6
  2
Pathway 12:
Condenser to TB
  5
  6
  2
Pathway 13:
TB to Environment
  6
  9
  2
Pathway 14:
Environment to CR
  9
  8
  2
Pathway 15:
CR to Environment
  8
  9
  2
End of Plant Model File
Scenario Description Name:
Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\[Pathname]\fgr11&12.inp
c:\[Pathname]\bfn.rft
  0.0000E+00
  1
  9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  9
Compartment 1:
  0
  1
  0
  0
  0
  0
  0
  1
 10
  0.0000E+00   0.0000E+00
  3.3000E-02   7.5000E-01
  5.3300E-01   3.7000E-01
  2.0330E+00   1.0600E+00
  5.0330E+00   6.4000E-01
  8.3670E+00   5.6000E-01
  1.2033E+01   5.3000E-01
  1.9478E+01   5.1000E-01
  2.4033E+01   0.0000E+00
  7.2000E+02   0.0000E+00
  1
 10
  0.0000E+00   0.0000E+00
  3.3000E-02   7.5000E-01
  5.3300E-01   3.7000E-01
  2.0330E+00   1.0600E+00
  5.0330E+00   6.4000E-01
  8.3670E+00   5.6000E-01
  1.2033E+01   5.3000E-01
  1.9478E+01   5.1000E-01
  2.4033E+01   0.0000E+00
  7.2000E+02   0.0000E+00
Compartment 2:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 3:
  0
  1
  0
  0
  0
  0
  0
  0
  0
```

```
Compartment 4:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 5:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 6:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 7:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 8:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 9:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Pathways:
 15
Pathway 1:
 0
 0
 0
 0
 0
 1
 3
   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 0.0000E+00
   2.0330E+00   1.1940E+05   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 2:
   0
   0
   0
   0
   0
   1
   3
   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
 0.0000E+00
   2.0330E+00   1.1940E+05   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 3:
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   2.2080E+00   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   1.6580E+00   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   2.4750E+04   9.0000E+01   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 6:
 3
 0
 0
 0
 0
 1
 7
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 2.4000E+02   1.3900E+02   9.0000E+01   0.0000E+00
0.0000E+00
 2.6400E+02   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 4.8000E+02   1.3900E+02   9.0000E+01   0.0000E+00
0.0000E+00
 5.0400E+02   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 6.9600E+02   1.3900E+02   9.0000E+01   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 7:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 8.0000E+00   1.6700E-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
Pathway 8:
 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
Pathway 9:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   2.4740E+04   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 10:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   1.3000E+00   9.9870E+01   9.9010E+01
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 11:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   6.7000E-03   8.9330E+01   1.6370E+01
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 12:
 0
 0
 0
 0
 0
 1
```

```
 2
 0.0000E+00   3.9700E+00   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 13:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   1.0000E+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 14:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   6.7170E+03   0.0000E+00   0.0000E+00
0.0000E+00
 1.6700E-01   6.7170E+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 15:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   6.7170E+03   1.0000E+02   1.0000E+02
1.0000E+02
 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:
Control_Room
 8
 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
Location 2:
EAB
 9
 1
 4
 0.0000E+00   0.0000E+00
 2.0000E+00   2.6200E-04
 4.0000E+00   0.0000E+00
 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:
LPZ
 9
 1
 6
 0.0000E+00   1.3100E-04
 2.0000E+00   6.6100E-05
 8.0000E+00   4.6900E-05
 2.4000E+01   2.2300E-05
 9.6000E+01   7.9600E-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
Effective Volume Location:
 1
 6
 0.0000E+00   3.2200E-04
 2.0000E+00   2.7700E-04
 8.0000E+00   1.3100E-04
 2.4000E+01   7.9100E-05
 9.6000E+01   6.1000E-05
 7.2000E+02   0.0000E+00
Simulation Parameters:
 4
 0.0000E+00   1.0000E-01
 8.0000E+00   1.0000E+00
 2.4000E+01   2.4000E+01
 7.2000E+02   0.0000E+00
Output Filename:
C:\[Pathname]\B3_Final_TBRoof.o1
 1
 1
 1
 1
 1
End of Scenario File
```

RUN B4 – STACKBASE_ESF.PSF

```
Radtrad 3.02 1/5/2000
 Base of Stack Release-ESF Leakage
 Nuclide Inventory File:
 C:\ Pathname]\BFNESF.nif
 Plant Power Level:
  4.0310E+03
 Compartments:
   6
 Compartment 1:
 SP
   3
  1.4105E+05
   0
   0
   0
   0
   0
 Compartment 2:
 RB
   3
  1.3110E+06
   0
   0
   0
   0
   0
 Compartment 3:
 SR
   3
  3.4560E+04
   0
   0
   0
   0
   0
 Compartment 4:
 CR
   1
  2.1000E+05
   0
   0
   0
   0
   0
 Compartment 5:
 Environment
   2
  0.0000E+00
   0
   0
   0
   0
   0
Compartment 6:
Dummy
  3
 1.0000E+06
  0
  0
  0
  0
  0
Pathways:
  6
Pathway 1:
SP to RB
  1
  2
  2
Pathway 2:
RB to SR
  2
  3
  2
Pathway 3:
SR to Environment
  3
  5
  2
Pathway 4:
SR to Dummy
  3
  6
  2
Pathway 5:
Environment to CR
  5
  4
  2
Pathway 6:
CR to Environment
  4
  5
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
C:\ Pathname]\Fgr11&12.inp
C:\[Pathname]\BFN.rft
  0.0000E+00
  1
```

```
  9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  6
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
Compartment 4:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 5:
  0
  1
  0
  0
  0
  0
  0
  0
  0
  0
Compartment 6:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Pathways:
  6
Pathway 1:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   2.6740E+00   1.0000E+02   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 2:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   2.4750E+04   9.0000E+01   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 3:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   2.0000E+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
Pathway 4:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   2.4740E+04   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
  3
  0.0000E+00   6.7170E+03   0.0000E+00   0.0000E+00
0.0000E+00
  1.6700E-01   6.7170E+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 6:
  1
  0
  0
  0
  0
  1
  2
  0.0000E+00   6.7170E+03   1.0000E+02   1.0000E+02
1.0000E+02
  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:
Control_Room
  4
  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
Location 2:
EAB
  5
  1
  4
  0.0000E+00   0.0000E+00
  2.0000E+00   2.6200E-04
  4.0000E+00   0.0000E+00
  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:
LPZ
```

```
  5
  1
  6
  0.0000E+00   1.3100E-04
  2.0000E+00   6.6100E-05
  8.0000E+00   4.6900E-05
  2.4000E+01   2.2300E-05
  9.6000E+01   7.9600E-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
 Effective Volume Location:
  1
  6
  0.0000E+00   2.0000E-04
  2.0000E+00   1.2800E-04
  8.0000E+00   5.7200E-05
  2.4000E+01   4.0500E-05
  9.6000E+01   3.0900E-05
  7.2000E+02   0.0000E+00
 Simulation Parameters:
  4
  0.0000E+00   1.0000E-01
  8.0000E+00   1.0000E+00
  2.4000E+01   2.4000E+01
  7.2000E+02   0.0000E+00
 Output Filename:
 C:\[Pathname]\B4_Final_Stackbase_ESF.o0
  1
  1
  1
  1
  1
 End of Scenario File
```

RUN B5 – STACKTOP_ESF.PSF

```
Radtrad 3.02 1/5/2000
 Top of Stack -ESF Leakage
 Nuclide Inventory File:
 c:\[Pathname]\bfnesf.nif
 Plant Power Level:
  4.0310E+03
 Compartments:
  6
 Compartment 1:
 SP
  3
  1.4105E+05
  0
  0
  0
  0
  0
 Compartment 2:
 RB
  3
  1.3110E+06
  0
  0
  0
  0
  0
 Compartment 3:
 SR
  3
  3.4560E+04
  0
  0
  0
  0
  0
 Compartment 4:
 CR
  1
  2.1000E+05
  0
  0
  0
  0
  0
 Compartment 5:
 Environment
  2
  0.0000E+00
  0
  0
  0
  0
  0
 Compartment 6:
 Dummy
  3
  1.0000E+06
  0
  0
  0
  0
  0
 Pathways:
```

```
  6
Pathway 1:
SP to RB
  1
  2
  2
Pathway 2:
RB to SR
  2
  3
  2
Pathway 3:
SR to Dummy
  3
  6
  2
Pathway 4:
SR to Environment
  3
  5
  2
Pathway 5:
Environment to CR
  5
  4
  2
Pathway 6:
CR to Environment
  4
  5
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\ Pathname]\fgr11&12.inp
c:\ Pathname]\bfn.rft
  0.0000E+00
  1
  9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  6
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
Compartment 4:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 5:
  1
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 6:
  0
  1
  0
  0
```

```
  0
  0
  0
  0
  0
Pathways:
  6
Pathway 1:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   2.6740E+00   1.0000E+02   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 2:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   2.4750E+04   9.0000E+01   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 3:
  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
Pathway 4:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   2.4740E+04   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
  3
  0.0000E+00   6.7170E+03   0.0000E+00   0.0000E+00
0.0000E+00
  1.6700E-01   6.7170E+03   4.0200E+01   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 6:
  1
  0
  0
  0
  0
  1
  2
```

```
  0.0000E+00   6.7170E+03   1.0000E+02   1.0000E+02
1.0000E+02
  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:
 Control_Room
  4
  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
 Location 2:
 EAB
  5
  1
  5
  0.0000E+00   0.0000E+00
  2.0000E+00   1.1900E-06
  3.5000E+00   2.3500E-05
  4.0000E+00   0.0000E+00
  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:
 LPZ
  5
  1
  8
  0.0000E+00   1.1300E-06
  2.0000E+00   5.7500E-07
  3.5000E+00   1.2600E-05
  4.0000E+00   5.7500E-07
  8.0000E+00   4.1000E-07
  2.4000E+01   1.9700E-07
  9.6000E+01   6.8800E-08
  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
Effective Volume Location:
  1
  8
  0.0000E+00   1.4100E-07
  2.0000E+00   4.5000E-08
  3.5000E+00   3.4000E-05
  4.0000E+00   4.5000E-08
  8.0000E+00   2.5400E-08
  2.4000E+01   7.3600E-09
  9.6000E+01   1.2400E-09
  7.2000E+02   0.0000E+00
Simulation Parameters:
  4
  0.0000E+00   1.0000E-01
  8.0000E+00   1.0000E+00
  2.4000E+01   2.4000E+01
  7.2000E+02   0.0000E+00
Output Filename:
C:\[Pathname]\B5_Final_Stacktop_ESF.o0
  1
  1
  1
  1
  1
End of Scenario File
```

RUN B5' – STACKTOP_ESF_FUMIGATION.PSF

```
Radtrad 3.02 1/5/2000
 Top of Stack ESF-CR Fumigation
 Nuclide Inventory File:
 c:\[Pathname]\bfnesf.nif
 Plant Power Level:
  4.0310E+03
Compartments:
  6
Compartment 1:
SP
  3
 1.4105E+05
  0
```

```
0
0
0
0
Compartment 2:
RB
3
1.3110E+06
0
0
0
0
0
Compartment 3:
SR
3
3.4560E+04
0
0
0
0
0
Compartment 4:
CR
1
2.1000E+05
0
0
0
0
0
Compartment 5:
Environment
2
0.0000E+00
0
0
0
0
0
Compartment 6:
Dummy
3
1.0000E+06
0
0
0
0
0
Pathways:
6
Pathway 1:
SP to RB
1
2
2
Pathway 2:
RB to SR
2
3
2
Pathway 3:
SR to Dummy
3
6
2
Pathway 4:
SR to Environment
3
5
2
Pathway 5:
Environment to CR
5
4
2
Pathway 6:
CR to Environment
4
5
2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
1
1   1.0000E+00
c:\ [Pathname]\fgr11&12.inp
c:\ [Pathname]\bfn.rft
0.0000E+00
1
9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
Overlying Pool:
0
0.0000E+00
0
0
0
0
Compartments:
6
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
Compartment 4:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 5:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 6:
 0
 1
 0
 0
 0
 0
 0
 0
```

```
   0
 Pathways:
   6
 Pathway 1:
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   2.6740E+00   1.0000E+02   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 2:
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   2.4750E+04   9.0000E+01   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 3:
   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
 Pathway 4:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   2.4740E+04   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
  3
  0.0000E+00   6.7170E+03   0.0000E+00   0.0000E+00
0.0000E+00
  1.6700E-01   6.7170E+03   4.0200E+01   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 6:
  1
  0
  0
  0
  0
  1
  2
  0.0000E+00   6.7170E+03   1.0000E+02   1.0000E+02
1.0000E+02
  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:
 Control_Room
  4
  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
 Location 2:
 EAB
  5
  1
  4
  0.0000E+00   1.1900E-06
  4.2000E+00   2.3500E-05
  4.7000E+00   1.1900E-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:
 LPZ
  5
  1
  8
  0.0000E+00   1.1300E-06
  2.0000E+00   5.7500E-07
  4.2000E+00   1.2600E-05
  4.7000E+00   5.7500E-07
  8.0000E+00   4.1000E-07
  2.4000E+01   1.9700E-07
  9.6000E+01   6.8800E-08
  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
Effective Volume Location:
  1
  2
  0.0000E+00   3.4000E-05
  7.2000E+02   0.0000E+00
Simulation Parameters:
  4
  0.0000E+00   1.0000E-01
  8.0000E+00   1.0000E+00
  2.4000E+01   2.4000E+01
  7.2000E+02   0.0000E+00
Output Filename:
C:\ [Pathname]\B5'_ESF_Fumigation.o0
  1
  1
  1
  1
  1
End of Scenario File
```

Appendix B2
RADTRAD Secondary Input Files

RADTRAD Secondary Input Files used in Appendix B are the same as those used in Appendix D.

Refer to Appendix D2 for a listing of the following files:

BFN.NIF
BFNESF.NIF
BFN.RFT
FGR11&12.INP

Appendix B3
RADTRAD Output Files (Excerpts)

RUN B1 – STACKBASE.O0

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

Time (hr)	DW I-131 (Curies)	Torus I-131 (Curies)	RB I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	1.3676E+06	0.0000E+00	7.3635E+01
0.500	4.2291E+06	0.0000E+00	7.3149E+02
0.533	4.4754E+06	0.0000E+00	8.2206E+02
0.533	4.4784E+06	0.0000E+00	8.2298E+02
0.900	9.6128E+06	0.0000E+00	2.3163E+03
1.200	1.3664E+07	0.0000E+00	4.1448E+03
1.500	1.7281E+07	0.0000E+00	6.2538E+03
1.800	2.0509E+07	0.0000E+00	8.4754E+03
2.000	2.2466E+07	0.0000E+00	9.9629E+03
2.033	2.2775E+07	0.0000E+00	1.0207E+04
2.033	2.2440E+07	3.3281E+05	1.0209E+04
2.400	1.0875E+07	8.2496E+06	1.2018E+04
2.700	9.0685E+06	6.8789E+06	1.2232E+04
3.000	7.5625E+06	5.7365E+06	1.1772E+04
3.300	6.3074E+06	4.7844E+06	1.0934E+04
3.600	5.2613E+06	3.9909E+06	9.9135E+03
3.900	4.3895E+06	3.3295E+06	8.8332E+03
4.000	4.1324E+06	3.1345E+06	8.4741E+03
4.300	3.4487E+06	2.6158E+06	7.4272E+03
4.600	2.8788E+06	2.1835E+06	6.4510E+03
4.900	2.4038E+06	1.8232E+06	5.5638E+03
5.033	2.2194E+06	1.6833E+06	5.2008E+03
5.400	1.9449E+06	1.4694E+06	4.3366E+03
5.700	1.7439E+06	1.3174E+06	3.7670E+03
6.000	1.5639E+06	1.1815E+06	3.2914E+03
6.300	1.4028E+06	1.0597E+06	2.8899E+03
6.600	1.2586E+06	9.5076E+05	2.5479E+03
6.900	1.1295E+06	8.5322E+05	2.2541E+03
7.200	1.0139E+06	7.6589E+05	1.9999E+03
7.500	9.1041E+05	6.8772E+05	1.7785E+03
7.800	8.1778E+05	6.1774E+05	1.5848E+03
8.000	7.6149E+05	5.7521E+05	1.4689E+03
8.300	6.8447E+05	5.1702E+05	1.3123E+03
8.367	6.6840E+05	5.0488E+05	1.2799E+03
8.667	6.0921E+05	4.5982E+05	1.1469E+03
8.967	5.5530E+05	4.1912E+05	1.0313E+03
9.300	5.0128E+05	3.7834E+05	9.1967E+02
9.600	4.5735E+05	3.4517E+05	8.3158E+02
9.900	4.1748E+05	3.1508E+05	7.5341E+02
10.200	3.8131E+05	2.8776E+05	6.8374E+02
12.033	2.2249E+05	1.6786E+05	3.8816E+02
19.478	4.5793E+04	3.4464E+04	6.8481E+01
24.000	3.0543E+04	2.2956E+04	4.1738E+01
24.033	3.0488E+04	2.2914E+04	4.1644E+01
96.000	2.1688E+04	1.6286E+04	2.7961E+01
240.000	1.0956E+04	8.2274E+03	1.4125E+01
264.000	4.7667E+03	3.5771E+03	6.3106E+00
480.000	1.7107E+03	1.2846E+03	2.2055E+00
504.000	7.4427E+02	5.5853E+02	9.8534E-01
696.000	2.9930E+02	2.2476E+02	3.8588E-01
720.000	1.3022E+02	9.7723E+01	1.7240E-01

Time (hr)	SR I-131 (Curies)	Condenser I-131 (Curies)	TB I-131 (Curies)

0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	2.0245E-01	1.4886E-01	8.2642E-05
0.500	2.5652E+00	1.7383E+00	2.5651E-04
0.533	2.9022E+00	1.9848E+00	2.7153E-04
0.533	2.9056E+00	1.9873E+00	2.7170E-04
0.900	8.3972E+00	6.3260E+00	5.8387E-04
1.200	1.5275E+01	1.2371E+01	8.3139E-04
1.500	2.3294E+01	2.0548E+01	1.0536E-03
1.800	3.1792E+01	3.0747E+01	1.2531E-03
2.000	3.7502E+01	3.8620E+01	1.3748E-03
2.033	3.8439E+01	3.9999E+01	1.3941E-03
2.033	3.8449E+01	4.0013E+01	1.3826E-03
2.400	4.5849E+01	4.8855E+01	6.7741E-04
2.700	4.6994E+01	5.5391E+01	5.7128E-04
3.000	4.5456E+01	6.1494E+01	4.8303E-04
3.300	4.2403E+01	6.7233E+01	4.0970E-04
3.600	3.8598E+01	7.2668E+01	3.4879E-04
3.900	3.4530E+01	7.7846E+01	2.9823E-04
4.000	3.3173E+01	7.9522E+01	2.8337E-04
4.300	2.9203E+01	8.4421E+01	2.4399E-04
4.600	2.5490E+01	8.9148E+01	2.1137E-04
4.900	2.2107E+01	9.3730E+01	1.8439E-04
5.033	2.0722E+01	9.5721E+01	1.7398E-04
5.400	1.7403E+01	1.0113E+02	1.5928E-04
5.700	1.5215E+01	1.0548E+02	1.4863E-04
6.000	1.3390E+01	1.0976E+02	1.3923E-04
6.300	1.1850E+01	1.1399E+02	1.3093E-04
6.600	1.0539E+01	1.1817E+02	1.2364E-04
6.900	9.4126E+00	1.2231E+02	1.1723E-04
7.200	8.4385E+00	1.2639E+02	1.1162E-04
7.500	7.5904E+00	1.3044E+02	1.0672E-04
7.800	6.8484E+00	1.3446E+02	1.0246E-04
8.000	6.4045E+00	1.3711E+02	9.9941E-05
8.300	5.8049E+00	1.4107E+02	9.6597E-05
8.367	5.6809E+00	1.4195E+02	9.5917E-05
8.667	5.1704E+00	1.4587E+02	9.3628E-05
8.967	4.7269E+00	1.4976E+02	9.1648E-05
9.300	4.2988E+00	1.5405E+02	8.9790E-05
9.600	3.9609E+00	1.5789E+02	8.8391E-05
9.900	3.6611E+00	1.6171E+02	8.7228E-05
10.200	3.3938E+00	1.6551E+02	8.6279E-05
12.033	2.2587E+00	1.8830E+02	8.4075E-05
19.478	1.0121E+00	2.7527E+02	1.0137E-04
24.000	8.9421E-01	3.2452E+02	1.1623E-04
24.033	8.9374E-01	3.2487E+02	1.1634E-04
96.000	6.2912E-01	8.3539E+02	2.7876E-04
240.000	3.1781E-01	9.8295E+02	3.2276E-04
264.000	5.1086E+00	9.2802E+02	3.0271E-04
480.000	4.9623E-02	4.1873E+02	1.3643E-04
504.000	7.9766E-01	3.7714E+02	1.2259E-04
696.000	8.6821E-03	1.5191E+02	4.9381E-05
720.000	1.3956E-01	1.3485E+02	4.3784E-05

Time (hr)	Dummy I-131 (Curies)	CR I-131 (Curies)	Environment I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	3.8129E-01	1.6830E-07	2.8105E-04
0.500	1.7907E+01	7.2865E-06	1.4173E-02
0.533	2.1830E+01	8.7632E-06	1.7304E-02
0.533	2.1871E+01	8.7787E-06	1.7337E-02
0.900	1.0668E+02	3.7084E-05	8.5203E-02
1.200	2.5861E+02	8.1234E-05	2.0712E-01
1.500	5.0758E+02	1.4402E-04	4.0730E-01
1.800	8.6360E+02	2.2107E-04	6.9396E-01
2.000	1.1621E+03	2.7781E-04	9.3454E-01
2.033	1.2161E+03	2.7784E-04	9.7805E-01
2.033	1.2166E+03	2.7784E-04	9.7849E-01

2.400	1.8899E+03	2.9744E-04	1.5230E+00
2.700	2.4905E+03	3.1725E-04	2.0094E+00
3.000	3.0863E+03	3.2696E-04	2.4926E+00
3.300	3.6507E+03	3.2456E-04	2.9510E+00
3.600	4.1696E+03	3.1192E-04	3.3732E+00
3.900	4.6367E+03	2.9204E-04	3.7541E+00
4.000	4.7807E+03	2.8432E-04	3.8716E+00
4.300	5.1775E+03	2.5921E-04	4.1963E+00
4.600	5.5243E+03	2.3278E-04	4.4808E+00
4.900	5.8249E+03	2.0657E-04	4.7284E+00
5.033	5.9445E+03	1.9531E-04	4.8272E+00
5.400	6.2364E+03	1.6619E-04	5.0692E+00
5.700	6.4397E+03	1.4529E-04	5.2387E+00
6.000	6.6169E+03	1.2718E-04	5.3874E+00
6.300	6.7724E+03	1.1166E-04	5.5186E+00
6.600	6.9094E+03	9.8420E-05	5.6350E+00
6.900	7.0306E+03	8.7105E-05	5.7388E+00
7.200	7.1381E+03	7.7408E-05	5.8316E+00
7.500	7.2338E+03	6.9060E-05	5.9150E+00
7.800	7.3192E+03	6.1838E-05	5.9901E+00
8.000	7.3710E+03	5.7558E-05	6.0361E+00
8.300	7.4556E+03	4.1042E-05	6.0996E+00
8.367	7.4733E+03	3.8354E-05	6.1130E+00
8.667	7.5474E+03	2.9287E-05	6.1694E+00
8.967	7.6143E+03	2.3515E-05	6.2209E+00
9.300	7.6811E+03	1.9341E-05	6.2730E+00
9.600	7.7353E+03	1.6763E-05	6.3160E+00
9.900	7.7846E+03	1.4861E-05	6.3556E+00
10.200	7.8294E+03	1.3388E-05	6.3923E+00
12.033	8.0307E+03	8.3337E-06	6.5684E+00
19.478	8.3189E+03	3.4046E-06	6.9336E+00
24.000	8.3809E+03	2.9558E-06	7.0813E+00
24.033	8.3813E+03	2.9015E-06	7.0823E+00
96.000	8.6919E+03	1.4622E-06	8.9526E+00
240.000	7.6462E+03	5.6358E-07	1.1228E+01
264.000	1.4885E+04	9.2030E-06	1.7850E+01
480.000	7.5827E+03	8.7997E-08	1.8501E+01
504.000	8.1963E+03	1.4369E-06	1.9535E+01
696.000	4.2605E+03	1.5396E-08	1.9630E+01
720.000	4.1288E+03	2.5141E-07	1.9811E+01

##
Cumulative Dose Summary
##

	Control_Room		EAB		LPZ	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.001	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.167	2.1729E-06	8.4361E-08	0.0000E+00	0.0000E+00	1.9774E-05	9.5811E-07
0.500	2.9689E-04	1.1513E-05	0.0000E+00	0.0000E+00	9.9410E-04	4.7777E-05
0.533	3.8251E-04	1.4831E-05	0.0000E+00	0.0000E+00	1.2132E-03	5.8238E-05
0.533	3.8344E-04	1.4868E-05	0.0000E+00	0.0000E+00	1.2155E-03	5.8349E-05
0.900	2.8735E-03	1.1257E-04	0.0000E+00	0.0000E+00	5.9672E-03	2.9511E-04
1.200	8.4700E-03	3.4547E-04	0.0000E+00	0.0000E+00	1.4543E-02	7.7503E-04
1.500	1.9304E-02	8.2328E-04	0.0000E+00	0.0000E+00	2.8657E-02	1.6193E-03
1.800	3.6992E-02	1.6364E-03	0.0000E+00	0.0000E+00	4.8870E-02	2.8729E-03
2.000	5.3168E-02	2.3982E-03	0.0000E+00	0.0000E+00	6.5821E-02	3.9433E-03
2.033	5.6140E-02	2.5394E-03	6.1237E-03	3.8836E-04	6.7366E-02	4.0413E-03
2.033	5.6170E-02	2.5408E-03	6.1856E-03	3.9229E-04	6.7382E-02	4.0423E-03
2.400	9.0121E-02	4.1703E-03	8.2768E-02	5.3010E-03	8.6703E-02	5.2807E-03
2.700	1.1999E-01	5.6255E-03	1.5100E-01	9.7326E-03	1.0392E-01	6.3988E-03
3.000	1.5126E-01	7.1636E-03	2.1859E-01	1.4175E-02	1.2097E-01	7.5196E-03
3.300	1.8279E-01	8.7252E-03	2.8252E-01	1.8435E-02	1.3710E-01	8.5943E-03
3.600	2.1350E-01	1.0253E-02	3.4121E-01	2.2408E-02	1.5191E-01	9.5966E-03
3.900	2.4253E-01	1.1703E-02	3.9400E-01	2.6045E-02	1.6522E-01	1.0514E-02
4.000	2.5174E-01	1.2164E-02	4.1026E-01	2.7179E-02	1.6932E-01	1.0800E-02
4.300	2.7774E-01	1.3468E-02	4.1026E-01	2.7179E-02	1.8063E-01	1.1601E-02
4.600	3.0120E-01	1.4647E-02	4.1026E-01	2.7179E-02	1.9051E-01	1.2317E-02

4.900	3.2208E-01	1.5698E-02	4.1026E-01	2.7179E-02	1.9907E-01	1.2955E-02
5.033	3.3053E-01	1.6125E-02	4.1026E-01	2.7179E-02	2.0249E-01	1.3215E-02
5.400	3.5143E-01	1.7180E-02	4.1026E-01	2.7179E-02	2.1082E-01	1.3865E-02
5.700	3.6610E-01	1.7922E-02	4.1026E-01	2.7179E-02	2.1664E-01	1.4334E-02
6.000	3.7889E-01	1.8570E-02	4.1026E-01	2.7179E-02	2.2173E-01	1.4756E-02
6.300	3.9007E-01	1.9137E-02	4.1026E-01	2.7179E-02	2.2621E-01	1.5138E-02
6.600	3.9988E-01	1.9635E-02	4.1026E-01	2.7179E-02	2.3017E-01	1.5485E-02
6.900	4.0851E-01	2.0073E-02	4.1026E-01	2.7179E-02	2.3369E-01	1.5801E-02
7.200	4.1615E-01	2.0461E-02	4.1026E-01	2.7179E-02	2.3682E-01	1.6091E-02
7.500	4.2293E-01	2.0805E-02	4.1026E-01	2.7179E-02	2.3963E-01	1.6358E-02
7.800	4.2897E-01	2.1111E-02	4.1026E-01	2.7179E-02	2.4216E-01	1.6603E-02
8.000	4.3264E-01	2.1297E-02	4.1026E-01	2.7179E-02	2.4370E-01	1.6756E-02
8.300	4.3711E-01	2.1524E-02	4.1026E-01	2.7179E-02	2.4448E-01	1.6874E-02
8.367	4.3793E-01	2.1566E-02	4.1026E-01	2.7179E-02	2.4464E-01	1.6899E-02
8.667	4.4100E-01	2.1721E-02	4.1026E-01	2.7179E-02	2.4533E-01	1.7007E-02
8.967	4.4339E-01	2.1842E-02	4.1026E-01	2.7179E-02	2.4595E-01	1.7109E-02
9.300	4.4555E-01	2.1951E-02	4.1026E-01	2.7179E-02	2.4658E-01	1.7215E-02
9.600	4.4718E-01	2.2033E-02	4.1026E-01	2.7179E-02	2.4710E-01	1.7305E-02
9.900	4.4861E-01	2.2104E-02	4.1026E-01	2.7179E-02	2.4757E-01	1.7389E-02
10.200	4.4988E-01	2.2168E-02	4.1026E-01	2.7179E-02	2.4801E-01	1.7470E-02
12.033	4.5561E-01	2.2450E-02	4.1026E-01	2.7179E-02	2.5010E-01	1.7881E-02
19.478	4.6630E-01	2.2930E-02	4.1026E-01	2.7179E-02	2.5429E-01	1.8876E-02
24.000	4.7019E-01	2.3079E-02	4.1026E-01	2.7179E-02	2.5590E-01	1.9250E-02
24.033	4.7021E-01	2.3080E-02	4.1026E-01	2.7179E-02	2.5591E-01	1.9251E-02
96.000	4.8887E-01	2.3732E-02	4.1026E-01	2.7179E-02	2.6711E-01	2.0719E-02
240.000	4.9964E-01	2.4103E-02	4.1026E-01	2.7179E-02	2.7165E-01	2.1208E-02
264.000	5.3001E-01	2.5148E-02	4.1026E-01	2.7179E-02	2.8481E-01	2.2474E-02
480.000	5.3361E-01	2.5274E-02	4.1026E-01	2.7179E-02	2.8611E-01	2.2585E-02
504.000	5.3835E-01	2.5444E-02	4.1026E-01	2.7179E-02	2.8816E-01	2.2740E-02
696.000	5.3888E-01	2.5464E-02	4.1026E-01	2.7179E-02	2.8835E-01	2.2753E-02
720.000	5.3971E-01	2.5497E-02	4.1026E-01	2.7179E-02	2.8871E-01	2.2777E-02

```
######################################################################
                        Worst Two-Hour Doses
    Note: All of the dose locations are shown below but the
          worst two-hour dose is only meaningful for the EAB
          dose location.  Please disregard the two-hour worst
          doses for the other dose locations
######################################################################
```

Control_Room

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
2.0	1.6118E-04	1.9857E-01	9.7656E-03

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
2.0	7.1341E-03	4.1026E-01	2.7179E-02

LPZ

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
1.5	1.9350E-03	1.1831E-01	7.6432E-03

RUN B2 – STACKTOP.O0

Environment Integral Nuclide Release:

Time (h) = 0.5000	Ci	kg	Atoms	Bq
Kr-85	1.7752E+00	4.5248E-06	3.2058E+19	6.5684E+10
Kr-85m	3.3809E+01	4.1083E-09	2.9107E+16	1.2510E+12
Kr-87	5.6464E+01	1.9934E-09	1.3798E+16	2.0892E+12
Kr-88	8.9199E+01	7.1136E-09	4.8681E+16	3.3004E+12
Rb-86	2.8873E-02	3.5485E-10	2.4848E+15	1.0683E+09
I-131	1.7538E+01	1.4146E-07	6.5031E+17	6.4890E+11
I-132	2.3284E+01	2.2557E-09	1.0291E+16	8.6150E+11

I-133	3.5902E+01	3.1693E-08	1.4350E+17	1.3284E+12
I-134	2.8884E+01	1.0827E-09	4.8660E+15	1.0687E+12
I-135	3.3034E+01	9.4064E-09	4.1960E+16	1.2223E+12
Xe-133	2.7115E+02	1.4486E-06	6.5592E+18	1.0033E+13
Xe-135	9.9182E+01	3.8838E-08	1.7325E+17	3.6697E+12
Cs-134	2.5859E+00	1.9986E-06	8.9820E+18	9.5677E+10
Cs-136	8.7928E-01	1.1997E-08	5.3123E+16	3.2533E+10
Cs-137	1.8305E+00	2.1045E-05	9.2506E+19	6.7728E+10

Environment Integral Nuclide Release:

Time (h) = 2.0000	Ci	kg	Atoms	Bq
Co-58	2.4399E-02	7.6731E-10	7.9669E+15	9.0275E+08
Co-60	2.4329E-02	2.1523E-08	2.1603E+17	9.0019E+08
Kr-85	3.2892E+02	8.3838E-04	5.9398E+21	1.2170E+13
Kr-85m	5.2098E+03	6.3306E-07	4.4852E+18	1.9276E+14
Kr-87	5.5285E+03	1.9518E-07	1.3510E+18	2.0455E+14
Kr-88	1.2371E+04	9.8661E-07	6.7517E+18	4.5774E+14
Rb-86	1.6879E+00	2.0744E-08	1.4526E+17	6.2451E+10
Sr-89	3.8018E+01	1.3086E-06	8.8545E+18	1.4066E+12
Sr-90	4.3230E+00	3.1692E-05	2.1206E+20	1.5995E+11
Sr-91	4.2174E+01	1.1634E-08	7.6992E+16	1.5604E+12
Sr-92	3.2850E+01	2.6135E-09	1.7107E+16	1.2155E+12
Y-90	7.8977E-02	1.4516E-10	9.7132E+14	2.9222E+09
Y-91	4.9573E-01	2.0214E-08	1.3377E+17	1.8342E+10
Y-92	5.2798E+00	5.4871E-10	3.5917E+15	1.9535E+11
Y-93	5.0519E-01	1.5142E-10	9.8052E+14	1.8692E+10
Zr-95	6.6606E-01	3.1004E-08	1.9654E+17	2.4644E+10
Zr-97	6.3178E-01	3.3049E-10	2.0518E+15	2.3376E+10
Nb-95	6.6887E-01	1.7105E-08	1.0843E+17	2.4748E+10
Mo-99	8.5361E+00	1.7798E-08	1.0826E+17	3.1584E+11
Tc-99m	7.6063E+00	1.4466E-09	8.7993E+15	2.8143E+11
Ru-103	6.9814E+00	2.1632E-07	1.2647E+18	2.5831E+11
Ru-105	3.5685E+00	5.3087E-10	3.0447E+15	1.3204E+11
Ru-106	2.5402E+00	7.5928E-07	4.3137E+18	9.3989E+10
Rh-105	4.3592E+00	5.1646E-09	2.9621E+16	1.6129E+11
Sb-127	9.4288E+00	3.5307E-08	1.6742E+17	3.4886E+11
Sb-129	2.2113E+01	3.9323E-09	1.8357E+16	8.1817E+11
Te-127	9.4208E+00	3.5697E-09	1.6927E+16	3.4857E+11
Te-127m	1.2708E+00	1.3473E-07	6.3885E+17	4.7020E+10
Te-129	2.5186E+01	1.2026E-09	5.6143E+15	9.3189E+11
Te-129m	5.5149E+00	1.8306E-07	8.5460E+17	2.0405E+11
Te-131m	1.6937E+01	2.1240E-08	9.7642E+16	6.2667E+11
Te-132	1.2883E+02	4.2435E-07	1.9360E+18	4.7667E+12
I-131	1.1565E+03	9.3284E-06	4.2883E+19	4.2790E+13
I-132	1.3350E+03	1.2934E-07	5.9007E+17	4.9397E+13
I-133	2.2899E+03	2.0214E-06	9.1529E+18	8.4726E+13
I-134	8.3243E+02	3.1204E-08	1.4024E+17	3.0800E+13
I-135	1.9473E+03	5.5448E-07	2.4735E+18	7.2049E+13
Xe-133	5.0107E+04	2.6769E-04	1.2121E+21	1.8540E+15
Xe-135	1.8807E+04	7.3644E-06	3.2851E+19	6.9584E+14
Cs-134	1.5141E+02	1.1703E-04	5.2593E+20	5.6023E+12
Cs-136	5.1363E+01	7.0081E-07	3.1032E+18	1.9004E+12
Cs-137	1.0719E+02	1.2323E-03	5.4168E+21	3.9659E+12

Ba-139	2.9376E+01	1.7959E-09	7.7807E+15	1.0869E+12
Ba-140	6.6798E+01	9.1244E-07	3.9249E+18	2.4715E+12
La-140	1.5508E+00	2.7901E-09	1.2002E+16	5.7380E+10
La-141	4.5820E-01	8.1020E-11	3.4604E+14	1.6953E+10
La-142	2.8578E-01	1.9964E-11	8.4664E+13	1.0574E+10
Ce-141	1.5478E+00	5.4320E-08	2.3200E+17	5.7268E+10
Ce-143	1.3996E+00	2.1076E-09	8.8757E+15	5.1786E+10
Ce-144	1.3008E+00	4.0784E-07	1.7056E+18	4.8129E+10
Pr-143	5.6315E-01	8.3630E-09	3.5219E+16	2.0837E+10
Nd-147	2.4560E-01	3.0359E-09	1.2437E+16	9.0872E+09
Np-239	1.7400E+01	7.5003E-08	1.8899E+17	6.4380E+11
Pu-238	9.5784E-03	5.5950E-07	1.4157E+18	3.5440E+08
Pu-239	4.2148E-04	6.7809E-06	1.7086E+19	1.5595E+07
Pu-240	5.9075E-04	2.5925E-06	6.5052E+18	2.1858E+07
Pu-241	1.5195E-01	1.4751E-06	3.6860E+18	5.6223E+09
Am-241	7.4459E-05	2.1694E-08	5.4210E+16	2.7550E+06
Cm-242	1.6850E-02	5.0841E-09	1.2652E+16	6.2346E+08
Cm-244	7.7815E-04	9.6183E-09	2.3739E+16	2.8791E+07

Environment Integral Nuclide Release:

Time (h) = 8.0000	Ci	kg	Atoms	Bq
Co-58	2.1970E-01	6.9094E-09	7.1740E+16	8.1290E+09
Co-60	2.1926E-01	1.9397E-07	1.9469E+18	8.1127E+09
Kr-85	7.0378E+03	1.7938E-02	1.2709E+23	2.6040E+14
Kr-85m	6.8093E+04	8.2742E-06	5.8622E+19	2.5194E+15
Kr-87	2.8651E+04	1.0115E-06	7.0015E+18	1.0601E+15
Kr-88	1.2588E+05	1.0039E-05	6.8697E+19	4.6574E+15
Rb-86	1.0160E+01	1.2486E-07	8.7433E+17	3.7590E+11
Sr-89	3.4222E+02	1.1779E-05	7.9704E+19	1.2662E+13
Sr-90	3.8961E+01	2.8563E-04	1.9112E+21	1.4416E+12
Sr-91	3.2728E+02	9.0284E-08	5.9748E+17	1.2109E+13
Sr-92	1.8415E+02	1.4650E-08	9.5898E+16	6.8134E+12
Y-90	1.4442E+00	2.6544E-09	1.7762E+16	5.3435E+10
Y-91	4.5858E+00	1.8699E-07	1.2375E+18	1.6968E+11
Y-92	8.3377E+01	8.6649E-09	5.6719E+16	3.0849E+12
Y-93	3.9541E+00	1.1852E-09	7.6744E+15	1.4630E+11
Zr-95	5.9971E+00	2.7916E-07	1.7696E+18	2.2189E+11
Zr-97	5.2268E+00	2.7342E-09	1.6975E+16	1.9339E+11
Nb-95	6.0280E+00	1.5416E-07	9.7722E+17	2.2304E+11
Mo-99	7.5236E+01	1.5687E-07	9.5421E+17	2.7837E+12
Tc-99m	6.8211E+01	1.2972E-08	7.8910E+16	2.5238E+12
Ru-103	6.2821E+01	1.9465E-06	1.1381E+19	2.3244E+12
Ru-105	2.3689E+01	3.5241E-09	2.0212E+16	8.7649E+11
Ru-106	2.2890E+01	6.8419E-06	3.8871E+19	8.4694E+11
Rh-105	3.8724E+01	4.5879E-08	2.6313E+17	1.4328E+12
Sb-127	8.3632E+01	3.1317E-07	1.4850E+18	3.0944E+12
Sb-129	1.4566E+02	2.5902E-08	1.2092E+17	5.3893E+12
Te-127	8.4262E+01	3.1928E-08	1.5140E+17	3.1177E+12
Te-127m	1.1455E+01	1.2144E-06	5.7587E+18	4.2385E+11
Te-129	1.8237E+02	8.7083E-09	4.0653E+16	6.7478E+12
Te-129m	4.9675E+01	1.6489E-06	7.6978E+18	1.8380E+12
Te-131m	1.4539E+02	1.8233E-07	8.3817E+17	5.3794E+12
Te-132	1.1394E+03	3.7531E-06	1.7123E+19	4.2158E+13

I-131	7.4697E+03	6.0251E-05	2.7698E+20	2.7638E+14
I-132	6.3650E+03	6.1663E-07	2.8132E+18	2.3550E+14
I-133	1.3889E+04	1.2261E-05	5.5515E+19	5.1389E+14
I-134	1.7982E+03	6.7406E-08	3.0293E+17	6.6532E+13
I-135	1.0253E+04	2.9195E-06	1.3023E+19	3.7936E+14
Xe-133	1.0555E+06	5.6387E-03	2.5532E+22	3.9052E+16
Xe-135	3.3955E+05	1.3296E-04	5.9313E+20	1.2563E+16
Cs-134	9.1426E+02	7.0663E-04	3.1757E+21	3.3828E+13
Cs-136	3.0874E+02	4.2125E-06	1.8653E+19	1.1423E+13
Cs-137	6.4726E+02	7.4414E-03	3.2710E+22	2.3949E+13
Ba-139	1.1621E+02	7.1048E-09	3.0782E+16	4.2999E+12
Ba-140	5.9912E+02	8.1837E-06	3.5203E+19	2.2167E+13
La-140	3.1621E+01	5.6890E-08	2.4471E+17	1.1700E+12
La-141	2.9344E+00	5.1887E-10	2.2161E+15	1.0857E+11
La-142	1.2098E+00	8.4510E-11	3.5840E+14	4.4761E+10
Ce-141	1.3931E+01	4.8892E-07	2.0882E+18	5.1544E+11
Ce-143	1.2067E+01	1.8171E-08	7.6524E+16	4.4648E+11
Ce-144	1.1721E+01	3.6749E-06	1.5368E+19	4.3367E+11
Pr-143	5.1022E+00	7.5770E-08	3.1909E+17	1.8878E+11
Nd-147	2.2011E+00	2.7208E-08	1.1146E+17	8.1441E+10
Np-239	1.5279E+02	6.5861E-07	1.6595E+18	5.6533E+12
Pu-238	8.6326E-02	5.0425E-06	1.2759E+19	3.1941E+09
Pu-239	3.7996E-03	6.1130E-05	1.5403E+20	1.4059E+08
Pu-240	5.3242E-03	2.3365E-05	5.8629E+19	1.9699E+08
Pu-241	1.3695E+00	1.3294E-05	3.3220E+19	5.0671E+10
Am-241	6.7155E-04	1.9566E-07	4.8892E+17	2.4847E+07
Cm-242	1.5181E-01	4.5803E-08	1.1398E+17	5.6168E+09
Cm-244	7.0130E-03	8.6685E-08	2.1395E+17	2.5948E+08

Environment Integral Nuclide Release:

Time (h) = 24.0000	Ci	kg	Atoms	Bq
Co-58	2.4967E-01	7.8518E-09	8.1525E+16	9.2379E+09
Co-60	2.4926E-01	2.2051E-07	2.2132E+18	9.2225E+09
Kr-85	2.7033E+04	6.8902E-02	4.8816E+23	1.0002E+15
Kr-85m	1.1038E+05	1.3412E-05	9.5024E+19	4.0839E+15
Kr-87	2.9785E+04	1.0515E-06	7.2787E+18	1.1021E+15
Kr-88	1.6414E+05	1.3090E-05	8.9578E+19	6.0731E+15
Rb-86	1.1401E+01	1.4011E-07	9.8115E+17	4.2183E+11
Sr-89	3.8884E+02	1.3384E-05	9.0563E+19	1.4387E+13
Sr-90	4.4292E+01	3.2470E-04	2.1727E+21	1.6388E+12
Sr-91	3.5382E+02	9.7607E-08	6.4594E+17	1.3092E+13
Sr-92	1.8854E+02	1.5000E-08	9.8188E+16	6.9761E+12
Y-90	2.0297E+00	3.7307E-09	2.4963E+16	7.5100E+10
Y-91	5.2615E+00	2.1455E-07	1.4198E+18	1.9468E+11
Y-92	9.3113E+01	9.6767E-09	6.3342E+16	3.4452E+12
Y-93	4.2847E+00	1.2842E-09	8.3160E+15	1.5853E+11
Zr-95	6.8148E+00	3.1722E-07	2.0109E+18	2.5215E+11
Zr-97	5.7579E+00	3.0119E-09	1.8699E+16	2.1304E+11
Nb-95	6.8527E+00	1.7525E-07	1.1109E+18	2.5355E+11
Mo-99	8.4764E+01	1.7673E-07	1.0751E+18	3.1363E+12
Tc-99m	7.7209E+01	1.4683E-08	8.9319E+16	2.8567E+12
Ru-103	7.1370E+01	2.2114E-06	1.2929E+19	2.6407E+12
Ru-105	2.4779E+01	3.6862E-09	2.1142E+16	9.1682E+11

Ru-106	2.6020E+01	7.7774E-06	4.4186E+19	9.6274E+11
Rh-105	4.3561E+01	5.1609E-08	2.9600E+17	1.6118E+12
Sb-127	9.4460E+01	3.5371E-07	1.6772E+18	3.4950E+12
Sb-129	1.5217E+02	2.7060E-08	1.2632E+17	5.6302E+12
Te-127	9.5444E+01	3.6165E-08	1.7149E+17	3.5314E+12
Te-127m	1.3023E+01	1.3807E-06	6.5470E+18	4.8187E+11
Te-129	1.9425E+02	9.2755E-09	4.3301E+16	7.1873E+12
Te-129m	5.6444E+01	1.8736E-06	8.7468E+18	2.0884E+12
Te-131m	1.6219E+02	2.0340E-07	9.3502E+17	6.0010E+12
Te-132	1.2855E+03	4.2342E-06	1.9317E+19	4.7562E+13
I-131	8.9321E+03	7.2048E-05	3.3121E+20	3.3049E+14
I-132	6.7529E+03	6.5421E-07	2.9847E+18	2.4986E+14
I-133	1.5942E+04	1.4073E-05	6.3721E+19	5.8985E+14
I-134	1.7994E+03	6.7451E-08	3.0314E+17	6.6577E+13
I-135	1.1069E+04	3.1519E-06	1.4060E+19	4.0956E+14
Xe-133	3.8766E+06	2.0710E-02	9.3774E+22	1.4343E+17
Xe-135	7.8018E+05	3.0551E-04	1.3628E+21	2.8867E+16
Cs-134	1.0272E+03	7.9396E-04	3.5681E+21	3.8008E+13
Cs-136	3.4627E+02	4.7247E-06	2.0921E+19	1.2812E+13
Cs-137	7.2727E+02	8.3612E-03	3.6754E+22	2.6909E+13
Ba-139	1.1678E+02	7.1396E-09	3.0932E+16	4.3210E+12
Ba-140	6.7973E+02	9.2848E-06	3.9939E+19	2.5150E+13
La-140	4.4950E+01	8.0869E-08	3.4786E+17	1.6631E+12
La-141	3.0524E+00	5.3973E-10	2.3052E+15	1.1294E+11
La-142	1.2181E+00	8.5091E-11	3.6087E+14	4.5069E+10
Ce-141	1.5826E+01	5.5542E-07	2.3722E+18	5.8556E+11
Ce-143	1.3483E+01	2.0303E-08	8.5501E+16	4.9886E+11
Ce-144	1.3323E+01	4.1773E-06	1.7469E+19	4.9296E+11
Pr-143	5.8128E+00	8.6322E-08	3.6353E+17	2.1507E+11
Nd-147	2.4965E+00	3.0859E-08	1.2642E+17	9.2369E+10
Np-239	1.7190E+02	7.4096E-07	1.8670E+18	6.3602E+12
Pu-238	9.8136E-02	5.7324E-06	1.4505E+19	3.6311E+09
Pu-239	4.3200E-03	6.9502E-05	1.7512E+20	1.5984E+08
Pu-240	6.0526E-03	2.6562E-05	6.6650E+19	2.2395E+08
Pu-241	1.5568E+00	1.5113E-05	3.7765E+19	5.7603E+10
Am-241	7.6367E-04	2.2250E-07	5.5600E+17	2.8256E+07
Cm-242	1.7255E-01	5.2062E-08	1.2955E+17	6.3843E+09
Cm-244	7.9725E-03	9.8544E-08	2.4322E+17	2.9498E+08

Environment Integral Nuclide Release:

Time (h) = 48.0000	Ci	kg	Atoms	Bq
Co-58	2.5098E-01	7.8930E-09	8.1953E+16	9.2864E+09
Co-60	2.5058E-01	2.2168E-07	2.2250E+18	9.2716E+09
Kr-85	5.6341E+04	1.4360E-01	1.0174E+24	2.0846E+15
Kr-85m	1.1395E+05	1.3847E-05	9.8104E+19	4.2163E+15
Kr-87	2.9785E+04	1.0515E-06	7.2787E+18	1.1021E+15
Kr-88	1.6485E+05	1.3147E-05	8.9970E+19	6.0996E+15
Rb-86	1.1454E+01	1.4076E-07	9.8569E+17	4.2378E+11
Sr-89	3.9087E+02	1.3454E-05	9.1036E+19	1.4462E+13
Sr-90	4.4527E+01	3.2643E-04	2.1842E+21	1.6475E+12
Sr-91	3.5403E+02	9.7665E-08	6.4632E+17	1.3099E+13
Sr-92	1.8854E+02	1.5000E-08	9.8189E+16	6.9761E+12
Y-90	2.1055E+00	3.8699E-09	2.5894E+16	7.7902E+10

Y-91	5.2937E+00	2.1586E-07	1.4285E+18	1.9587E+11
Y-92	9.3125E+01	9.6780E-09	6.3350E+16	3.4456E+12
Y-93	4.2875E+00	1.2851E-09	8.3216E+15	1.5864E+11
Zr-95	6.8506E+00	3.1888E-07	2.0214E+18	2.5347E+11
Zr-97	5.7665E+00	3.0165E-09	1.8727E+16	2.1336E+11
Nb-95	6.8891E+00	1.7618E-07	1.1168E+18	2.5490E+11
Mo-99	8.5088E+01	1.7741E-07	1.0792E+18	3.1483E+12
Tc-99m	7.7538E+01	1.4746E-08	8.9700E+16	2.8689E+12
Ru-103	7.1741E+01	2.2229E-06	1.2997E+19	2.6544E+12
Ru-105	2.4780E+01	3.6864E-09	2.1143E+16	9.1687E+11
Ru-106	2.6158E+01	7.8187E-06	4.4420E+19	9.6785E+11
Rh-105	4.3697E+01	5.1770E-08	2.9692E+17	1.6168E+12
Sb-127	9.4856E+01	3.5520E-07	1.6843E+18	3.5097E+12
Sb-129	1.5218E+02	2.7061E-08	1.2633E+17	5.6305E+12
Te-127	9.5884E+01	3.6332E-08	1.7228E+17	3.5477E+12
Te-127m	1.3093E+01	1.3880E-06	6.5819E+18	4.8444E+11
Te-129	1.9451E+02	9.2881E-09	4.3360E+16	7.1970E+12
Te-129m	5.6737E+01	1.8834E-06	8.7922E+18	2.0993E+12
Te-131m	1.6261E+02	2.0392E-07	9.3744E+17	6.0165E+12
Te-132	1.2906E+03	4.2512E-06	1.9395E+19	4.7754E+13
I-131	9.8371E+03	7.9347E-05	3.6476E+20	3.6397E+14
I-132	6.7883E+03	6.5765E-07	3.0003E+18	2.5117E+14
I-133	1.6593E+04	1.4647E-05	6.6322E+19	6.1393E+14
I-134	1.7994E+03	6.7451E-08	3.0314E+17	6.6577E+13
I-135	1.1126E+04	3.1682E-06	1.4133E+19	4.1167E+14
Xe-133	7.5802E+06	4.0497E-02	1.8337E+23	2.8047E+17
Xe-135	9.2992E+05	3.6414E-04	1.6244E+21	3.4407E+16
Cs-134	1.0322E+03	7.9781E-04	3.5855E+21	3.8193E+13
Cs-136	3.4784E+02	4.7461E-06	2.1016E+19	1.2870E+13
Cs-137	7.3081E+02	8.4019E-03	3.6932E+22	2.7040E+13
Ba-139	1.1678E+02	7.1396E-09	3.0932E+16	4.3210E+12
Ba-140	6.8309E+02	9.3308E-06	4.0137E+19	2.5274E+13
La-140	4.6541E+01	8.3733E-08	3.6018E+17	1.7220E+12
La-141	3.0525E+00	5.3975E-10	2.3053E+15	1.1294E+11
La-142	1.2181E+00	8.5091E-11	3.6087E+14	4.5069E+10
Ce-141	1.5908E+01	5.5830E-07	2.3845E+18	5.8859E+11
Ce-143	1.3520E+01	2.0359E-08	8.5737E+16	5.0024E+11
Ce-144	1.3394E+01	4.1994E-06	1.7562E+19	4.9558E+11
Pr-143	5.8451E+00	8.6801E-08	3.6555E+17	2.1627E+11
Nd-147	2.5087E+00	3.1010E-08	1.2704E+17	9.2821E+10
Np-239	1.7252E+02	7.4364E-07	1.8738E+18	6.3832E+12
Pu-238	9.8658E-02	5.7629E-06	1.4582E+19	3.6504E+09
Pu-239	4.3430E-03	6.9873E-05	1.7606E+20	1.6069E+08
Pu-240	6.0848E-03	2.6703E-05	6.7004E+19	2.2514E+08
Pu-241	1.5651E+00	1.5193E-05	3.7966E+19	5.7909E+10
Am-241	7.6778E-04	2.2370E-07	5.5899E+17	2.8408E+07
Cm-242	1.7346E-01	5.2337E-08	1.3024E+17	6.4180E+09
Cm-244	8.0149E-03	9.9068E-08	2.4451E+17	2.9655E+08

Environment Integral Nuclide Release:

Time (h) = 96.0000	Ci	kg	Atoms	Bq
Co-58	2.5344E-01	7.9703E-09	8.2755E+16	9.3772E+09
Co-60	2.5310E-01	2.2391E-07	2.2473E+18	9.3647E+09

Kr-85	1.1257E+05	2.8692E-01	2.0328E+24	4.1650E+15
Kr-85m	1.1404E+05	1.3858E-05	9.8179E+19	4.2195E+15
Kr-87	2.9785E+04	1.0515E-06	7.2787E+18	1.1021E+15
Kr-88	1.6486E+05	1.3147E-05	8.9971E+19	6.0997E+15
Rb-86	1.1548E+01	1.4193E-07	9.9386E+17	4.2729E+11
Sr-89	3.9465E+02	1.3584E-05	9.1917E+19	1.4602E+13
Sr-90	4.4975E+01	3.2971E-04	2.2062E+21	1.6641E+12
Sr-91	3.5407E+02	9.7676E-08	6.4639E+17	1.3101E+13
Sr-92	1.8854E+02	1.5000E-08	9.8189E+16	6.9761E+12
Y-90	2.3464E+00	4.3128E-09	2.8858E+16	8.6818E+10
Y-91	5.3549E+00	2.1835E-07	1.4450E+18	1.9813E+11
Y-92	9.3125E+01	9.6780E-09	6.3350E+16	3.4456E+12
Y-93	4.2881E+00	1.2853E-09	8.3228E+15	1.5866E+11
Zr-95	6.9174E+00	3.2200E-07	2.0412E+18	2.5594E+11
Zr-97	5.7707E+00	3.0187E-09	1.8741E+16	2.1352E+11
Nb-95	6.9583E+00	1.7795E-07	1.1280E+18	2.5746E+11
Mo-99	8.5514E+01	1.7830E-07	1.0846E+18	3.1640E+12
Tc-99m	7.7974E+01	1.4829E-08	9.0204E+16	2.8850E+12
Ru-103	7.2427E+01	2.2441E-06	1.3121E+19	2.6798E+12
Ru-105	2.4780E+01	3.6864E-09	2.1143E+16	9.1687E+11
Ru-106	2.6420E+01	7.8969E-06	4.4864E+19	9.7753E+11
Rh-105	4.3828E+01	5.1925E-08	2.9781E+17	1.6216E+12
Sb-127	9.5434E+01	3.5736E-07	1.6946E+18	3.5311E+12
Sb-129	1.5218E+02	2.7061E-08	1.2633E+17	5.6305E+12
Te-127	9.6564E+01	3.6590E-08	1.7350E+17	3.5729E+12
Te-127m	1.3225E+01	1.4020E-06	6.6481E+18	4.8931E+11
Te-129	1.9498E+02	9.3104E-09	4.3464E+16	7.2143E+12
Te-129m	5.7277E+01	1.9013E-06	8.8759E+18	2.1193E+12
Te-131m	1.6297E+02	2.0437E-07	9.3952E+17	6.0299E+12
Te-132	1.2978E+03	4.2749E-06	1.9503E+19	4.8020E+13
I-131	1.1365E+04	9.1672E-05	4.2142E+20	4.2050E+14
I-132	6.8304E+03	6.6172E-07	3.0189E+18	2.5272E+14
I-133	1.7001E+04	1.5008E-05	6.7955E+19	6.2904E+14
I-134	1.7994E+03	6.7451E-08	3.0314E+17	6.6577E+13
I-135	1.1131E+04	3.1695E-06	1.4139E+19	4.1185E+14
Xe-133	1.3427E+07	7.1734E-02	3.2481E+23	4.9681E+17
Xe-135	9.5690E+05	3.7471E-04	1.6715E+21	3.5405E+16
Cs-134	1.0417E+03	8.0513E-04	3.6183E+21	3.8543E+13
Cs-136	3.5060E+02	4.7837E-06	2.1182E+19	1.2972E+13
Cs-137	7.3753E+02	8.4791E-03	3.7272E+22	2.7288E+13
Ba-139	1.1678E+02	7.1396E-09	3.0932E+16	4.3210E+12
Ba-140	6.8899E+02	9.4113E-06	4.0483E+19	2.5493E+13
La-140	5.0970E+01	9.1701E-08	3.9446E+17	1.8859E+12
La-141	3.0525E+00	5.3975E-10	2.3053E+15	1.1294E+11
La-142	1.2181E+00	8.5091E-11	3.6087E+14	4.5069E+10
Ce-141	1.6059E+01	5.6359E-07	2.4071E+18	5.9417E+11
Ce-143	1.3554E+01	2.0411E-08	8.5955E+16	5.0151E+11
Ce-144	1.3528E+01	4.2413E-06	1.7737E+19	5.0053E+11
Pr-143	5.9055E+00	8.7698E-08	3.6932E+17	2.1850E+11
Nd-147	2.5298E+00	3.1271E-08	1.2811E+17	9.3603E+10
Np-239	1.7329E+02	7.4696E-07	1.8821E+18	6.4116E+12
Pu-238	9.9651E-02	5.8208E-06	1.4728E+19	3.6871E+09
Pu-239	4.3870E-03	7.0579E-05	1.7784E+20	1.6232E+08
Pu-240	6.1460E-03	2.6972E-05	6.7678E+19	2.2740E+08

Pu-241	1.5809E+00	1.5346E-05	3.8347E+19	5.8492E+10
Am-241	7.7570E-04	2.2601E-07	5.6475E+17	2.8701E+07
Cm-242	1.7518E-01	5.2857E-08	1.3153E+17	6.4818E+09
Cm-244	8.0954E-03	1.0006E-07	2.4697E+17	2.9953E+08

Environment Integral Nuclide Release:

Time (h) = 120.0000	Ci	kg	Atoms	Bq
Co-58	2.5460E-01	8.0068E-09	8.3134E+16	9.4202E+09
Co-60	2.5431E-01	2.2497E-07	2.2580E+18	9.4094E+09
Kr-85	1.3953E+05	3.5564E-01	2.5197E+24	5.1627E+15
Kr-85m	1.1404E+05	1.3858E-05	9.8179E+19	4.2195E+15
Kr-87	2.9785E+04	1.0515E-06	7.2787E+18	1.1021E+15
Kr-88	1.6486E+05	1.3147E-05	8.9971E+19	6.0997E+15
Rb-86	1.1591E+01	1.4246E-07	9.9756E+17	4.2888E+11
Sr-89	3.9643E+02	1.3645E-05	9.2331E+19	1.4668E+13
Sr-90	4.5190E+01	3.3129E-04	2.2167E+21	1.6720E+12
Sr-91	3.5407E+02	9.7676E-08	6.4639E+17	1.3101E+13
Sr-92	1.8854E+02	1.5000E-08	9.8189E+16	6.9761E+12
Y-90	2.4951E+00	4.5860E-09	3.0686E+16	9.2318E+10
Y-91	5.3838E+00	2.1953E-07	1.4528E+18	1.9920E+11
Y-92	9.3125E+01	9.6780E-09	6.3350E+16	3.4456E+12
Y-93	4.2882E+00	1.2853E-09	8.3228E+15	1.5866E+11
Zr-95	6.9489E+00	3.2346E-07	2.0505E+18	2.5711E+11
Zr-97	5.7711E+00	3.0189E-09	1.8742E+16	2.1353E+11
Nb-95	6.9914E+00	1.7879E-07	1.1334E+18	2.5868E+11
Mo-99	8.5652E+01	1.7859E-07	1.0863E+18	3.1691E+12
Tc-99m	7.8116E+01	1.4856E-08	9.0368E+16	2.8903E+12
Ru-103	7.2748E+01	2.2541E-06	1.3179E+19	2.6917E+12
Ru-105	2.4780E+01	3.6864E-09	2.1143E+16	9.1687E+11
Ru-106	2.6545E+01	7.9343E-06	4.5077E+19	9.8216E+11
Rh-105	4.3858E+01	5.1961E-08	2.9802E+17	1.6227E+12
Sb-127	9.5645E+01	3.5815E-07	1.6983E+18	3.5389E+12
Sb-129	1.5218E+02	2.7061E-08	1.2633E+17	5.6305E+12
Te-127	9.6827E+01	3.6689E-08	1.7398E+17	3.5826E+12
Te-127m	1.3288E+01	1.4087E-06	6.6798E+18	4.9164E+11
Te-129	1.9520E+02	9.3208E-09	4.3512E+16	7.2223E+12
Te-129m	5.7528E+01	1.9096E-06	8.9148E+18	2.1286E+12
Te-131m	1.6304E+02	2.0446E-07	9.3994E+17	6.0325E+12
Te-132	1.3003E+03	4.2831E-06	1.9540E+19	4.8112E+13
I-131	1.2008E+04	9.6859E-05	4.4527E+20	4.4430E+14
I-132	6.8450E+03	6.6313E-07	3.0254E+18	2.5326E+14
I-133	1.7055E+04	1.5056E-05	6.8172E+19	6.3105E+14
I-134	1.7994E+03	6.7451E-08	3.0314E+17	6.6577E+13
I-135	1.1131E+04	3.1695E-06	1.4139E+19	4.1185E+14
Xe-133	1.5721E+07	8.3986E-02	3.8028E+23	5.8166E+17
Xe-135	9.5747E+05	3.7493E-04	1.6725E+21	3.5426E+16
Cs-134	1.0462E+03	8.0863E-04	3.6341E+21	3.8711E+13
Cs-136	3.5182E+02	4.8003E-06	2.1256E+19	1.3017E+13
Cs-137	7.4075E+02	8.5161E-03	3.7435E+22	2.7408E+13
Ba-139	1.1678E+02	7.1396E-09	3.0932E+16	4.3210E+12
Ba-140	6.9160E+02	9.4469E-06	4.0636E+19	2.5589E+13
La-140	5.3386E+01	9.6048E-08	4.1315E+17	1.9753E+12
La-141	3.0525E+00	5.3975E-10	2.3053E+15	1.1294E+11

La-142	1.2181E+00	8.5091E-11	3.6087E+14	4.5069E+10
Ce-141	1.6129E+01	5.6605E-07	2.4176E+18	5.9676E+11
Ce-143	1.3562E+01	2.0422E-08	8.6002E+16	5.0179E+11
Ce-144	1.3592E+01	4.2614E-06	1.7821E+19	5.0289E+11
Pr-143	5.9331E+00	8.8109E-08	3.7105E+17	2.1953E+11
Nd-147	2.5390E+00	3.1385E-08	1.2858E+17	9.3944E+10
Np-239	1.7352E+02	7.4797E-07	1.8847E+18	6.4203E+12
Pu-238	1.0013E-01	5.8486E-06	1.4799E+19	3.7047E+09
Pu-239	4.4081E-03	7.0919E-05	1.7870E+20	1.6310E+08
Pu-240	6.1753E-03	2.7101E-05	6.8001E+19	2.2849E+08
Pu-241	1.5884E+00	1.5419E-05	3.8530E+19	5.8771E+10
Am-241	7.7954E-04	2.2713E-07	5.6755E+17	2.8843E+07
Cm-242	1.7601E-01	5.3105E-08	1.3215E+17	6.5122E+09
Cm-244	8.1341E-03	1.0054E-07	2.4815E+17	3.0096E+08

Environment Integral Nuclide Release:

Time (h) = 240.0000	Ci	kg	Atoms	Bq
Co-58	2.5979E-01	8.1701E-09	8.4830E+16	9.6123E+09
Co-60	2.5986E-01	2.2989E-07	2.3073E+18	9.6148E+09
Kr-85	2.6366E+05	6.7202E-01	4.7612E+24	9.7553E+15
Kr-85m	1.1404E+05	1.3858E-05	9.8179E+19	4.2195E+15
Kr-87	2.9785E+04	1.0515E-06	7.2787E+18	1.1021E+15
Kr-88	1.6486E+05	1.3147E-05	8.9971E+19	6.0997E+15
Rb-86	1.1769E+01	1.4464E-07	1.0129E+18	4.3546E+11
Sr-89	4.0429E+02	1.3916E-05	9.4162E+19	1.4959E+13
Sr-90	4.6179E+01	3.3854E-04	2.2652E+21	1.7086E+12
Sr-91	3.5407E+02	9.7676E-08	6.4639E+17	1.3101E+13
Sr-92	1.8854E+02	1.5000E-08	9.8189E+16	6.9761E+12
Y-90	3.3355E+00	6.1307E-09	4.1022E+16	1.2341E+11
Y-91	5.5122E+00	2.2477E-07	1.4875E+18	2.0395E+11
Y-92	9.3125E+01	9.6780E-09	6.3350E+16	3.4456E+12
Y-93	4.2882E+00	1.2853E-09	8.3228E+15	1.5866E+11
Zr-95	7.0896E+00	3.3001E-07	2.0920E+18	2.6232E+11
Zr-97	5.7714E+00	3.0190E-09	1.8743E+16	2.1354E+11
Nb-95	7.1433E+00	1.8268E-07	1.1580E+18	2.6430E+11
Mo-99	8.5976E+01	1.7926E-07	1.0904E+18	3.1811E+12
Tc-99m	7.8448E+01	1.4919E-08	9.0752E+16	2.9026E+12
Ru-103	7.4151E+01	2.2975E-06	1.3433E+19	2.7436E+12
Ru-105	2.4780E+01	3.6864E-09	2.1143E+16	9.1687E+11
Ru-106	2.7118E+01	8.1057E-06	4.6050E+19	1.0034E+12
Rh-105	4.3901E+01	5.2012E-08	2.9831E+17	1.6243E+12
Sb-127	9.6234E+01	3.6036E-07	1.7088E+18	3.5607E+12
Sb-129	1.5218E+02	2.7061E-08	1.2633E+17	5.6305E+12
Te-127	9.7678E+01	3.7012E-08	1.7550E+17	3.6141E+12
Te-127m	1.3575E+01	1.4391E-06	6.8241E+18	5.0226E+11
Te-129	1.9614E+02	9.3657E-09	4.3722E+16	7.2572E+12
Te-129m	5.8617E+01	1.9458E-06	9.0836E+18	2.1688E+12
Te-131m	1.6313E+02	2.0457E-07	9.4043E+17	6.0357E+12
Te-132	1.3067E+03	4.3042E-06	1.9637E+19	4.8349E+13
I-131	1.4323E+04	1.1553E-04	5.3111E+20	5.2996E+14
I-132	6.8825E+03	6.6677E-07	3.0420E+18	2.5465E+14
I-133	1.7097E+04	1.5093E-05	6.8338E+19	6.3259E+14
I-134	1.7994E+03	6.7451E-08	3.0314E+17	6.6577E+13

I-135	1.1131E+04	3.1695E-06	1.4139E+19	4.1185E+14
Xe-133	2.3003E+07	1.2289E-01	5.5644E+23	8.5111E+17
Xe-135	9.5757E+05	3.7497E-04	1.6727E+21	3.5430E+16
Cs-134	1.0671E+03	8.2473E-04	3.7064E+21	3.9481E+13
Cs-136	3.5664E+02	4.8661E-06	2.1547E+19	1.3196E+13
Cs-137	7.5559E+02	8.6867E-03	3.8184E+22	2.7957E+13
Ba-139	1.1678E+02	7.1396E-09	3.0932E+16	4.3210E+12
Ba-140	7.0185E+02	9.5870E-06	4.1239E+19	2.5969E+13
La-140	6.4318E+01	1.1571E-07	4.9775E+17	2.3798E+12
La-141	3.0525E+00	5.3975E-10	2.3053E+15	1.1294E+11
La-142	1.2181E+00	8.5091E-11	3.6087E+14	4.5069E+10
Ce-141	1.6432E+01	5.7669E-07	2.4631E+18	6.0798E+11
Ce-143	1.3572E+01	2.0437E-08	8.6065E+16	5.0215E+11
Ce-144	1.3884E+01	4.3531E-06	1.8205E+19	5.1371E+11
Pr-143	6.0453E+00	8.9774E-08	3.7807E+17	2.2368E+11
Nd-147	2.5744E+00	3.1823E-08	1.3037E+17	9.5253E+10
Np-239	1.7401E+02	7.5009E-07	1.8900E+18	6.4385E+12
Pu-238	1.0232E-01	5.9767E-06	1.5123E+19	3.7858E+09
Pu-239	4.5055E-03	7.2486E-05	1.8264E+20	1.6670E+08
Pu-240	6.3105E-03	2.7694E-05	6.9490E+19	2.3349E+08
Pu-241	1.6231E+00	1.5757E-05	3.9373E+19	6.0056E+10
Am-241	7.9771E-04	2.3242E-07	5.8078E+17	2.9515E+07
Cm-242	1.7974E-01	5.4232E-08	1.3496E+17	6.6504E+09
Cm-244	8.3120E-03	1.0274E-07	2.5357E+17	3.0754E+08

Environment Integral Nuclide Release:

Time (h) = 480.0000	Ci	kg	Atoms	Bq
Co-58	2.8048E-01	8.8206E-09	9.1585E+16	1.0378E+10
Co-60	2.8278E-01	2.5017E-07	2.5109E+18	1.0463E+10
Kr-85	9.2888E+05	2.3676E+00	1.6774E+25	3.4368E+16
Kr-85m	1.1404E+05	1.3858E-05	9.8179E+19	4.2195E+15
Kr-87	2.9785E+04	1.0515E-06	7.2787E+18	1.1021E+15
Kr-88	1.6486E+05	1.3147E-05	8.9971E+19	6.0997E+15
Rb-86	1.2408E+01	1.5249E-07	1.0678E+18	4.5910E+11
Sr-89	4.3514E+02	1.4978E-05	1.0135E+20	1.6100E+13
Sr-90	5.0265E+01	3.6850E-04	2.4657E+21	1.8598E+12
Sr-91	3.5407E+02	9.7676E-08	6.4639E+17	1.3101E+13
Sr-92	1.8854E+02	1.5000E-08	9.8189E+16	6.9761E+12
Y-90	7.2026E+00	1.3239E-08	8.8582E+16	2.6650E+11
Y-91	6.0196E+00	2.4546E-07	1.6244E+18	2.2273E+11
Y-92	9.3125E+01	9.6780E-09	6.3350E+16	3.4456E+12
Y-93	4.2882E+00	1.2853E-09	8.3228E+15	1.5866E+11
Zr-95	7.6478E+00	3.5599E-07	2.2567E+18	2.8297E+11
Zr-97	5.7714E+00	3.0190E-09	1.8743E+16	2.1354E+11
Nb-95	7.7667E+00	1.9862E-07	1.2591E+18	2.8737E+11
Mo-99	8.6501E+01	1.8035E-07	1.0971E+18	3.2005E+12
Tc-99m	7.8986E+01	1.5021E-08	9.1375E+16	2.9225E+12
Ru-103	7.9573E+01	2.4655E-06	1.4415E+19	2.9442E+12
Ru-105	2.4780E+01	3.6864E-09	2.1143E+16	9.1687E+11
Ru-106	2.9471E+01	8.8090E-06	5.0046E+19	1.0904E+12
Rh-105	4.3931E+01	5.2048E-08	2.9851E+17	1.6254E+12
Sb-127	9.7484E+01	3.6504E-07	1.7309E+18	3.6069E+12
Sb-129	1.5218E+02	2.7061E-08	1.2633E+17	5.6305E+12

Te-127	1.0005E+02	3.7910E-08	1.7976E+17	3.7018E+12
Te-127m	1.4741E+01	1.5628E-06	7.4103E+18	5.4541E+11
Te-129	1.9974E+02	9.5376E-09	4.4525E+16	7.3904E+12
Te-129m	6.2780E+01	2.0840E-06	9.7287E+18	2.3229E+12
Te-131m	1.6317E+02	2.0463E-07	9.4069E+17	6.0374E+12
Te-132	1.3188E+03	4.3439E-06	1.9818E+19	4.8794E+13
I-131	2.3376E+04	1.8855E-04	8.6678E+20	8.6490E+14
I-132	6.9745E+03	6.7569E-07	3.0826E+18	2.5806E+14
I-133	1.7107E+04	1.5101E-05	6.8378E+19	6.3296E+14
I-134	1.7994E+03	6.7451E-08	3.0314E+17	6.6577E+13
I-135	1.1131E+04	3.1695E-06	1.4139E+19	4.1185E+14
Xe-133	4.7326E+07	2.5283E-01	1.1448E+24	1.7510E+18
Xe-135	9.5757E+05	3.7497E-04	1.6727E+21	3.5430E+16
Cs-134	1.1529E+03	8.9105E-04	4.0045E+21	4.2656E+13
Cs-136	3.7297E+02	5.0889E-06	2.2534E+19	1.3800E+13
Cs-137	8.1692E+02	9.3918E-03	4.1284E+22	3.0226E+13
Ba-139	1.1678E+02	7.1396E-09	3.0932E+16	4.3210E+12
Ba-140	7.3638E+02	1.0059E-05	4.3268E+19	2.7246E+13
La-140	1.0356E+02	1.8632E-07	8.0148E+17	3.8319E+12
La-141	3.0525E+00	5.3975E-10	2.3053E+15	1.1294E+11
La-142	1.2181E+00	8.5091E-11	3.6087E+14	4.5069E+10
Ce-141	1.7588E+01	6.1725E-07	2.6363E+18	6.5074E+11
Ce-143	1.3578E+01	2.0446E-08	8.6104E+16	5.0238E+11
Ce-144	1.5081E+01	4.7285E-06	1.9775E+19	5.5801E+11
Pr-143	6.4308E+00	9.5499E-08	4.0217E+17	2.3794E+11
Nd-147	2.6898E+00	3.3249E-08	1.3621E+17	9.9521E+10
Np-239	1.7470E+02	7.5304E-07	1.8975E+18	6.4639E+12
Pu-238	1.1138E-01	6.5061E-06	1.6462E+19	4.1211E+09
Pu-239	4.9084E-03	7.8969E-05	1.9898E+20	1.8161E+08
Pu-240	6.8694E-03	3.0147E-05	7.5644E+19	2.5417E+08
Pu-241	1.7667E+00	1.7150E-05	4.2855E+19	6.5367E+10
Am-241	8.7522E-04	2.5500E-07	6.3721E+17	3.2383E+07
Cm-242	1.9494E-01	5.8818E-08	1.4637E+17	7.2128E+09
Cm-244	9.0473E-03	1.1183E-07	2.7601E+17	3.3475E+08

Environment Integral Nuclide Release:

Time (h) = 720.0000	Ci	kg	Atoms	Bq
Co-58	2.8932E-01	9.0988E-09	9.4473E+16	1.0705E+10
Co-60	2.9374E-01	2.5986E-07	2.6082E+18	1.0868E+10
Kr-85	1.2521E+06	3.1915E+00	2.2611E+25	4.6328E+16
Kr-85m	1.1404E+05	1.3858E-05	9.8179E+19	4.2195E+15
Kr-87	2.9785E+04	1.0515E-06	7.2787E+18	1.1021E+15
Kr-88	1.6486E+05	1.3147E-05	8.9971E+19	6.0997E+15
Rb-86	1.2607E+01	1.5493E-07	1.0849E+18	4.6645E+11
Sr-89	4.4773E+02	1.5411E-05	1.0428E+20	1.6566E+13
Sr-90	5.2226E+01	3.8287E-04	2.5619E+21	1.9324E+12
Sr-91	3.5407E+02	9.7676E-08	6.4639E+17	1.3101E+13
Sr-92	1.8854E+02	1.5000E-08	9.8189E+16	6.9761E+12
Y-90	9.1672E+00	1.6849E-08	1.1274E+17	3.3919E+11
Y-91	6.2314E+00	2.5410E-07	1.6815E+18	2.3056E+11
Y-92	9.3125E+01	9.6780E-09	6.3350E+16	3.4456E+12
Y-93	4.2882E+00	1.2853E-09	8.3228E+15	1.5866E+11
Zr-95	7.8835E+00	3.6697E-07	2.3262E+18	2.9169E+11

Zr-97	5.7714E+00	3.0190E-09	1.8743E+16	2.1354E+11
Nb-95	8.0552E+00	2.0600E-07	1.3058E+18	2.9804E+11
Mo-99	8.6517E+01	1.8039E-07	1.0973E+18	3.2011E+12
Tc-99m	7.9003E+01	1.5025E-08	9.1394E+16	2.9231E+12
Ru-103	8.1687E+01	2.5310E-06	1.4798E+19	3.0224E+12
Ru-105	2.4780E+01	3.6864E-09	2.1143E+16	9.1687E+11
Ru-106	3.0576E+01	9.1392E-06	5.1922E+19	1.1313E+12
Rh-105	4.3931E+01	5.2048E-08	2.9851E+17	1.6254E+12
Sb-127	9.7565E+01	3.6534E-07	1.7324E+18	3.6099E+12
Sb-129	1.5218E+02	2.7061E-08	1.2633E+17	5.6305E+12
Te-127	1.0066E+02	3.8141E-08	1.8086E+17	3.7244E+12
Te-127m	1.5263E+01	1.6181E-06	7.6729E+18	5.6473E+11
Te-129	2.0109E+02	9.6023E-09	4.4827E+16	7.4405E+12
Te-129m	6.4348E+01	2.1360E-06	9.9716E+18	2.3809E+12
Te-131m	1.6317E+02	2.0463E-07	9.4069E+17	6.0374E+12
Te-132	1.3193E+03	4.3457E-06	1.9826E+19	4.8815E+13
I-131	2.5004E+04	2.0169E-04	9.2718E+20	9.2516E+14
I-132	6.9788E+03	6.7610E-07	3.0845E+18	2.5822E+14
I-133	1.7107E+04	1.5101E-05	6.8378E+19	6.3296E+14
I-134	1.7994E+03	6.7451E-08	3.0314E+17	6.6577E+13
I-135	1.1131E+04	3.1695E-06	1.4139E+19	4.1185E+14
Xe-133	4.9970E+07	2.6696E-01	1.2088E+24	1.8489E+18
Xe-135	9.5757E+05	3.7497E-04	1.6727E+21	3.5430E+16
Cs-134	1.1936E+03	9.2254E-04	4.1460E+21	4.4163E+13
Cs-136	3.7722E+02	5.1468E-06	2.2790E+19	1.3957E+13
Cs-137	8.4633E+02	9.7300E-03	4.2770E+22	3.1314E+13
Ba-139	1.1678E+02	7.1396E-09	3.0932E+16	4.3210E+12
Ba-140	7.4520E+02	1.0179E-05	4.3786E+19	2.7573E+13
La-140	1.1380E+02	2.0475E-07	8.8072E+17	4.2107E+12
La-141	3.0525E+00	5.3975E-10	2.3053E+15	1.1294E+11
La-142	1.2181E+00	8.5091E-11	3.6087E+14	4.5069E+10
Ce-141	1.8019E+01	6.3240E-07	2.7010E+18	6.6672E+11
Ce-143	1.3578E+01	2.0446E-08	8.6104E+16	5.0238E+11
Ce-144	1.5640E+01	4.9036E-06	2.0507E+19	5.7868E+11
Pr-143	6.5331E+00	9.7019E-08	4.0857E+17	2.4173E+11
Nd-147	2.7165E+00	3.3579E-08	1.3756E+17	1.0051E+11
Np-239	1.7471E+02	7.5310E-07	1.8976E+18	6.4644E+12
Pu-238	1.1573E-01	6.7603E-06	1.7106E+19	4.2821E+09
Pu-239	5.1020E-03	8.2082E-05	2.0682E+20	1.8877E+08
Pu-240	7.1377E-03	3.1324E-05	7.8599E+19	2.6409E+08
Pu-241	1.8355E+00	1.7818E-05	4.4524E+19	6.7913E+10
Am-241	9.1602E-04	2.6689E-07	6.6691E+17	3.3893E+07
Cm-242	2.0188E-01	6.0911E-08	1.5158E+17	7.4694E+09
Cm-244	9.3999E-03	1.1619E-07	2.8676E+17	3.4779E+08

##
I-131 Summary
##

	DW	Torus	RB
Time (hr)	I-131 (Curies)	I-131 (Curies)	I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00

0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	1.3676E+06	0.0000E+00	7.3635E+01
0.500	4.2291E+06	0.0000E+00	7.3149E+02
0.533	4.4754E+06	0.0000E+00	8.2206E+02
0.533	4.4784E+06	0.0000E+00	8.2298E+02
0.900	9.6128E+06	0.0000E+00	2.3163E+03
1.200	1.3664E+07	0.0000E+00	4.1448E+03
1.500	1.7281E+07	0.0000E+00	6.2538E+03
1.800	2.0509E+07	0.0000E+00	8.4754E+03
2.000	2.2466E+07	0.0000E+00	9.9629E+03
2.033	2.2775E+07	0.0000E+00	1.0207E+04
2.033	2.2440E+07	3.3281E+05	1.0209E+04
2.400	1.0875E+07	8.2496E+06	1.2018E+04
2.700	9.0685E+06	6.8789E+06	1.2232E+04
3.000	7.5625E+06	5.7365E+06	1.1772E+04
3.300	6.3074E+06	4.7844E+06	1.0934E+04
3.500	5.5891E+06	4.2395E+06	1.0265E+04
3.800	4.6626E+06	3.5367E+06	9.1945E+03
4.000	4.1324E+06	3.1345E+06	8.4741E+03
4.300	3.4487E+06	2.6158E+06	7.4272E+03
4.600	2.8788E+06	2.1835E+06	6.4510E+03
4.900	2.4038E+06	1.8232E+06	5.5638E+03
5.033	2.2194E+06	1.6833E+06	5.2008E+03
5.400	1.9449E+06	1.4694E+06	4.3366E+03
5.700	1.7439E+06	1.3174E+06	3.7670E+03
6.000	1.5639E+06	1.1815E+06	3.2914E+03
6.300	1.4028E+06	1.0597E+06	2.8899E+03
6.600	1.2586E+06	9.5076E+05	2.5479E+03
6.900	1.1295E+06	8.5322E+05	2.2541E+03
7.200	1.0139E+06	7.6589E+05	1.9999E+03
7.500	9.1041E+05	6.8772E+05	1.7785E+03
7.800	8.1778E+05	6.1774E+05	1.5848E+03
8.000	7.6149E+05	5.7521E+05	1.4689E+03
8.300	6.8447E+05	5.1702E+05	1.3123E+03
8.367	6.6840E+05	5.0488E+05	1.2799E+03
8.667	6.0921E+05	4.5982E+05	1.1469E+03
8.967	5.5530E+05	4.1912E+05	1.0313E+03
9.300	5.0128E+05	3.7834E+05	9.1967E+02
9.600	4.5735E+05	3.4517E+05	8.3158E+02
9.900	4.1748E+05	3.1508E+05	7.5341E+02
10.200	3.8131E+05	2.8776E+05	6.8374E+02
12.033	2.2249E+05	1.6786E+05	3.8816E+02
19.478	4.5793E+04	3.4464E+04	6.8481E+01
24.000	3.0543E+04	2.2956E+04	4.1738E+01
24.033	3.0488E+04	2.2914E+04	4.1644E+01
96.000	2.1688E+04	1.6286E+04	2.7961E+01
240.000	1.0956E+04	8.2274E+03	1.4125E+01
264.000	4.7667E+03	3.5771E+03	6.3106E+00
480.000	1.7107E+03	1.2846E+03	2.2055E+00
504.000	7.4427E+02	5.5853E+02	9.8534E-01
696.000	2.9930E+02	2.2476E+02	3.8588E-01
720.000	1.3022E+02	9.7723E+01	1.7240E-01
	SR	Condenser	TB

Time (hr)	I-131 (Curies)	I-131 (Curies)	I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	2.0250E-01	1.4886E-01	8.2642E-05
0.500	2.5662E+00	1.7383E+00	2.5651E-04
0.533	2.9032E+00	1.9848E+00	2.7153E-04
0.533	2.9067E+00	1.9873E+00	2.7170E-04
0.900	8.4004E+00	6.3260E+00	5.8387E-04
1.200	1.5281E+01	1.2371E+01	8.3139E-04
1.500	2.3303E+01	2.0548E+01	1.0536E-03
1.800	3.1805E+01	3.0747E+01	1.2531E-03
2.000	3.7517E+01	3.8620E+01	1.3748E-03
2.033	3.8455E+01	3.9999E+01	1.3941E-03
2.033	3.8464E+01	4.0013E+01	1.3826E-03
2.400	4.5868E+01	4.8855E+01	6.7741E-04
2.700	4.7013E+01	5.5391E+01	5.7128E-04
3.000	4.5474E+01	6.1494E+01	4.8303E-04
3.300	4.2420E+01	6.7233E+01	4.0970E-04
3.500	3.9931E+01	7.0887E+01	3.6785E-04
3.800	3.5908E+01	7.6146E+01	3.1404E-04
4.000	3.3186E+01	7.9522E+01	2.8337E-04
4.300	2.9215E+01	8.4421E+01	2.4399E-04
4.600	2.5500E+01	8.9148E+01	2.1137E-04
4.900	2.2117E+01	9.3730E+01	1.8439E-04
5.033	2.0731E+01	9.5721E+01	1.7398E-04
5.400	1.7410E+01	1.0113E+02	1.5928E-04
5.700	1.5221E+01	1.0548E+02	1.4863E-04
6.000	1.3395E+01	1.0976E+02	1.3923E-04
6.300	1.1855E+01	1.1399E+02	1.3093E-04
6.600	1.0543E+01	1.1817E+02	1.2364E-04
6.900	9.4165E+00	1.2231E+02	1.1723E-04
7.200	8.4419E+00	1.2639E+02	1.1162E-04
7.500	7.5935E+00	1.3044E+02	1.0672E-04
7.800	6.8512E+00	1.3446E+02	1.0246E-04
8.000	6.4071E+00	1.3711E+02	9.9941E-05
8.300	5.8073E+00	1.4107E+02	9.6597E-05
8.367	5.6832E+00	1.4195E+02	9.5917E-05
8.667	5.1725E+00	1.4587E+02	9.3628E-05
8.967	4.7288E+00	1.4976E+02	9.1648E-05
9.300	4.3005E+00	1.5405E+02	8.9790E-05
9.600	3.9625E+00	1.5789E+02	8.8391E-05
9.900	3.6626E+00	1.6171E+02	8.7228E-05
10.200	3.3952E+00	1.6551E+02	8.6279E-05
12.033	2.2596E+00	1.8830E+02	8.4075E-05
19.478	1.0125E+00	2.7527E+02	1.0137E-04
24.000	8.9457E-01	3.2452E+02	1.1623E-04
24.033	8.9410E-01	3.2487E+02	1.1634E-04
96.000	6.2937E-01	8.3539E+02	2.7876E-04
240.000	3.1794E-01	9.8295E+02	3.2276E-04
264.000	5.1107E+00	9.2802E+02	3.0271E-04
480.000	4.9643E-02	4.1873E+02	1.3643E-04
504.000	7.9798E-01	3.7714E+02	1.2259E-04
696.000	8.6856E-03	1.5191E+02	4.9381E-05

720.000	1.3962E-01	1.3485E+02	4.3784E-05

Time (hr)	Dummy I-131 (Curies)	CR I-131 (Curies)	Environment I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	3.3780E-02	1.4681E-07	3.4774E-01
0.500	3.8643E-01	6.3566E-06	1.7538E+01
0.533	4.4022E-01	7.6450E-06	2.1412E+01
0.533	4.4078E-01	7.6585E-06	2.1453E+01
0.900	1.3967E+00	3.2353E-05	1.0544E+02
1.200	2.7333E+00	7.0870E-05	2.5630E+02
1.500	4.5296E+00	1.2564E-04	5.0403E+02
1.800	6.7463E+00	1.9286E-04	8.5877E+02
2.000	8.4389E+00	2.4237E-04	1.1565E+03
2.033	8.7338E+00	2.3491E-04	1.2103E+03
2.033	8.7367E+00	2.3484E-04	1.2109E+03
2.400	1.0682E+01	1.8571E-04	1.8846E+03
2.700	1.2035E+01	1.6965E-04	2.4866E+03
3.000	1.3209E+01	1.6001E-04	3.0845E+03
3.300	1.4226E+01	1.5118E-04	3.6519E+03
3.500	1.4824E+01	1.4475E-04	4.0057E+03
3.800	1.5618E+01	3.9913E-02	4.4944E+03
4.000	1.6085E+01	5.3658E-02	4.7911E+03
4.300	1.6703E+01	3.0182E-02	5.1929E+03
4.600	1.7237E+01	1.6991E-02	5.5450E+03
4.900	1.7697E+01	9.5768E-03	5.8513E+03
5.033	1.7881E+01	7.4313E-03	5.9737E+03
5.400	1.8346E+01	3.6999E-03	6.2732E+03
5.700	1.8688E+01	2.1008E-03	6.4829E+03
6.000	1.9001E+01	1.1998E-03	6.6669E+03
6.300	1.9289E+01	6.9143E-04	6.8293E+03
6.600	1.9556E+01	4.0390E-04	6.9734E+03
6.900	1.9803E+01	2.4071E-04	7.1017E+03
7.200	2.0035E+01	1.4760E-04	7.2166E+03
7.500	2.0251E+01	9.4034E-05	7.3198E+03
7.800	2.0455E+01	6.2845E-05	7.4127E+03
8.000	2.0585E+01	4.9509E-05	7.4697E+03
8.300	2.0772E+01	3.3432E-05	7.5620E+03
8.367	2.0812E+01	3.0857E-05	7.5814E+03
8.667	2.0989E+01	2.2327E-05	7.6634E+03
8.967	2.1159E+01	1.7097E-05	7.7381E+03
9.300	2.1341E+01	1.3487E-05	7.8138E+03
9.600	2.1500E+01	1.1372E-05	7.8760E+03
9.900	2.1655E+01	9.8857E-06	7.9334E+03
10.200	2.1807E+01	8.7848E-06	7.9864E+03
12.033	2.2682E+01	5.2815E-06	8.2384E+03
19.478	2.6287E+01	2.0022E-06	8.7390E+03
24.000	2.8869E+01	1.7076E-06	8.9321E+03
24.033	2.8889E+01	1.6328E-06	8.9335E+03
96.000	1.0432E+02	3.4546E-07	1.1365E+04
240.000	2.8014E+02	2.9402E-08	1.4323E+04
264.000	3.0346E+02	4.5765E-07	2.2529E+04

480.000	3.1993E+02	4.5909E-09	2.3376E+04
504.000	3.1187E+02	7.1457E-08	2.4657E+04
696.000	2.2012E+02	8.0324E-10	2.4780E+04
720.000	2.0844E+02	1.2502E-08	2.5004E+04

##

Cumulative Dose Summary

##

	Control_Room		EAB		LPZ	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.001	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.167	1.8954E-06	7.3587E-08	0.0000E+00	0.0000E+00	2.1104E-04	1.0226E-05
0.500	2.5900E-04	1.0044E-05	0.0000E+00	0.0000E+00	1.0611E-02	5.0997E-04
0.533	3.3369E-04	1.2939E-05	0.0000E+00	0.0000E+00	1.2949E-02	6.2162E-04
0.533	3.3451E-04	1.2970E-05	0.0000E+00	0.0000E+00	1.2974E-02	6.2281E-04
0.900	2.5069E-03	9.8210E-05	0.0000E+00	0.0000E+00	6.3696E-02	3.1500E-03
1.200	7.3893E-03	3.0139E-04	0.0000E+00	0.0000E+00	1.5524E-01	8.2727E-03
1.500	1.6841E-02	7.1824E-04	0.0000E+00	0.0000E+00	3.0590E-01	1.7284E-02
1.800	3.2273E-02	1.4276E-03	0.0000E+00	0.0000E+00	5.2166E-01	3.0665E-02
2.000	4.6385E-02	2.0922E-03	0.0000E+00	0.0000E+00	7.0261E-01	4.2091E-02
2.033	4.8938E-02	2.2135E-03	3.4419E-02	2.1827E-03	7.1924E-01	4.3145E-02
2.033	4.8963E-02	2.2147E-03	3.4767E-02	2.2048E-03	7.1941E-01	4.3156E-02
2.400	7.3465E-02	3.3854E-03	4.6521E-01	2.9793E-02	9.2739E-01	5.6486E-02
2.700	9.0611E-02	4.2155E-03	8.4875E-01	5.4700E-02	1.1127E+00	6.8521E-02
3.000	1.0654E-01	4.9950E-03	1.2286E+00	7.9669E-02	1.2963E+00	8.0586E-02
3.300	1.2156E-01	5.7361E-03	1.5879E+00	1.0361E-01	1.4699E+00	9.2155E-02
3.500	1.3106E-01	6.2074E-03	1.8115E+00	1.1870E-01	1.5779E+00	9.9444E-02
3.800	2.2581E+00	1.1299E-01	7.8932E+00	5.3507E-01	4.8387E+00	3.2269E-01
4.000	5.2804E+00	2.6486E-01	1.1576E+01	7.9128E-01	6.8132E+00	4.6006E-01
4.300	9.1956E+00	4.6167E-01	1.1576E+01	7.9128E-01	6.9349E+00	4.6868E-01
4.600	1.1392E+01	5.7207E-01	1.1576E+01	7.9128E-01	7.0413E+00	4.7639E-01
4.900	1.2625E+01	6.3408E-01	1.1576E+01	7.9128E-01	7.1335E+00	4.8326E-01
5.033	1.2982E+01	6.5201E-01	1.1576E+01	7.9128E-01	7.1702E+00	4.8605E-01
5.400	1.3603E+01	6.8325E-01	1.1576E+01	7.9128E-01	7.2600E+00	4.9305E-01
5.700	1.3870E+01	6.9670E-01	1.1576E+01	7.9128E-01	7.3226E+00	4.9809E-01
6.000	1.4022E+01	7.0433E-01	1.1576E+01	7.9128E-01	7.3774E+00	5.0264E-01
6.300	1.4109E+01	7.0870E-01	1.1576E+01	7.9128E-01	7.4256E+00	5.0675E-01
6.600	1.4159E+01	7.1123E-01	1.1576E+01	7.9128E-01	7.4682E+00	5.1048E-01
6.900	1.4188E+01	7.1271E-01	1.1576E+01	7.9128E-01	7.5061E+00	5.1389E-01
7.200	1.4206E+01	7.1361E-01	1.1576E+01	7.9128E-01	7.5399E+00	5.1701E-01
7.500	1.4217E+01	7.1417E-01	1.1576E+01	7.9128E-01	7.5701E+00	5.1988E-01
7.800	1.4224E+01	7.1453E-01	1.1576E+01	7.9128E-01	7.5973E+00	5.2252E-01
8.000	1.4227E+01	7.1470E-01	1.1576E+01	7.9128E-01	7.6139E+00	5.2416E-01
8.300	1.4231E+01	7.1489E-01	1.1576E+01	7.9128E-01	7.6238E+00	5.2556E-01
8.367	1.4232E+01	7.1493E-01	1.1576E+01	7.9128E-01	7.6259E+00	5.2586E-01
8.667	1.4234E+01	7.1505E-01	1.1576E+01	7.9128E-01	7.6346E+00	5.2715E-01
8.967	1.4236E+01	7.1514E-01	1.1576E+01	7.9128E-01	7.6425E+00	5.2836E-01
9.300	1.4238E+01	7.1522E-01	1.1576E+01	7.9128E-01	7.6506E+00	5.2961E-01
9.600	1.4239E+01	7.1528E-01	1.1576E+01	7.9128E-01	7.6571E+00	5.3067E-01
9.900	1.4240E+01	7.1533E-01	1.1576E+01	7.9128E-01	7.6632E+00	5.3167E-01

```
 10.200 1.4241E+01 7.1537E-01 1.1576E+01 7.9128E-01 7.6687E+00 5.3261E-01
 12.033 1.4244E+01 7.1556E-01 1.1576E+01 7.9128E-01 7.6949E+00 5.3743E-01
 19.478 1.4251E+01 7.1586E-01 1.1576E+01 7.9128E-01 7.7452E+00 5.4885E-01
 24.000 1.4253E+01 7.1595E-01 1.1576E+01 7.9128E-01 7.7637E+00 5.5309E-01
 24.033 1.4253E+01 7.1595E-01 1.1576E+01 7.9128E-01 7.7638E+00 5.5310E-01
 96.000 1.4258E+01 7.1611E-01 1.1576E+01 7.9128E-01 7.8924E+00 5.6991E-01
240.000 1.4258E+01 7.1613E-01 1.1576E+01 7.9128E-01 7.9435E+00 5.7540E-01
264.000 1.4260E+01 7.1618E-01 1.1576E+01 7.9128E-01 8.0845E+00 5.8896E-01
480.000 1.4260E+01 7.1618E-01 1.1576E+01 7.9128E-01 8.0990E+00 5.9022E-01
504.000 1.4260E+01 7.1619E-01 1.1576E+01 7.9128E-01 8.1210E+00 5.9187E-01
696.000 1.4260E+01 7.1619E-01 1.1576E+01 7.9128E-01 8.1232E+00 5.9203E-01
720.000 1.4260E+01 7.1620E-01 1.1576E+01 7.9128E-01 8.1270E+00 5.9228E-01

####################################################################
                       Worst Two-Hour Doses
   Note: All of the dose locations are shown below but the
         worst two-hour dose is only meaningful for the EAB
         dose location.  Please disregard the two-hour worst
         doses for the other dose locations
####################################################################

Control_Room
   Time   Whole Body    Thyroid       TEDE
   (hr)     (rem)        (rem)        (rem)
    3.5   1.3189E-02   1.3561E+01   6.8152E-01

EAB
   Time   Whole Body    Thyroid       TEDE
   (hr)     (rem)        (rem)        (rem)
    2.0   2.2252E-01   1.1576E+01   7.9128E-01

LPZ
   Time   Whole Body    Thyroid       TEDE
   (hr)     (rem)        (rem)        (rem)
    2.0   1.1770E-01   6.1106E+00   4.1797E-01
```

RUN B3 – TBROOF.O0

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

                    DW                    Torus                  RB
Time (hr)     I-131 (Curies)        I-131 (Curies)        I-131 (Curies)
   0.001        0.0000E+00            0.0000E+00            0.0000E+00
   0.033        0.0000E+00            0.0000E+00            0.0000E+00
   0.033        0.0000E+00            0.0000E+00            0.0000E+00
   0.167        1.3676E+06            0.0000E+00            7.3635E+01
   0.500        4.2291E+06            0.0000E+00            7.3149E+02
   0.533        4.4754E+06            0.0000E+00            8.2206E+02
   0.533        4.4784E+06            0.0000E+00            8.2298E+02
   0.900        9.6128E+06            0.0000E+00            2.3163E+03
   1.200        1.3664E+07            0.0000E+00            4.1448E+03
   1.500        1.7281E+07            0.0000E+00            6.2538E+03
```

1.800	2.0509E+07	0.0000E+00	8.4754E+03
2.000	2.2466E+07	0.0000E+00	9.9629E+03
2.033	2.2775E+07	0.0000E+00	1.0207E+04
2.033	2.2440E+07	3.3281E+05	1.0209E+04
2.400	1.0875E+07	8.2496E+06	1.2018E+04
2.700	9.0685E+06	6.8789E+06	1.2232E+04
3.000	7.5625E+06	5.7365E+06	1.1772E+04
3.300	6.3074E+06	4.7844E+06	1.0934E+04
3.600	5.2613E+06	3.9909E+06	9.9135E+03
3.900	4.3895E+06	3.3295E+06	8.8332E+03
4.000	4.1324E+06	3.1345E+06	8.4741E+03
4.300	3.4487E+06	2.6158E+06	7.4272E+03
4.600	2.8788E+06	2.1835E+06	6.4510E+03
4.900	2.4038E+06	1.8232E+06	5.5638E+03
5.033	2.2194E+06	1.6833E+06	5.2008E+03
5.400	1.9449E+06	1.4694E+06	4.3366E+03
5.700	1.7439E+06	1.3174E+06	3.7670E+03
6.000	1.5639E+06	1.1815E+06	3.2914E+03
6.300	1.4028E+06	1.0597E+06	2.8899E+03
6.600	1.2586E+06	9.5076E+05	2.5479E+03
6.900	1.1295E+06	8.5322E+05	2.2541E+03
7.200	1.0139E+06	7.6589E+05	1.9999E+03
7.500	9.1041E+05	6.8772E+05	1.7785E+03
7.800	8.1778E+05	6.1774E+05	1.5848E+03
8.000	7.6149E+05	5.7521E+05	1.4689E+03
8.300	6.8447E+05	5.1702E+05	1.3123E+03
8.367	6.6840E+05	5.0488E+05	1.2799E+03
8.667	6.0921E+05	4.5982E+05	1.1469E+03
8.967	5.5530E+05	4.1912E+05	1.0313E+03
9.300	5.0128E+05	3.7834E+05	9.1967E+02
9.600	4.5735E+05	3.4517E+05	8.3158E+02
9.900	4.1748E+05	3.1508E+05	7.5341E+02
10.200	3.8131E+05	2.8776E+05	6.8374E+02
12.033	2.2249E+05	1.6786E+05	3.8816E+02
19.478	4.5793E+04	3.4464E+04	6.8481E+01
24.000	3.0543E+04	2.2956E+04	4.1738E+01
24.033	3.0488E+04	2.2914E+04	4.1644E+01
96.000	2.1688E+04	1.6286E+04	2.7961E+01
240.000	1.0956E+04	8.2274E+03	1.4125E+01
264.000	4.7667E+03	3.5771E+03	6.3106E+00
480.000	1.7107E+03	1.2846E+03	2.2055E+00
504.000	7.4427E+02	5.5853E+02	9.8534E-01
696.000	2.9930E+02	2.2476E+02	3.8588E-01
720.000	1.3022E+02	9.7723E+01	1.7240E-01

Time (hr)	SR I-131 (Curies)	Condenser I-131 (Curies)	TB I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	2.0250E-01	1.4886E-01	8.2642E-05
0.500	2.5662E+00	1.7383E+00	2.5651E-04
0.533	2.9032E+00	1.9848E+00	2.7153E-04
0.533	2.9067E+00	1.9873E+00	2.7170E-04

0.900	8.4004E+00	6.3260E+00	5.8387E-04
1.200	1.5281E+01	1.2371E+01	8.3139E-04
1.500	2.3303E+01	2.0548E+01	1.0536E-03
1.800	3.1805E+01	3.0747E+01	1.2531E-03
2.000	3.7517E+01	3.8620E+01	1.3748E-03
2.033	3.8455E+01	3.9999E+01	1.3941E-03
2.033	3.8464E+01	4.0013E+01	1.3826E-03
2.400	4.5868E+01	4.8855E+01	6.7741E-04
2.700	4.7013E+01	5.5391E+01	5.7128E-04
3.000	4.5474E+01	6.1494E+01	4.8303E-04
3.300	4.2420E+01	6.7233E+01	4.0970E-04
3.600	3.8613E+01	7.2668E+01	3.4879E-04
3.900	3.4544E+01	7.7846E+01	2.9823E-04
4.000	3.3186E+01	7.9522E+01	2.8337E-04
4.300	2.9215E+01	8.4421E+01	2.4399E-04
4.600	2.5500E+01	8.9148E+01	2.1137E-04
4.900	2.2117E+01	9.3730E+01	1.8439E-04
5.033	2.0731E+01	9.5721E+01	1.7398E-04
5.400	1.7410E+01	1.0113E+02	1.5928E-04
5.700	1.5221E+01	1.0548E+02	1.4863E-04
6.000	1.3395E+01	1.0976E+02	1.3923E-04
6.300	1.1855E+01	1.1399E+02	1.3093E-04
6.600	1.0543E+01	1.1817E+02	1.2364E-04
6.900	9.4165E+00	1.2231E+02	1.1723E-04
7.200	8.4419E+00	1.2639E+02	1.1162E-04
7.500	7.5935E+00	1.3044E+02	1.0672E-04
7.800	6.8512E+00	1.3446E+02	1.0246E-04
8.000	6.4071E+00	1.3711E+02	9.9941E-05
8.300	5.8073E+00	1.4107E+02	9.6597E-05
8.367	5.6832E+00	1.4195E+02	9.5917E-05
8.667	5.1725E+00	1.4587E+02	9.3628E-05
8.967	4.7288E+00	1.4976E+02	9.1648E-05
9.300	4.3005E+00	1.5405E+02	8.9790E-05
9.600	3.9625E+00	1.5789E+02	8.8391E-05
9.900	3.6626E+00	1.6171E+02	8.7228E-05
10.200	3.3952E+00	1.6551E+02	8.6279E-05
12.033	2.2596E+00	1.8830E+02	8.4075E-05
19.478	1.0125E+00	2.7527E+02	1.0137E-04
24.000	8.9457E-01	3.2452E+02	1.1623E-04
24.033	8.9410E-01	3.2487E+02	1.1634E-04
96.000	6.2937E-01	8.3539E+02	2.7876E-04
240.000	3.1794E-01	9.8295E+02	3.2276E-04
264.000	5.1107E+00	9.2802E+02	3.0271E-04
480.000	4.9643E-02	4.1873E+02	1.3643E-04
504.000	7.9798E-01	3.7714E+02	1.2259E-04
696.000	8.6856E-03	1.5191E+02	4.9381E-05
720.000	1.3962E-01	1.3485E+02	4.3784E-05

Time (hr)	Dummy I-131 (Curies)	CR I-131 (Curies)	Environment I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	3.4788E-01	3.1562E-05	3.3641E-02

0.500	1.7540E+01	2.9123E-04	3.7950E-01
0.533	2.1414E+01	3.2505E-04	4.3178E-01
0.533	2.1455E+01	3.2539E-04	4.3231E-01
0.900	1.0541E+02	8.6773E-04	1.3553E+00
1.200	2.5618E+02	1.4950E-03	2.6328E+00
1.500	5.0365E+02	2.1732E-03	4.3325E+00
1.800	8.5788E+02	2.8467E-03	6.4114E+00
2.000	1.1551E+03	3.2788E-03	7.9887E+00
2.033	1.2088E+03	3.3105E-03	8.2628E+00
2.033	1.2093E+03	3.3108E-03	8.2655E+00
2.400	1.8815E+03	2.6803E-03	9.9512E+00
2.700	2.4815E+03	2.2474E-03	1.1072E+01
3.000	3.0768E+03	1.8888E-03	1.2018E+01
3.300	3.6409E+03	1.5915E-03	1.2819E+01
3.600	4.1595E+03	1.3448E-03	1.3500E+01
3.900	4.6265E+03	1.1401E-03	1.4081E+01
4.000	4.7703E+03	1.0799E-03	1.4255E+01
4.300	5.1670E+03	9.2028E-04	1.4729E+01
4.600	5.5137E+03	7.8789E-04	1.5138E+01
4.900	5.8142E+03	6.7816E-04	1.5493E+01
5.033	5.9338E+03	6.3575E-04	1.5636E+01
5.400	6.2256E+03	5.4376E-04	1.6003E+01
5.700	6.4288E+03	4.8959E-04	1.6280E+01
6.000	6.6059E+03	4.4721E-04	1.6538E+01
6.300	6.7613E+03	4.1286E-04	1.6781E+01
6.600	6.8982E+03	3.8426E-04	1.7010E+01
6.900	7.0193E+03	3.6004E-04	1.7227E+01
7.200	7.1267E+03	3.3926E-04	1.7433E+01
7.500	7.2223E+03	3.2133E-04	1.7629E+01
7.800	7.3076E+03	3.0581E-04	1.7817E+01
8.000	7.3593E+03	2.9662E-04	1.7939E+01
8.300	7.4438E+03	2.2231E-04	1.8115E+01
8.367	7.4615E+03	2.1052E-04	1.8154E+01
8.667	7.5355E+03	1.7200E-04	1.8325E+01
8.967	7.6023E+03	1.4916E-04	1.8491E+01
9.300	7.6689E+03	1.3415E-04	1.8672E+01
9.600	7.7231E+03	1.2590E-04	1.8833E+01
9.900	7.7723E+03	1.2055E-04	1.8991E+01
10.200	7.8170E+03	1.1696E-04	1.9147E+01
12.033	8.0176E+03	1.0943E-04	2.0079E+01
19.478	8.3025E+03	1.2923E-04	2.4141E+01
24.000	8.3620E+03	1.4840E-04	2.7087E+01
24.033	8.3624E+03	1.4487E-04	2.7110E+01
96.000	8.5977E+03	2.1758E-04	1.1757E+02
240.000	7.3747E+03	1.9487E-04	3.9376E+02
264.000	1.4599E+04	1.8301E-04	4.3889E+02
480.000	7.2714E+03	8.2492E-05	7.1085E+02
504.000	7.8939E+03	7.4161E-05	7.2948E+02
696.000	4.0452E+03	2.9872E-05	8.2206E+02
720.000	3.9251E+03	2.6492E-05	8.2876E+02

```
#######################################################################
                     Cumulative Dose Summary
#######################################################################
```

	Control_Room		EAB		LPZ	
Time	Thyroid	TEDE	Thyroid	TEDE	Thyroid	TEDE
(hr)	(rem)	(rem)	(rem)	(rem)	(rem)	(rem)
0.001	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.167	5.2449E-04	2.0642E-05	0.0000E+00	0.0000E+00	2.3684E-03	1.1659E-04
0.500	1.6412E-02	6.4546E-04	0.0000E+00	0.0000E+00	2.6647E-02	1.3126E-03
0.533	1.9702E-02	7.7474E-04	0.0000E+00	0.0000E+00	3.0307E-02	1.4926E-03
0.533	1.9737E-02	7.7611E-04	0.0000E+00	0.0000E+00	3.0345E-02	1.4944E-03
0.900	8.7376E-02	3.5566E-03	0.0000E+00	0.0000E+00	9.5488E-02	5.2084E-03
1.200	2.0227E-01	8.7576E-03	0.0000E+00	0.0000E+00	1.8629E-01	1.1150E-02
1.500	3.8201E-01	1.7356E-02	0.0000E+00	0.0000E+00	3.0716E-01	1.9459E-02
1.800	6.2837E-01	2.9526E-02	0.0000E+00	0.0000E+00	4.5479E-01	2.9908E-02
2.000	8.2856E-01	3.9589E-02	0.0000E+00	0.0000E+00	5.6663E-01	3.7961E-02
2.033	8.6404E-01	4.1384E-02	3.8811E-02	2.8075E-03	5.7642E-01	3.8669E-02
2.033	8.6440E-01	4.1402E-02	3.9200E-02	2.8356E-03	5.7652E-01	3.8676E-02
2.400	1.2222E+00	5.9600E-02	2.7749E-01	2.1323E-02	6.3664E-01	4.3340E-02
2.700	1.4617E+00	7.1881E-02	4.3527E-01	3.4377E-02	6.7644E-01	4.6634E-02
3.000	1.6622E+00	8.2215E-02	5.6801E-01	4.6050E-02	7.0993E-01	4.9579E-02
3.300	1.8304E+00	9.0924E-02	6.8000E-01	5.6565E-02	7.3819E-01	5.2232E-02
3.600	1.9718E+00	9.8278E-02	7.7480E-01	6.6108E-02	7.6210E-01	5.4639E-02
3.900	2.0911E+00	1.0450E-01	8.5537E-01	7.4832E-02	7.8243E-01	5.6840E-02
4.000	2.1266E+00	1.0636E-01	8.7950E-01	7.7580E-02	7.8852E-01	5.7534E-02
4.300	2.2222E+00	1.1137E-01	8.7950E-01	7.7580E-02	8.0501E-01	5.9507E-02
4.600	2.3035E+00	1.1565E-01	8.7950E-01	7.7580E-02	8.1919E-01	6.1340E-02
4.900	2.3731E+00	1.1931E-01	8.7950E-01	7.7580E-02	8.3147E-01	6.3053E-02
5.033	2.4007E+00	1.2077E-01	8.7950E-01	7.7580E-02	8.3639E-01	6.3778E-02
5.400	2.4685E+00	1.2435E-01	8.7950E-01	7.7580E-02	8.4898E-01	6.5707E-02
5.700	2.5171E+00	1.2692E-01	8.7950E-01	7.7580E-02	8.5845E-01	6.7218E-02
6.000	2.5609E+00	1.2923E-01	8.7950E-01	7.7580E-02	8.6727E-01	6.8676E-02
6.300	2.6011E+00	1.3135E-01	8.7950E-01	7.7580E-02	8.7552E-01	7.0082E-02
6.600	2.6382E+00	1.3330E-01	8.7950E-01	7.7580E-02	8.8326E-01	7.1442E-02
6.900	2.6726E+00	1.3511E-01	8.7950E-01	7.7580E-02	8.9056E-01	7.2759E-02
7.200	2.7049E+00	1.3679E-01	8.7950E-01	7.7580E-02	8.9747E-01	7.4036E-02
7.500	2.7353E+00	1.3837E-01	8.7950E-01	7.7580E-02	9.0404E-01	7.5275E-02
7.800	2.7641E+00	1.3985E-01	8.7950E-01	7.7580E-02	9.1031E-01	7.6479E-02
8.000	2.7824E+00	1.4080E-01	8.7950E-01	7.7580E-02	9.1434E-01	7.7264E-02
8.300	2.8058E+00	1.4199E-01	8.7950E-01	7.7580E-02	9.1648E-01	7.7995E-02
8.367	2.8102E+00	1.4222E-01	8.7950E-01	7.7580E-02	9.1695E-01	7.8155E-02
8.667	2.8275E+00	1.4309E-01	8.7950E-01	7.7580E-02	9.1900E-01	7.8866E-02
8.967	2.8419E+00	1.4382E-01	8.7950E-01	7.7580E-02	9.2100E-01	7.9563E-02
9.300	2.8561E+00	1.4452E-01	8.7950E-01	7.7580E-02	9.2316E-01	8.0319E-02
9.600	2.8677E+00	1.4510E-01	8.7950E-01	7.7580E-02	9.2507E-01	8.0987E-02
9.900	2.8787E+00	1.4563E-01	8.7950E-01	7.7580E-02	9.2695E-01	8.1642E-02
10.200	2.8893E+00	1.4615E-01	8.7950E-01	7.7580E-02	9.2880E-01	8.2285E-02
12.033	2.9497E+00	1.4898E-01	8.7950E-01	7.7580E-02	9.3971E-01	8.5990E-02
19.478	3.1967E+00	1.5937E-01	8.7950E-01	7.7580E-02	9.8578E-01	9.9089E-02
24.000	3.3687E+00	1.6604E-01	8.7950E-01	7.7580E-02	1.0180E+00	1.0623E-01
24.033	3.3695E+00	1.6607E-01	8.7950E-01	7.7580E-02	1.0181E+00	1.0625E-01
96.000	5.0946E+00	2.2689E-01	8.7950E-01	7.7580E-02	1.5532E+00	1.7292E-01
240.000	7.6617E+00	3.1393E-01	8.7950E-01	7.7580E-02	2.1042E+00	2.3162E-01
264.000	8.0796E+00	3.2789E-01	8.7950E-01	7.7580E-02	2.1939E+00	2.4023E-01

```
480.000 1.0599E+01 4.1138E-01 8.7950E-01 7.7580E-02 2.7339E+00 2.8607E-01
504.000 1.0771E+01 4.1707E-01 8.7950E-01 7.7580E-02 2.7709E+00 2.8877E-01
696.000 1.1630E+01 4.4540E-01 8.7950E-01 7.7580E-02 2.9548E+00 3.0107E-01
720.000 1.1692E+01 4.4746E-01 8.7950E-01 7.7580E-02 2.9681E+00 3.0187E-01

####################################################################
                        Worst Two-Hour Doses
    Note: All of the dose locations are shown below but the
          worst two-hour dose is only meaningful for the EAB
          dose location.  Please disregard the two-hour worst
          doses for the other dose locations
####################################################################

Control_Room
   Time    Whole Body    Thyroid        TEDE
   (hr)      (rem)        (rem)         (rem)
    1.3    1.8006E-03   1.5682E+00   7.9300E-02

EAB
   Time    Whole Body    Thyroid        TEDE
   (hr)      (rem)        (rem)         (rem)
    2.0    3.3437E-02   8.7950E-01   7.7580E-02

LPZ
   Time    Whole Body    Thyroid        TEDE
   (hr)      (rem)        (rem)         (rem)
    0.7    1.3227E-02   6.1649E-01   4.3451E-02
```

RUN B4 – STACKBASE_ESF.O0

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

Time (hr)	SP I-131 (Curies)	RB I-131 (Curies)	SR I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	2.8743E+06	1.0395E+01	1.9626E-01
0.500	1.0021E+07	1.1236E+02	2.6999E+00
0.533	1.0735E+07	1.2749E+02	3.0839E+00
0.900	2.2868E+07	3.7146E+02	9.2642E+00
1.200	3.3546E+07	6.7639E+02	1.7134E+01
1.500	4.4198E+07	1.0474E+03	2.6794E+01
1.800	5.4823E+07	1.4651E+03	3.7717E+01
2.000	6.1891E+07	1.7624E+03	4.5510E+01
2.033	6.3068E+07	1.8131E+03	4.6841E+01
2.400	6.5328E+07	2.3073E+03	6.0106E+01
2.700	6.5236E+07	2.5846E+03	6.7614E+01
3.000	6.5143E+07	2.7805E+03	7.2918E+01
3.300	6.5051E+07	2.9184E+03	7.6655E+01
3.600	6.4959E+07	3.0152E+03	7.9277E+01
3.900	6.4866E+07	3.0827E+03	8.1107E+01
4.000	6.4836E+07	3.1002E+03	8.1582E+01

4.300	6.4744E+07	3.1413E+03	8.2699E+01
4.600	6.4652E+07	3.1693E+03	8.3458E+01
4.900	6.4560E+07	3.1878E+03	8.3964E+01
5.200	6.4469E+07	3.1997E+03	8.4288E+01
5.500	6.4377E+07	3.2068E+03	8.4484E+01
5.800	6.4286E+07	3.2105E+03	8.4588E+01
6.100	6.4195E+07	3.2119E+03	8.4627E+01
6.400	6.4104E+07	3.2115E+03	8.4621E+01
6.700	6.4013E+07	3.2099E+03	8.4581E+01
7.000	6.3922E+07	3.2075E+03	8.4519E+01
7.300	6.3832E+07	3.2045E+03	8.4440E+01
7.600	6.3741E+07	3.2010E+03	8.4349E+01
7.900	6.3651E+07	3.1972E+03	8.4250E+01
8.000	6.3621E+07	3.1959E+03	8.4216E+01
8.300	6.3531E+07	3.1918E+03	8.4109E+01
8.600	6.3440E+07	3.1877E+03	8.3999E+01
8.900	6.3350E+07	3.1834E+03	8.3887E+01
9.200	6.3261E+07	3.1790E+03	8.3773E+01
9.500	6.3171E+07	3.1747E+03	8.3657E+01
9.800	6.3081E+07	3.1703E+03	8.3541E+01
10.100	6.2992E+07	3.1658E+03	8.3424E+01
10.400	6.2903E+07	3.1614E+03	8.3307E+01
24.000	5.8984E+07	2.9645E+03	7.8120E+01
96.000	4.1961E+07	2.1089E+03	5.5574E+01
720.000	2.1933E+06	1.1024E+02	2.9049E+00

Time (hr)	CR I-131 (Curies)	Environment I-131 (Curies)	Dummy I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	1.6205E-07	2.7055E-04	3.3466E-01
0.500	7.4772E-06	1.4494E-02	1.7924E+01
0.533	9.0686E-06	1.7838E-02	2.2059E+01
0.900	4.0324E-05	9.2002E-02	1.1374E+02
1.200	8.9902E-05	2.2764E-01	2.8134E+02
1.500	1.6242E-04	4.5509E-01	5.6231E+02
1.800	2.5529E-04	7.9012E-01	9.7599E+02
2.000	3.2670E-04	1.0788E+00	1.3324E+03
2.033	3.2743E-04	1.1323E+00	1.3983E+03
2.400	3.6427E-04	1.8177E+00	2.2440E+03
2.700	4.1156E-04	2.4851E+00	3.0668E+03
3.000	4.5815E-04	3.2185E+00	3.9704E+03
3.300	4.9846E-04	3.9985E+00	4.9307E+03
3.600	5.3104E-04	4.8113E+00	5.9305E+03
3.900	5.5630E-04	5.6471E+00	6.9575E+03
4.000	5.6327E-04	5.9295E+00	7.3044E+03
4.300	5.8049E-04	6.7854E+00	8.3548E+03
4.600	5.9308E-04	7.6509E+00	9.4161E+03
4.900	6.0213E-04	8.5229E+00	1.0484E+04
5.200	6.0849E-04	9.3992E+00	1.1557E+04
5.500	6.1287E-04	1.0278E+01	1.2631E+04
5.800	6.1579E-04	1.1159E+01	1.3706E+04
6.100	6.1765E-04	1.2040E+01	1.4781E+04
6.400	6.1873E-04	1.2921E+01	1.5855E+04

6.700	6.1926E-04	1.3802E+01	1.6927E+04
7.000	6.1939E-04	1.4683E+01	1.7998E+04
7.300	6.1922E-04	1.5563E+01	1.9067E+04
7.600	6.1886E-04	1.6442E+01	2.0133E+04
7.900	6.1835E-04	1.7320E+01	2.1197E+04
8.000	6.1815E-04	1.7612E+01	2.1551E+04
8.300	4.6800E-04	1.8489E+01	2.2612E+04
8.600	3.8350E-04	1.9364E+01	2.3670E+04
8.900	3.3588E-04	2.0238E+01	2.4726E+04
9.200	3.0897E-04	2.1111E+01	2.5779E+04
9.500	2.9369E-04	2.1983E+01	2.6829E+04
9.800	2.8494E-04	2.2854E+01	2.7877E+04
10.100	2.7986E-04	2.3723E+01	2.8922E+04
10.400	2.7684E-04	2.4592E+01	2.9964E+04
24.000	2.5644E-04	6.2637E+01	7.4523E+04
96.000	1.2917E-04	2.2786E+02	2.3664E+05
720.000	5.1514E-06	6.1383E+02	1.3853E+05

##
Cumulative Dose Summary
##

	Control_Room		EAB		LPZ	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.001	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.167	2.0754E-06	6.6131E-08	0.0000E+00	0.0000E+00	1.8917E-05	6.8703E-07
0.500	2.9787E-04	9.4707E-06	0.0000E+00	0.0000E+00	1.0102E-03	3.6258E-05
0.533	3.8645E-04	1.2284E-05	0.0000E+00	0.0000E+00	1.2427E-03	4.4540E-05
0.900	3.0336E-03	9.6234E-05	0.0000E+00	0.0000E+00	6.3860E-03	2.2653E-04
1.200	9.1008E-03	2.8831E-04	0.0000E+00	0.0000E+00	1.5754E-02	5.5551E-04
1.500	2.0979E-02	6.6379E-04	0.0000E+00	0.0000E+00	3.1405E-02	1.1022E-03
1.800	4.0696E-02	1.2863E-03	0.0000E+00	0.0000E+00	5.4374E-02	1.9009E-03
2.000	5.9050E-02	1.8653E-03	0.0000E+00	0.0000E+00	7.4111E-02	2.5852E-03
2.033	6.2487E-02	1.9737E-03	7.2907E-03	2.5230E-04	7.5950E-02	2.6489E-03
2.400	1.0201E-01	3.2191E-03	1.0065E-01	3.4785E-03	9.9503E-02	3.4628E-03
2.700	1.3846E-01	4.3666E-03	1.9120E-01	6.5971E-03	1.2235E-01	4.2496E-03
3.000	1.7925E-01	5.6497E-03	2.9038E-01	1.0002E-02	1.4737E-01	5.1087E-03
3.300	2.2398E-01	7.0558E-03	3.9552E-01	1.3602E-02	1.7390E-01	6.0169E-03
3.600	2.7197E-01	8.5631E-03	5.0472E-01	1.7331E-02	2.0145E-01	6.9577E-03
3.900	3.2248E-01	1.0149E-02	6.1666E-01	2.1144E-02	2.2969E-01	7.9197E-03
4.000	3.3977E-01	1.0691E-02	6.5441E-01	2.2428E-02	2.3921E-01	8.2437E-03
4.300	3.9267E-01	1.2350E-02	6.5441E-01	2.2428E-02	2.6801E-01	9.2222E-03
4.600	4.4678E-01	1.4047E-02	6.5441E-01	2.2428E-02	2.9705E-01	1.0207E-02
4.900	5.0171E-01	1.5768E-02	6.5441E-01	2.2428E-02	3.2622E-01	1.1195E-02
5.200	5.5719E-01	1.7505E-02	6.5441E-01	2.2428E-02	3.5544E-01	1.2183E-02
5.500	6.1299E-01	1.9251E-02	6.5441E-01	2.2428E-02	3.8467E-01	1.3170E-02
5.800	6.6896E-01	2.1003E-02	6.5441E-01	2.2428E-02	4.1387E-01	1.4154E-02
6.100	7.2499E-01	2.2755E-02	6.5441E-01	2.2428E-02	4.4301E-01	1.5136E-02
6.400	7.8100E-01	2.4506E-02	6.5441E-01	2.2428E-02	4.7207E-01	1.6114E-02
6.700	8.3692E-01	2.6253E-02	6.5441E-01	2.2428E-02	5.0105E-01	1.7088E-02

7.000	8.9273E-01	2.7996E-02	6.5441E-01	2.2428E-02	5.2993E-01	1.8058E-02
7.300	9.4839E-01	2.9734E-02	6.5441E-01	2.2428E-02	5.5872E-01	1.9023E-02
7.600	1.0039E+00	3.1466E-02	6.5441E-01	2.2428E-02	5.8739E-01	1.9984E-02
7.900	1.0592E+00	3.3192E-02	6.5441E-01	2.2428E-02	6.1597E-01	2.0941E-02
8.000	1.0776E+00	3.3766E-02	6.5441E-01	2.2428E-02	6.2547E-01	2.1259E-02
8.300	1.1254E+00	3.5257E-02	6.5441E-01	2.2428E-02	6.3584E-01	2.1629E-02
8.600	1.1629E+00	3.6427E-02	6.5441E-01	2.2428E-02	6.4618E-01	2.1998E-02
8.900	1.1946E+00	3.7416E-02	6.5441E-01	2.2428E-02	6.5647E-01	2.2365E-02
9.200	1.2231E+00	3.8301E-02	6.5441E-01	2.2428E-02	6.6673E-01	2.2729E-02
9.500	1.2496E+00	3.9128E-02	6.5441E-01	2.2428E-02	6.7695E-01	2.3092E-02
9.800	1.2750E+00	3.9920E-02	6.5441E-01	2.2428E-02	6.8713E-01	2.3454E-02
10.100	1.2998E+00	4.0692E-02	6.5441E-01	2.2428E-02	6.9727E-01	2.3813E-02
10.400	1.3242E+00	4.1451E-02	6.5441E-01	2.2428E-02	7.0738E-01	2.4171E-02
24.000	2.3345E+00	7.2755E-02	6.5441E-01	2.2428E-02	1.1329E+00	3.8873E-02
96.000	3.9824E+00	1.2323E-01	6.5441E-01	2.2428E-02	2.1213E+00	7.0096E-02
720.000	5.8011E+00	1.7864E-01	6.5441E-01	2.2428E-02	2.8897E+00	9.3804E-02

```
####################################################################
                        Worst Two-Hour Doses
    Note: All of the dose locations are shown below but the
          worst two-hour dose is only meaningful for the EAB
          dose location.  Please disregard the two-hour worst
          doses for the other dose locations
####################################################################
```

Control_Room

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
5.2	4.9249E-05	3.7265E-01	1.1650E-02

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
2.0	1.9545E-03	6.5441E-01	2.2428E-02

LPZ

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
4.1	5.1154E-04	1.9420E-01	6.5660E-03

RUN B5 – STACKTOP_ESF.O0

Environment Integral Nuclide Release:

Time (h) = 0.5000	Ci	kg	Atoms	Bq
I-131	1.7935E+01	1.4467E-07	6.6504E+17	6.6360E+11
I-132	2.2979E+01	2.2262E-09	1.0156E+16	8.5021E+11
I-133	3.6722E+01	3.2417E-08	1.4678E+17	1.3587E+12
I-134	2.9492E+01	1.1055E-09	4.9683E+15	1.0912E+12
I-135	3.3778E+01	9.6182E-09	4.2905E+16	1.2498E+12

Xe-133	9.1229E-01	4.8738E-09	2.2068E+16	3.3755E+10
Xe-135	1.0194E+01	3.9919E-09	1.7807E+16	3.7719E+11

Environment Integral Nuclide Release:

Time (h) = 2.0000	Ci	kg	Atoms	Bq
I-131	1.3351E+03	1.0769E-05	4.9505E+19	4.9397E+13
I-132	1.2322E+03	1.1938E-07	5.4462E+17	4.5592E+13
I-133	2.6440E+03	2.3340E-06	1.0568E+19	9.7827E+13
I-134	9.5023E+02	3.5620E-08	1.6008E+17	3.5159E+13
I-135	2.2458E+03	6.3949E-07	2.8527E+18	8.3095E+13
Xe-133	7.1931E+02	3.8429E-06	1.7400E+19	2.6615E+13
Xe-135	7.3692E+03	2.8857E-06	1.2872E+19	2.7266E+14

Environment Integral Nuclide Release:

Time (h) = 8.0000	Ci	kg	Atoms	Bq
I-131	2.1795E+04	1.7580E-04	8.0817E+20	8.0641E+14
I-132	8.3962E+03	8.1342E-07	3.7110E+18	3.1066E+14
I-133	3.9044E+04	3.4466E-05	1.5606E+20	1.4446E+15
I-134	2.6627E+03	9.9814E-08	4.4858E+17	9.8520E+13
I-135	2.6365E+04	7.5075E-06	3.3490E+19	9.7552E+14
Xe-133	3.1634E+04	1.6900E-04	7.6523E+20	1.1705E+15
Xe-135	2.4964E+05	9.7755E-05	4.3607E+20	9.2366E+15

Environment Integral Nuclide Release:

Time (h) = 24.0000	Ci	kg	Atoms	Bq
I-131	7.7513E+04	6.2523E-04	2.8742E+21	2.8680E+15
I-132	9.9224E+03	9.6127E-07	4.3855E+18	3.6713E+14
I-133	1.1103E+05	9.8012E-05	4.4379E+20	4.1081E+15
I-134	2.6812E+03	1.0051E-07	4.5169E+17	9.9204E+13
I-135	5.0066E+04	1.4256E-05	6.3595E+19	1.8524E+15
Xe-133	2.0868E+05	1.1148E-03	5.0479E+21	7.7211E+15
Xe-135	8.9025E+05	3.4861E-04	1.5551E+21	3.2939E+16

Environment Integral Nuclide Release:

Time (h) = 48.0000	Ci	kg	Atoms	Bq
I-131	1.5353E+05	1.2384E-03	5.6931E+21	5.6807E+15
I-132	9.9333E+03	9.6233E-07	4.3903E+18	3.6753E+14
I-133	1.6579E+05	1.4635E-04	6.6266E+20	6.1341E+15
I-134	2.6812E+03	1.0051E-07	4.5169E+17	9.9204E+13
I-135	5.4856E+04	1.5620E-05	6.9680E+19	2.0297E+15
Xe-133	5.9859E+05	3.1979E-03	1.4480E+22	2.2148E+16
Xe-135	1.2629E+06	4.9454E-04	2.2061E+21	4.6728E+16

Environment Integral Nuclide Release:

Time (h) = 96.0000	Ci	kg	Atoms	Bq
I-131	2.8198E+05	2.2745E-03	1.0456E+22	1.0433E+16
I-132	9.9333E+03	9.6233E-07	4.3904E+18	3.6753E+14
I-133	2.0021E+05	1.7673E-04	8.0024E+20	7.4076E+15
I-134	2.6812E+03	1.0051E-07	4.5169E+17	9.9204E+13

I-135	5.5262E+04	1.5736E-05	7.0195E+19	2.0447E+15
Xe-133	1.4255E+06	7.6154E-03	3.4482E+22	5.2742E+16
Xe-135	1.3529E+06	5.2979E-04	2.3633E+21	5.0058E+16

Environment Integral Nuclide Release:

Time (h) = 120.0000	Ci	kg	Atoms	Bq
I-131	3.3606E+05	2.7107E-03	1.2461E+22	1.2434E+16
I-132	9.9333E+03	9.6233E-07	4.3904E+18	3.6753E+14
I-133	2.0479E+05	1.8078E-04	8.1854E+20	7.5771E+15
I-134	2.6812E+03	1.0051E-07	4.5169E+17	9.9204E+13
I-135	5.5265E+04	1.5737E-05	7.0198E+19	2.0448E+15
Xe-133	1.7861E+06	9.5419E-03	4.3205E+22	6.6085E+16
Xe-135	1.3551E+06	5.3065E-04	2.3671E+21	5.0140E+16

Environment Integral Nuclide Release:

Time (h) = 240.0000	Ci	kg	Atoms	Bq
I-131	5.2961E+05	4.2719E-03	1.9638E+22	1.9595E+16
I-132	9.0296E+03	8.7478E-07	3.9909E+18	3.3409E+14
I-133	2.0548E+05	1.8139E-04	8.2130E+20	7.6026E+15
I-134	2.2441E+03	8.4121E-08	3.7805E+17	8.3031E+13
I-135	5.3100E+04	1.5120E-05	6.7449E+19	1.9647E+15
Xe-133	2.9679E+06	1.5856E-02	7.1794E+22	1.0981E+17
Xe-135	1.3169E+06	5.1568E-04	2.3004E+21	4.8726E+16

Environment Integral Nuclide Release:

Time (h) = 240.0000	Ci	kg	Atoms	Bq
I-131	5.3091E+05	4.2824E-03	1.9686E+22	1.9644E+16
I-132	9.9333E+03	9.6233E-07	4.3904E+18	3.6753E+14
I-133	2.0829E+05	1.8387E-04	8.3254E+20	7.7067E+15
I-134	2.6812E+03	1.0051E-07	4.5169E+17	9.9204E+13
I-135	5.5265E+04	1.5737E-05	7.0199E+19	2.0448E+15
Xe-133	2.9770E+06	1.5904E-02	7.2014E+22	1.1015E+17
Xe-135	1.3556E+06	5.3081E-04	2.3679E+21	5.0155E+16

Environment Integral Nuclide Release:

Time (h) = 720.0000	Ci	kg	Atoms	Bq
I-131	7.5961E+05	6.1272E-03	2.8167E+22	2.8106E+16
I-132	9.9333E+03	9.6233E-07	4.3904E+18	3.6753E+14
I-133	2.0835E+05	1.8392E-04	8.3277E+20	7.7088E+15
I-134	2.6812E+03	1.0051E-07	4.5169E+17	9.9204E+13
I-135	5.5265E+04	1.5737E-05	7.0199E+19	2.0448E+15
Xe-133	3.9243E+06	2.0965E-02	9.4929E+22	1.4520E+17
Xe-135	1.3556E+06	5.3081E-04	2.3679E+21	5.0155E+16

##
I-131 Summary
##

SP RB SR

Time (hr)	I-131 (Curies)	I-131 (Curies)	I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	2.8743E+06	1.0395E+01	1.9631E-01
0.500	1.0021E+07	1.1236E+02	2.7009E+00
0.533	1.0735E+07	1.2749E+02	3.0850E+00
0.900	2.2868E+07	3.7146E+02	9.2677E+00
1.200	3.3546E+07	6.7639E+02	1.7141E+01
1.500	4.4198E+07	1.0474E+03	2.6805E+01
1.800	5.4823E+07	1.4651E+03	3.7732E+01
2.000	6.1891E+07	1.7624E+03	4.5528E+01
2.033	6.3068E+07	1.8131E+03	4.6860E+01
2.400	6.5328E+07	2.3073E+03	6.0130E+01
2.700	6.5236E+07	2.5846E+03	6.7641E+01
3.000	6.5143E+07	2.7805E+03	7.2947E+01
3.300	6.5051E+07	2.9184E+03	7.6686E+01
3.500	6.4989E+07	2.9867E+03	7.8536E+01
3.800	6.4897E+07	3.0628E+03	8.0602E+01
4.000	6.4836E+07	3.1002E+03	8.1615E+01
4.300	6.4744E+07	3.1413E+03	8.2733E+01
4.600	6.4652E+07	3.1693E+03	8.3492E+01
4.900	6.4560E+07	3.1878E+03	8.3997E+01
5.200	6.4469E+07	3.1997E+03	8.4322E+01
5.500	6.4377E+07	3.2068E+03	8.4518E+01
5.800	6.4286E+07	3.2105E+03	8.4622E+01
6.100	6.4195E+07	3.2119E+03	8.4662E+01
6.400	6.4104E+07	3.2115E+03	8.4655E+01
6.700	6.4013E+07	3.2099E+03	8.4616E+01
7.000	6.3922E+07	3.2075E+03	8.4553E+01
7.300	6.3832E+07	3.2045E+03	8.4474E+01
7.600	6.3741E+07	3.2010E+03	8.4383E+01
7.900	6.3651E+07	3.1972E+03	8.4284E+01
8.000	6.3621E+07	3.1959E+03	8.4250E+01
8.300	6.3531E+07	3.1918E+03	8.4143E+01
8.600	6.3440E+07	3.1877E+03	8.4033E+01
8.900	6.3350E+07	3.1834E+03	8.3921E+01
9.200	6.3261E+07	3.1790E+03	8.3807E+01
9.500	6.3171E+07	3.1747E+03	8.3691E+01
9.800	6.3081E+07	3.1703E+03	8.3575E+01
10.100	6.2992E+07	3.1658E+03	8.3458E+01
10.400	6.2903E+07	3.1614E+03	8.3341E+01
24.000	5.8984E+07	2.9645E+03	7.8152E+01
96.000	4.1961E+07	2.1089E+03	5.5596E+01
720.000	2.1933E+06	1.1024E+02	2.9061E+00

	CR	Environment	Dummy
Time (hr)	I-131 (Curies)	I-131 (Curies)	I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	1.4136E-07	3.3475E-01	1.3530E-04
0.500	6.5231E-06	1.7935E+01	7.2476E-03
0.533	7.9114E-06	2.2074E+01	8.9196E-03
0.900	3.5179E-05	1.1385E+02	4.5990E-02
1.200	7.8432E-05	2.8169E+02	1.1376E-01

1.500	1.4170E-04	5.6317E+02	2.2738E-01
1.800	2.2272E-04	9.7776E+02	3.9465E-01
2.000	2.8502E-04	1.3351E+03	5.3877E-01
2.033	2.7647E-04	1.4012E+03	5.6543E-01
2.400	2.2470E-04	2.2494E+03	9.0740E-01
2.700	2.1624E-04	3.0753E+03	1.2401E+00
3.000	2.2021E-04	3.9829E+03	1.6055E+00
3.300	2.2859E-04	4.9481E+03	1.9938E+00
3.500	2.3467E-04	5.6150E+03	2.2619E+00
3.800	8.4274E-02	6.6409E+03	2.6740E+00
4.000	1.1975E-01	7.3377E+03	2.9536E+00
4.300	6.7379E-02	8.3968E+03	3.3784E+00
4.600	3.7962E-02	9.4679E+03	3.8075E+00
4.900	2.1439E-02	1.0547E+04	4.2395E+00
5.200	1.2160E-02	1.1631E+04	4.6731E+00
5.500	6.9478E-03	1.2719E+04	5.1075E+00
5.800	4.0206E-03	1.3809E+04	5.5423E+00
6.100	2.3765E-03	1.4899E+04	5.9769E+00
6.400	1.4531E-03	1.5990E+04	6.4112E+00
6.700	9.3440E-04	1.7080E+04	6.8449E+00
7.000	6.4298E-04	1.8170E+04	7.2778E+00
7.300	4.7919E-04	1.9259E+04	7.7099E+00
7.600	3.8708E-04	2.0347E+04	8.1411E+00
7.900	3.3520E-04	2.1433E+04	8.5714E+00
8.000	3.2354E-04	2.1795E+04	8.7146E+00
8.300	2.4810E-04	2.2880E+04	9.1435E+00
8.600	2.0565E-04	2.3963E+04	9.5713E+00
8.900	1.8171E-04	2.5045E+04	9.9982E+00
9.200	1.6818E-04	2.6125E+04	1.0424E+01
9.500	1.6049E-04	2.7204E+04	1.0849E+01
9.800	1.5607E-04	2.8282E+04	1.1272E+01
10.100	1.5350E-04	2.9358E+04	1.1695E+01
10.400	1.5197E-04	3.0432E+04	1.2117E+01
24.000	1.4092E-04	7.7513E+04	3.0135E+01
96.000	2.9048E-05	2.8198E+05	9.5688E+01
720.000	2.5582E-07	7.5961E+05	5.6015E+01

###

Cumulative Dose Summary

###

	Control_Room		EAB		LPZ	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.001	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.167	1.8104E-06	5.7685E-08	0.0000E+00	0.0000E+00	2.0190E-04	7.3325E-06
0.500	2.5985E-04	8.2620E-06	0.0000E+00	0.0000E+00	1.0783E-02	3.8702E-04
0.533	3.3713E-04	1.0716E-05	0.0000E+00	0.0000E+00	1.3264E-02	4.7542E-04
0.900	2.6465E-03	8.3955E-05	0.0000E+00	0.0000E+00	6.8167E-02	2.4181E-03
1.200	7.9396E-03	2.5152E-04	0.0000E+00	0.0000E+00	1.6816E-01	5.9297E-03
1.500	1.8302E-02	5.7910E-04	0.0000E+00	0.0000E+00	3.3523E-01	1.1765E-02
1.800	3.5504E-02	1.1222E-03	0.0000E+00	0.0000E+00	5.8041E-01	2.0291E-02
2.000	5.1517E-02	1.6274E-03	0.0000E+00	0.0000E+00	7.9109E-01	2.7596E-02

2.033	5.4467E-02	1.7204E-03	4.0979E-02	1.4181E-03	8.1089E-01	2.8281E-02
2.400	8.2788E-02	2.6128E-03	5.6570E-01	1.9552E-02	1.0644E+00	3.7043E-02
2.700	1.0339E-01	3.2615E-03	1.0746E+00	3.7080E-02	1.3104E+00	4.5513E-02
3.000	1.2380E-01	3.9033E-03	1.6321E+00	5.6220E-02	1.5797E+00	5.4761E-02
3.300	1.4475E-01	4.5618E-03	2.2231E+00	7.6451E-02	1.8653E+00	6.4537E-02
3.500	1.5913E-01	5.0137E-03	2.6303E+00	9.0361E-02	2.0620E+00	7.1258E-02
3.800	4.3961E+00	1.3804E-01	1.4967E+01	5.1097E-01	8.6768E+00	2.9677E-01
4.000	1.0748E+01	3.3739E-01	2.3325E+01	7.9539E-01	1.3158E+01	4.4927E-01
4.300	1.9193E+01	6.0228E-01	2.3325E+01	7.9539E-01	1.3468E+01	4.5981E-01
4.600	2.3933E+01	7.5085E-01	2.3325E+01	7.9539E-01	1.3781E+01	4.7041E-01
4.900	2.6598E+01	8.3434E-01	2.3325E+01	7.9539E-01	1.4095E+01	4.8104E-01
5.200	2.8101E+01	8.8141E-01	2.3325E+01	7.9539E-01	1.4409E+01	4.9168E-01
5.500	2.8954E+01	9.0809E-01	2.3325E+01	7.9539E-01	1.4724E+01	5.0230E-01
5.800	2.9442E+01	9.2337E-01	2.3325E+01	7.9539E-01	1.5038E+01	5.1290E-01
6.100	2.9726E+01	9.3225E-01	2.3325E+01	7.9539E-01	1.5352E+01	5.2346E-01
6.400	2.9896E+01	9.3756E-01	2.3325E+01	7.9539E-01	1.5665E+01	5.3399E-01
6.700	3.0002E+01	9.4087E-01	2.3325E+01	7.9539E-01	1.5977E+01	5.4448E-01
7.000	3.0072E+01	9.4306E-01	2.3325E+01	7.9539E-01	1.6288E+01	5.5492E-01
7.300	3.0122E+01	9.4461E-01	2.3325E+01	7.9539E-01	1.6597E+01	5.6531E-01
7.600	3.0160E+01	9.4581E-01	2.3325E+01	7.9539E-01	1.6906E+01	5.7566E-01
7.900	3.0192E+01	9.4681E-01	2.3325E+01	7.9539E-01	1.7214E+01	5.8596E-01
8.000	3.0202E+01	9.4712E-01	2.3325E+01	7.9539E-01	1.7316E+01	5.8938E-01
8.300	3.0227E+01	9.4790E-01	2.3325E+01	7.9539E-01	1.7428E+01	5.9339E-01
8.600	3.0247E+01	9.4853E-01	2.3325E+01	7.9539E-01	1.7540E+01	5.9737E-01
8.900	3.0264E+01	9.4906E-01	2.3325E+01	7.9539E-01	1.7651E+01	6.0134E-01
9.200	3.0280E+01	9.4954E-01	2.3325E+01	7.9539E-01	1.7762E+01	6.0529E-01
9.500	3.0294E+01	9.4999E-01	2.3325E+01	7.9539E-01	1.7873E+01	6.0921E-01
9.800	3.0308E+01	9.5042E-01	2.3325E+01	7.9539E-01	1.7983E+01	6.1312E-01
10.100	3.0322E+01	9.5085E-01	2.3325E+01	7.9539E-01	1.8093E+01	6.1701E-01
10.400	3.0335E+01	9.5126E-01	2.3325E+01	7.9539E-01	1.8202E+01	6.2088E-01
24.000	3.0890E+01	9.6846E-01	2.3325E+01	7.9539E-01	2.2806E+01	7.7993E-01
96.000	3.1270E+01	9.8009E-01	2.3325E+01	7.9539E-01	3.3610E+01	1.1213E+00
720.000	3.1362E+01	9.8289E-01	2.3325E+01	7.9539E-01	4.1830E+01	1.3748E+00

```
#####################################################################
                         Worst Two-Hour Doses
    Note: All of the dose locations are shown below but the
          worst two-hour dose is only meaningful for the EAB
          dose location.  Please disregard the two-hour worst
          doses for the other dose locations
#####################################################################
```

Control_Room

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
3.5	4.1538E-03	2.8794E+01	9.0308E-01

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
2.0	6.6491E-02	2.3325E+01	7.9539E-01

LPZ

Time	Whole Body	Thyroid	TEDE

(hr)	(rem)	(rem)	(rem)
3.5	3.5533E-02	1.2662E+01	4.3104E-01

Appendix B4
Fumigation Spreadsheet

Time	Stacktop Release CR TEDE	(run B2') Delta CR TEDE	Stacktop ESF Release CR TEDE	(run B5') Delta CR TEDE	Total Delta CR TEDE
0.1	1.39E-06	1.39E-06	1.08E-06	1.08E-06	2.46E-06
0.2	4.01E-05	3.88E-05	3.16E-05	3.05E-05	6.93E-05
0.3	2.81E-04	2.40E-04	2.24E-04	1.93E-04	4.33E-04
0.4	9.68E-04	6.87E-04	7.85E-04	5.61E-04	1.25E-03
0.5	2.42E-03	1.45E-03	1.99E-03	1.21E-03	2.66E-03
0.6	4.97E-03	2.55E-03	4.15E-03	2.16E-03	4.71E-03
0.7	9.04E-03	4.07E-03	7.64E-03	3.50E-03	7.56E-03
0.8	1.51E-02	6.03E-03	1.29E-02	5.21E-03	1.12E-02
0.9	2.37E-02	8.61E-03	2.02E-02	7.39E-03	1.60E-02
1	3.56E-02	1.19E-02	3.03E-02	1.01E-02	2.20E-02
1.1	5.17E-02	1.61E-02	4.36E-02	1.33E-02	2.93E-02
1.2	7.27E-02	2.10E-02	6.07E-02	1.70E-02	3.80E-02
1.3	9.94E-02	2.68E-02	8.20E-02	2.13E-02	4.81E-02
1.4	1.33E-01	3.33E-02	1.08E-01	2.62E-02	5.94E-02
1.5	1.73E-01	4.05E-02	1.40E-01	3.15E-02	7.20E-02
1.6	2.22E-01	4.84E-02	1.77E-01	3.73E-02	8.57E-02
1.7	2.78E-01	5.68E-02	2.20E-01	4.35E-02	1.00E-01
1.8	3.44E-01	6.58E-02	2.71E-01	5.02E-02	1.16E-01
1.9	4.19E-01	7.52E-02	3.28E-01	5.72E-02	1.32E-01
2	5.35E-01	1.16E-01	3.92E-01	6.46E-02	1.80E-01
2.1	6.00E-01	6.45E-02	4.65E-01	7.23E-02	1.37E-01
2.2	7.05E-01	1.05E-01	5.45E-01	8.03E-02	1.86E-01
2.3	8.20E-01	1.16E-01	6.33E-01	8.85E-02	2.04E-01
2.4	9.46E-01	1.25E-01	7.30E-01	9.67E-02	2.22E-01
2.5	1.08E+00	1.34E-01	8.35E-01	1.05E-01	2.39E-01
2.6	1.22E+00	1.42E-01	9.47E-01	1.12E-01	2.54E-01
2.7	1.37E+00	1.49E-01	1.07E+00	1.20E-01	2.69E-01
2.8	1.53E+00	1.54E-01	1.19E+00	1.27E-01	2.81E-01
2.9	1.68E+00	1.59E-01	1.33E+00	1.33E-01	2.92E-01
3	1.85E+00	1.62E-01	1.47E+00	1.39E-01	3.02E-01
3.1	2.01E+00	1.65E-01	1.61E+00	1.45E-01	3.10E-01
3.2	2.18E+00	1.66E-01	1.76E+00	1.50E-01	3.16E-01
3.3	2.34E+00	1.66E-01	1.92E+00	1.55E-01	3.21E-01
3.4	2.51E+00	1.66E-01	2.07E+00	1.59E-01	3.25E-01
3.5	2.67E+00	1.65E-01	2.24E+00	1.63E-01	3.27E-01
3.6	2.84E+00	1.63E-01	2.40E+00	1.67E-01	3.29E-01
3.7	3.00E+00	1.60E-01	2.57E+00	1.70E-01	3.30E-01
3.8	3.15E+00	1.57E-01	2.75E+00	1.73E-01	3.30E-01
3.9	3.31E+00	1.54E-01	2.92E+00	1.75E-01	3.29E-01
4	3.46E+00	1.50E-01	3.10E+00	1.77E-01	3.28E-01
4.1	3.60E+00	1.46E-01	3.28E+00	1.80E-01	3.26E-01

4.2	3.75E+00	1.42E-01	3.46E+00	1.81E-01	3.24E-01
4.3	3.88E+00	1.38E-01	3.64E+00	1.83E-01	3.21E-01
4.4	4.02E+00	1.33E-01	3.83E+00	1.84E-01	3.18E-01
4.5	4.15E+00	1.29E-01	4.01E+00	1.86E-01	3.14E-01
4.6	4.27E+00	1.24E-01	4.20E+00	1.87E-01	3.11E-01
4.7	4.39E+00	1.19E-01	4.39E+00	1.88E-01	3.07E-01
4.8	4.50E+00	1.15E-01	4.57E+00	1.88E-01	3.03E-01
4.9	4.62E+00	1.10E-01	4.76E+00	1.89E-01	3.00E-01
5	4.75E+00	1.40E-01	4.95E+00	1.90E-01	3.30E-01
5.1	4.82E+00	6.75E-02	5.14E+00	1.90E-01	2.58E-01
5.2	4.92E+00	9.72E-02	5.33E+00	1.91E-01	2.88E-01
5.3	5.01E+00	9.29E-02	5.53E+00	1.91E-01	2.84E-01
5.4	5.10E+00	8.89E-02	5.72E+00	1.91E-01	2.80E-01
5.5	5.19E+00	8.50E-02	5.91E+00	1.92E-01	2.77E-01
5.6	5.27E+00	8.12E-02	6.10E+00	1.92E-01	2.73E-01
5.7	5.35E+00	7.76E-02	6.29E+00	1.92E-01	2.70E-01
5.8	5.42E+00	7.42E-02	6.48E+00	1.92E-01	2.66E-01
5.9	5.49E+00	7.09E-02	6.68E+00	1.92E-01	2.63E-01
6	5.56E+00	6.78E-02	6.87E+00	1.92E-01	2.60E-01
6.1	5.62E+00	6.49E-02	7.06E+00	1.92E-01	2.57E-01
6.2	5.68E+00	6.20E-02	7.25E+00	1.92E-01	2.54E-01
6.3	5.74E+00	5.94E-02	7.44E+00	1.92E-01	2.51E-01
6.4	5.80E+00	5.69E-02	7.64E+00	1.92E-01	2.49E-01
6.5	5.86E+00	5.45E-02	7.83E+00	1.92E-01	2.46E-01
6.6	5.91E+00	5.22E-02	8.02E+00	1.91E-01	2.44E-01
6.7	5.96E+00	5.00E-02	8.21E+00	1.91E-01	2.41E-01
6.8	6.01E+00	4.80E-02	8.40E+00	1.91E-01	2.39E-01
6.9	6.05E+00	4.61E-02	8.59E+00	1.91E-01	2.37E-01
7	6.10E+00	4.42E-02	8.78E+00	1.91E-01	2.35E-01
7.1	6.14E+00	4.24E-02	8.97E+00	1.91E-01	2.33E-01
7.2	6.18E+00	4.08E-02	9.16E+00	1.90E-01	2.31E-01
7.3	6.22E+00	3.92E-02	9.35E+00	1.90E-01	2.29E-01
7.4	6.26E+00	3.77E-02	9.54E+00	1.90E-01	2.28E-01
7.5	6.29E+00	3.62E-02	9.73E+00	1.90E-01	2.26E-01
7.6	6.33E+00	3.49E-02	9.92E+00	1.90E-01	2.24E-01
7.7	6.36E+00	3.36E-02	1.01E+01	1.89E-01	2.23E-01
7.8	6.39E+00	3.23E-02	1.03E+01	1.89E-01	2.21E-01
7.9	6.42E+00	3.11E-02	1.05E+01	1.89E-01	2.20E-01
8	6.45E+00	3.00E-02	1.07E+01	1.88E-01	2.18E-01

Appendix B5
Max 2-hour EAB TEDE Spreadsheet

Time hour	Stackbase Release (run B1)	Stacktop Release (run B2)	Tbroof Release (run B3)	Stackbase ESF Release (run B4)	Stacktop ESF Release (run B5)	Total EAB TEDE rem	2-hour EAB rem	
0.1	1.73E-07	9.75E-07	5.89E-05	1.23E-07	6.91E-07	6.09E-05	1.62E-01	EAB(2.1)-EAB(0.1)
0.2	1.92E-06	1.08E-05	2.33E-04	1.37E-06	7.72E-06	2.55E-04	1.82E-01	EAB(2.2)-EAB(0.2)
0.3	3.96E-06	2.23E-05	3.59E-04	2.86E-06	1.61E-05	4.05E-04	2.01E-01	...
0.4	1.77E-05	9.96E-05	8.99E-04	1.30E-05	7.30E-05	1.10E-03	2.20E-01	
0.5	4.68E-05	2.63E-04	1.66E-03	3.49E-05	1.96E-04	2.20E-03	2.40E-01	
0.6	9.56E-05	5.37E-04	2.63E-03	7.25E-05	4.08E-04	3.74E-03	2.59E-01	
0.7	1.67E-04	9.39E-04	3.79E-03	1.29E-04	7.25E-04	5.75E-03	2.78E-01	
0.8	2.66E-04	1.50E-03	5.38E-03	2.08E-04	1.17E-03	8.52E-03	2.96E-01	
0.9	4.03E-04	2.26E-03	7.60E-03	3.14E-04	1.77E-03	1.23E-02	3.14E-01	
1	5.90E-04	3.32E-03	1.04E-02	4.53E-04	2.55E-03	1.73E-02	3.30E-01	
1.1	8.38E-04	4.71E-03	1.38E-02	6.29E-04	3.54E-03	2.35E-02	3.45E-01	
1.2	1.16E-03	6.50E-03	1.78E-02	8.48E-04	4.76E-03	3.11E-02	3.58E-01	
1.3	1.55E-03	8.71E-03	2.23E-02	1.11E-03	6.24E-03	3.99E-02	3.70E-01	
1.4	2.03E-03	1.14E-02	2.73E-02	1.42E-03	8.00E-03	5.02E-02	3.81E-01	
1.5	2.59E-03	1.45E-02	3.29E-02	1.79E-03	1.00E-02	6.18E-02	3.90E-01	
1.6	3.24E-03	1.82E-02	3.89E-02	2.20E-03	1.24E-02	7.50E-02	3.97E-01	
1.7	3.98E-03	2.24E-02	4.54E-02	2.68E-03	1.51E-02	8.95E-02	4.02E-01	
1.8	4.82E-03	2.71E-02	5.24E-02	3.21E-03	1.80E-02	1.06E-01	4.06E-01	
1.9	5.75E-03	3.23E-02	5.98E-02	3.80E-03	2.14E-02	1.23E-01	4.08E-01	
2	6.77E-03	3.80E-02	6.77E-02	4.45E-03	2.50E-02	1.42E-01	4.08E-01	
2.1	7.89E-03	4.43E-02	7.59E-02	5.17E-03	2.91E-02	1.62E-01	4.06E-01	
2.2	9.10E-03	5.11E-02	8.25E-02	5.95E-03	3.34E-02	1.82E-01	4.05E-01	
2.3	1.04E-02	5.84E-02	8.76E-02	6.79E-03	3.82E-02	2.01E-01	4.04E-01	
2.4	1.18E-02	6.61E-02	9.25E-02	7.69E-03	4.32E-02	2.21E-01	4.01E-01	
2.5	1.32E-02	7.41E-02	9.72E-02	8.65E-03	4.86E-02	2.42E-01	3.99E-01	
2.6	1.46E-02	8.23E-02	1.02E-01	9.65E-03	5.42E-02	2.63E-01	3.95E-01	
2.7	1.61E-02	9.06E-02	1.06E-01	1.07E-02	6.01E-02	2.84E-01	3.91E-01	
2.8	1.76E-02	9.90E-02	1.10E-01	1.18E-02	6.61E-02	3.05E-01	3.87E-01	
2.9	1.91E-02	1.07E-01	1.14E-01	1.29E-02	7.24E-02	3.26E-01	3.82E-01	
3	2.06E-02	1.16E-01	1.18E-01	1.40E-02	7.88E-02	3.47E-01	3.77E-01	
3.1	2.21E-02	1.24E-01	1.22E-01	1.52E-02	8.53E-02	3.68E-01	3.72E-01	
3.2	2.35E-02	1.32E-01	1.26E-01	1.64E-02	9.19E-02	3.90E-01	3.66E-01	
3.3	2.49E-02	1.40E-01	1.29E-01	1.76E-02	9.87E-02	4.10E-01	3.61E-01	
3.4	2.63E-02	1.48E-01	1.32E-01	1.88E-02	1.06E-01	4.31E-01	3.56E-01	
3.5	2.77E-02	1.56E-01	1.36E-01	2.00E-02	1.12E-01	4.51E-01	3.50E-01	
3.6	2.90E-02	1.63E-01	1.39E-01	2.12E-02	1.19E-01	4.72E-01	3.45E-01	
3.7	3.03E-02	1.70E-01	1.42E-01	2.25E-02	1.26E-01	4.92E-01	3.40E-01	
3.8	3.15E-02	1.77E-01	1.45E-01	2.38E-02	1.34E-01	5.11E-01	3.35E-01	
3.9	3.28E-02	1.84E-01	1.48E-01	2.50E-02	1.41E-01	5.31E-01	3.30E-01	
4	3.39E-02	1.91E-01	1.51E-01	2.63E-02	1.48E-01	5.50E-01	3.25E-01	
4.1	3.51E-02	1.97E-01	1.53E-01	2.76E-02	1.55E-01	5.68E-01	3.20E-01	
4.2	3.62E-02	2.03E-01	1.56E-01	2.89E-02	1.62E-01	5.87E-01	3.16E-01	
4.3	3.72E-02	2.09E-01	1.59E-01	3.02E-02	1.70E-01	6.05E-01	3.11E-01	

4.4	3.82E-02	2.15E-01	1.61E-01	3.15E-02	1.77E-01	6.23E-01	3.07E-01
4.5	3.92E-02	2.20E-01	1.64E-01	3.28E-02	1.84E-01	6.40E-01	3.03E-01
4.6	4.02E-02	2.26E-01	1.66E-01	3.41E-02	1.92E-01	6.58E-01	2.99E-01
4.7	4.11E-02	2.31E-01	1.69E-01	3.54E-02	1.99E-01	6.75E-01	2.95E-01
4.8	4.20E-02	2.36E-01	1.71E-01	3.67E-02	2.06E-01	6.92E-01	2.92E-01
4.9	4.28E-02	2.41E-01	1.73E-01	3.80E-02	2.14E-01	7.08E-01	2.88E-01
5	4.36E-02	2.45E-01	1.75E-01	3.93E-02	2.21E-01	7.24E-01	2.85E-01
5.1	4.44E-02	2.49E-01	1.78E-01	4.06E-02	2.28E-01	7.40E-01	2.82E-01
5.2	4.51E-02	2.54E-01	1.80E-01	4.19E-02	2.36E-01	7.56E-01	2.79E-01
5.3	4.59E-02	2.58E-01	1.82E-01	4.32E-02	2.43E-01	7.71E-01	2.76E-01
5.4	4.65E-02	2.62E-01	1.84E-01	4.45E-02	2.50E-01	7.87E-01	2.73E-01
5.5	4.72E-02	2.65E-01	1.86E-01	4.58E-02	2.58E-01	8.02E-01	2.70E-01
5.6	4.79E-02	2.69E-01	1.88E-01	4.71E-02	2.65E-01	8.17E-01	2.67E-01
5.7	4.85E-02	2.72E-01	1.90E-01	4.84E-02	2.72E-01	8.31E-01	2.65E-01
5.8	4.91E-02	2.76E-01	1.92E-01	4.97E-02	2.80E-01	8.46E-01	2.63E-01
5.9	4.97E-02	2.79E-01	1.94E-01	5.10E-02	2.87E-01	8.60E-01	2.60E-01
6	5.02E-02	2.82E-01	1.96E-01	5.23E-02	2.94E-01	8.75E-01	2.58E-01

Appendix B6

Spreadsheet for AST Calculation Design Output Table

Run B2 - Top of Stack Release - Curies in the Environment

	0.5	2	8	24	48	96	120	240	480	720
Co-58	0.00E+00	2.44E-02	2.20E-01	2.50E-01	2.51E-01	2.53E-01	2.55E-01	2.60E-01	2.80E-01	2.89E-01
Co-60	0.00E+00	2.43E-02	2.19E-01	2.49E-01	2.51E-01	2.53E-01	2.54E-01	2.60E-01	2.83E-01	2.94E-01
Kr-85	1.78E+00	3.29E+02	7.04E+03	2.70E+04	5.63E+04	1.13E+05	1.40E+05	2.64E+05	9.29E+05	1.25E+06
Kr-85m	3.38E+01	5.21E+03	6.81E+04	1.10E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05
Kr-87	5.65E+01	5.53E+03	2.87E+04	2.98E+04	2.98E+04	2.98E+04	2.98E+04	2.98E+04	2.98E+04	2.98E+04
Kr-88	8.92E+01	1.24E+04	1.26E+05	1.64E+05	1.65E+05	1.65E+05	1.65E+05	1.65E+05	1.65E+05	1.65E+05
Rb-86	2.89E-02	1.69E+00	1.02E+01	1.14E+01	1.15E+01	1.15E+01	1.16E+01	1.18E+01	1.24E+01	1.26E+01
Sr-89	0.00E+00	3.80E+01	3.42E+02	3.89E+02	3.91E+02	3.95E+02	3.96E+02	4.04E+02	4.35E+02	4.48E+02
Sr-90	0.00E+00	4.32E+00	3.90E+01	4.43E+01	4.45E+01	4.50E+01	4.52E+01	4.62E+01	5.03E+01	5.22E+01
Sr-91	0.00E+00	4.22E+01	3.27E+02	3.54E+02	3.54E+02	3.54E+02	3.54E+02	3.54E+02	3.54E+02	3.54E+02
Sr-92	0.00E+00	3.29E+01	1.84E+02	1.89E+02	1.89E+02	1.89E+02	1.89E+02	1.89E+02	1.89E+02	1.89E+02
Y-90	0.00E+00	7.90E-02	1.44E+00	2.03E+00	2.11E+00	2.35E+00	2.50E+00	3.34E+00	7.20E+00	9.17E+00
Y-91	0.00E+00	4.96E-01	4.59E+00	5.26E+00	5.29E+00	5.35E+00	5.38E+00	5.51E+00	6.02E+00	6.23E+00
Y-92	0.00E+00	5.28E+00	8.34E+01	9.31E+01	9.31E+01	9.31E+01	9.31E+01	9.31E+01	9.31E+01	9.31E+01
Y-93	0.00E+00	5.05E-01	3.95E+00	4.28E+00	4.29E+00	4.29E+00	4.29E+00	4.29E+00	4.29E+00	4.29E+00
Zr-95	0.00E+00	6.66E-01	6.00E+00	6.81E+00	6.85E+00	6.92E+00	6.95E+00	7.09E+00	7.65E+00	7.88E+00
Zr-97	0.00E+00	6.32E-01	5.23E+00	5.76E+00	5.77E+00	5.77E+00	5.77E+00	5.77E+00	5.77E+00	5.77E+00
Nb-95	0.00E+00	6.69E-01	6.03E+00	6.85E+00	6.89E+00	6.96E+00	6.99E+00	7.14E+00	7.77E+00	8.06E+00
Mo-99	0.00E+00	8.54E+00	7.52E+01	8.48E+01	8.51E+01	8.55E+01	8.57E+01	8.60E+01	8.65E+01	8.65E+01
Tc-99m	0.00E+00	7.61E+00	6.82E+01	7.72E+01	7.75E+01	7.80E+01	7.81E+01	7.84E+01	7.90E+01	7.90E+01
Ru-103	0.00E+00	6.98E+00	6.28E+01	7.14E+01	7.17E+01	7.24E+01	7.27E+01	7.42E+01	7.96E+01	8.17E+01
Ru-105	0.00E+00	3.57E+00	2.37E+01	2.48E+01	2.48E+01	2.48E+01	2.48E+01	2.48E+01	2.48E+01	2.48E+01
Ru-106	0.00E+00	2.54E+00	2.29E+01	2.60E+01	2.62E+01	2.64E+01	2.65E+01	2.71E+01	2.95E+01	3.06E+01
Rh-105	0.00E+00	4.36E+00	3.87E+01	4.36E+01	4.37E+01	4.38E+01	4.39E+01	4.39E+01	4.39E+01	4.39E+01
Sb-127	0.00E+00	9.43E+00	8.36E+01	9.45E+01	9.49E+01	9.54E+01	9.56E+01	9.62E+01	9.75E+01	9.76E+01
Sb-129	0.00E+00	2.21E+01	1.46E+02	1.52E+02	1.52E+02	1.52E+02	1.52E+02	1.52E+02	1.52E+02	1.52E+02
Te-127	0.00E+00	9.42E+00	8.43E+01	9.54E+01	9.59E+01	9.66E+01	9.68E+01	9.77E+01	1.00E+02	1.01E+02
Te-127m	0.00E+00	1.27E+00	1.15E+01	1.30E+01	1.31E+01	1.32E+01	1.33E+01	1.36E+01	1.47E+01	1.53E+01
Te-129	0.00E+00	2.52E+01	1.82E+02	1.94E+02	1.95E+02	1.95E+02	1.95E+02	1.96E+02	2.00E+02	2.01E+02
Te-129m	0.00E+00	5.51E+00	4.97E+01	5.64E+01	5.67E+01	5.73E+01	5.75E+01	5.86E+01	6.28E+01	6.43E+01
Te-131m	0.00E+00	1.69E+01	1.45E+02	1.62E+02	1.63E+02	1.63E+02	1.63E+02	1.63E+02	1.63E+02	1.63E+02
Te-132	0.00E+00	1.29E+02	1.14E+03	1.29E+03	1.29E+03	1.30E+03	1.30E+03	1.31E+03	1.32E+03	1.32E+03
I-131	1.75E+01	1.16E+03	7.47E+03	8.93E+03	9.84E+03	1.14E+04	1.20E+04	1.43E+04	2.34E+04	2.50E+04
I-132	2.33E+01	1.34E+03	6.37E+03	6.75E+03	6.79E+03	6.83E+03	6.85E+03	6.88E+03	6.97E+03	6.98E+03
I-133	3.59E+01	2.29E+03	1.39E+04	1.59E+04	1.66E+04	1.70E+04	1.71E+04	1.71E+04	1.71E+04	1.71E+04
I-134	2.89E+01	8.32E+02	1.80E+03	1.80E+03	1.80E+03	1.80E+03	1.80E+03	1.80E+03	1.80E+03	1.80E+03
I-135	3.30E+01	1.95E+03	1.03E+04	1.11E+04	1.11E+04	1.11E+04	1.11E+04	1.11E+04	1.11E+04	1.11E+04
Xe-133	2.71E+02	5.01E+04	1.06E+06	3.88E+06	7.58E+06	1.34E+07	1.57E+07	2.30E+07	4.73E+07	5.00E+07
Xe-135	9.92E+01	1.88E+04	3.40E+05	7.80E+05	9.30E+05	9.57E+05	9.57E+05	9.58E+05	9.58E+05	9.58E+05
Cs-134	2.59E+00	1.51E+02	9.14E+02	1.03E+03	1.03E+03	1.04E+03	1.05E+03	1.07E+03	1.15E+03	1.19E+03
Cs-136	8.79E-01	5.14E+01	3.09E+02	3.46E+02	3.48E+02	3.51E+02	3.52E+02	3.57E+02	3.73E+02	3.77E+02
Cs-137	1.83E+00	1.07E+02	6.47E+02	7.27E+02	7.31E+02	7.38E+02	7.41E+02	7.56E+02	8.17E+02	8.46E+02
Ba-139	0.00E+00	2.94E+01	1.16E+02	1.17E+02	1.17E+02	1.17E+02	1.17E+02	1.17E+02	1.17E+02	1.17E+02
Ba-140	0.00E+00	6.68E+01	5.99E+02	6.80E+02	6.83E+02	6.89E+02	6.92E+02	7.02E+02	7.36E+02	7.45E+02
La-140	0.00E+00	1.55E+00	3.16E+01	4.50E+01	4.65E+01	5.10E+01	5.34E+01	6.43E+01	1.04E+02	1.14E+02

La-141	0.00E+00	4.58E-01	2.93E+00	3.05E+00	3.05E+00	3.05E+00	3.05E+00	3.05E+00	3.05E+00	3.05E+00
La-142	0.00E+00	2.86E-01	1.21E+00	1.22E+00	1.22E+00	1.22E+00	1.22E+00	1.22E+00	1.22E+00	1.22E+00
Ce-141	0.00E+00	1.55E+00	1.39E+01	1.58E+01	1.59E+01	1.61E+01	1.61E+01	1.64E+01	1.76E+01	1.80E+01
Ce-143	0.00E+00	1.40E+00	1.21E+01	1.35E+01	1.35E+01	1.36E+01	1.36E+01	1.36E+01	1.36E+01	1.36E+01
Ce-144	0.00E+00	1.30E+00	1.17E+01	1.33E+01	1.34E+01	1.35E+01	1.36E+01	1.39E+01	1.51E+01	1.56E+01
Pr-143	0.00E+00	5.63E-01	5.10E+00	5.81E+00	5.85E+00	5.91E+00	5.93E+00	6.05E+00	6.43E+00	6.53E+00
Nd-147	0.00E+00	2.46E-01	2.20E+00	2.50E+00	2.51E+00	2.53E+00	2.54E+00	2.57E+00	2.69E+00	2.72E+00
Np-239	0.00E+00	1.74E+01	1.53E+02	1.72E+02	1.73E+02	1.73E+02	1.74E+02	1.74E+02	1.75E+02	1.75E+02
Pu-238	0.00E+00	9.58E-03	8.63E-02	9.81E-02	9.87E-02	9.97E-02	1.00E-01	1.02E-01	1.11E-01	1.16E-01
Pu-239	0.00E+00	4.21E-04	3.80E-03	4.32E-03	4.34E-03	4.39E-03	4.41E-03	4.51E-03	4.91E-03	5.10E-03
Pu-240	0.00E+00	5.91E-04	5.32E-03	6.05E-03	6.08E-03	6.15E-03	6.18E-03	6.31E-03	6.87E-03	7.14E-03
Pu-241	0.00E+00	1.52E-01	1.37E+00	1.56E+00	1.57E+00	1.58E+00	1.59E+00	1.62E+00	1.77E+00	1.84E+00
Am-241	0.00E+00	7.45E-05	6.72E-04	7.64E-04	7.68E-04	7.76E-04	7.80E-04	7.98E-04	8.75E-04	9.16E-04
Cm-242	0.00E+00	1.69E-02	1.52E-01	1.73E-01	1.73E-01	1.75E-01	1.76E-01	1.80E-01	1.95E-01	2.02E-01
Cm-244	0.00E+00	7.78E-04	7.01E-03	7.97E-03	8.01E-03	8.10E-03	8.13E-03	8.31E-03	9.05E-03	9.40E-03

Run B5 - ESF Top of Stack Release - Curies in the Environment

	0.5	2	8	24	48	96	120	240	480	720
I-131	1.79E+01	1.34E+03	2.18E+04	7.75E+04	1.54E+05	2.82E+05	3.36E+05	5.30E+05	5.31E+05	7.60E+05
I-132	2.30E+01	1.23E+03	8.40E+03	9.92E+03	9.93E+03	9.93E+03	9.93E+03	9.03E+03	9.93E+03	9.93E+03
I-133	3.67E+01	2.64E+03	3.90E+04	1.11E+05	1.66E+05	2.00E+05	2.05E+05	2.05E+05	2.08E+05	2.08E+05
I-134	2.95E+01	9.50E+02	2.66E+03	2.68E+03	2.68E+03	2.68E+03	2.68E+03	2.24E+03	2.68E+03	2.68E+03
I-135	3.38E+01	2.25E+03	2.64E+04	5.01E+04	5.49E+04	5.53E+04	5.53E+04	5.31E+04	5.53E+04	5.53E+04
Xe-133	9.12E-01	7.19E+02	3.16E+04	2.09E+05	5.99E+05	1.43E+06	1.79E+06	2.97E+06	2.98E+06	3.92E+06
Xe-135	1.02E+01	7.37E+03	2.50E+05	8.90E+05	1.26E+06	1.35E+06	1.36E+06	1.32E+06	1.36E+06	1.36E+06

TVAN CALCULATION DESIGN OUTPUT

Calculation Identifier: ND-Q0031-920075 Revision 21	Engineering Change Document EDC- 69199A

Calculation Title:
Control Room and Offsite Doses Due to a LOCA

EJR 4/14/10 H. Pustulka	9-25-06	JWG 4/14/10 J. Metcalf	9/25/06
Preparer	Date	Verifier	Date
JWG 4/14/10 J. Metcalf	9/25/06		05/07/2010
Checker	Date	Approval	Date

This Calculation Design Output is a compilation of the design output requirements of the referenced calculation. Review of the referenced calculation for additional design output information is not required nor allowed. Any new design output or changes to design output portions of calculations shall be processed under the authority of the engineering change process.

Appendix B Design Output

EJR 4/14/10
THE ~~There are two items of~~ design output arising from the AST analysis of Appendix B (and the supporting Bx appendices).

EJR 4/14/10
~~Item 1~~

The following table is the AST update of the design output of the main body of the calculation. It was obtained by requesting in RADTRAD's runs B2 and B5 the detailed output for the environment control volume. The spreadsheet used to come up with this table is shown in Appendix B6.

Runs B2 + B5 - Top of Stack Releases with 10 GPM ESF Leakage (Analyzed as 20 GPM), 20 CFM Stack Bypass, and Unit 1 RB Volume - Curies Release Rates (uCi/sec)

Time Interval	0-0.5 hr	0.5-2 hr	2-8 hr	8-24 hr	24-48 hr
Seconds	1800	5400	21600	57600	86400
Total I	1.553E+05	2.905E+06	5.651E+06	2.737E+06	1.588E+06
Total NG	3.126E+05	1.850E+07	8.359E+07	7.259E+07	5.381E+07
Total I+NG	4.679E+05	2.140E+07	8.924E+07	7.533E+07	5.540E+07

Time Interval	48-96 hr	96-120 hr	120-240 hr	240-480 hr	480-720 hr
Seconds	172800	86400	432000	864000	864000
Total I	9.564E+05	6.872E+05	4.471E+05	1.941E+04	2.667E+05
Total NG	3.962E+07	3.107E+07	1.979E+07	2.898E+07	4.531E+06
Total I+NG	4.058E+07	3.176E+07	2.024E+07	2.900E+07	4.797E+06

Appendix C
Independent Review of the Alternative Source Term (AST) Application to TVA/BFN LOCA (No Drywell Spray Credit, Assumed 10 gpm ESF Leakage (Analyzed as 20 gpm), No Credit for Any Control Room Filters, 20 cfm Stack Bypass, and Limiting (Unit 1) Secondary Containment Volume and Turbine Building Release X/Qs)

This appendix presents check calculation results using the Polestar STARDOSE (Reference C-1) computer code to check the RADTRAD results presented in Appendix B.

STARDOSE Analysis

The Design Input Data and the Assumptions are the same as those used in Appendix B.

The STARDOSE LIBFILE1.TXT file is included as Appendix C1. This file has the following format (by column):

1. Radionuclide ID
2. Radionuclide group (Reference D-1)
3. Parent
4. Daughter
5. Ci/MW (Reference D-2, Item 1.1)
6. Decay constant, per sec (Reference C-2)
7. Thyroid DCF (rem/Ci) (Reference C-3)
8. WB DCF (rem-sec/Ci-m3) (Reference C-2 except where Reference C-3 provides updates)
9. Not used
10. Not used
11. Skin DCF (rem-sec/Ci-m3 (Reference C-2)
12. CEDE DCF (rem/Ci) (Reference C-3)
13. Ave beta energy
14. Not used
15. Not used
16. Not used
17. Not used
18. Not used

The 66 radionuclide inventories are taken from Reference D-2, Item 1.1. These 66 radionuclides include the 60 RADTRAD radionuclides minus two insignificant Cobalt nuclides plus eight additional radionuclides (mostly noble gases): Kr83m, Kr89, Xe131m, Xe133m, Xe135m, Xe137, Xe138, Ba137m.

The INPUT.DAT file is provided as Appendix C2. As previously noted, the model is the same as the corresponding RADTRAD case documented in Appendix B except for the turbine building which is completely removed from the model (Junction 11 and 12 of Figure B-1 go directly to the environment, Junction 13 is removed). Note that one STARDOSE run covers the five RADTRAD runs.

The maximum two-hour EAB dose was obtained using the 2.0 to 4.0 hour period identified in Appendix B.

Note also that the control room X/Qs used in STARDOSE do not reflect a 50% reduction allowed by SRP Section 6.4. Therefore, STARDOSE control room dose results, as shown in the output files, needs to be reduced by 50% prior to being compared with the RADTRAD control room dose results.

Results Summary and Comparison to RADTRAD Results (Doses in Rem TEDE)

	RADTRAD (Appendix B)	STARDOSE (Appendix C)
CR	1.18E+0	1.18E+0
EAB	1.71E+0	1.69E+0
LPZ	2.38E+0	2.47E+0

These results show good agreement between the two computer codes. Consequently, the RADTRAD results of Appendix B are considered acceptable.

Assessment of Control Room Dose if Particulate Make-Up Filters are Credited but without Unit 1 Limiting Secondary Containment Volume and Turbine Building Release X/Qs

It is desireable to know if the case analyzed herein (and in Appendix B with RADTRAD) would result in more than a ten percent reduction in dose margin from the case analyzed in Appendics D and E for Units 2 and 3 as long as the control room particulate make-up filters were available (90% removal efficiency as modeled in Appendices D and E) and there were no increase in stack bypass (from 10 to 20 cfm).

A comparison of the STARDOSE analysis results (in rem TEDE) for Appendix E vs. Appendix C is as follows:

	STARDOSE (Appendix E)	STARDOSE (Appendix C)
CR	4.76E-1	1.18E+0
EAB	9.72E-1	1.69E+0
LPZ	1.26E+0	2.47E+0

The control room results as calculated by STARDOSE do not include the 0.76 rem contribution for secondary containment shine; when this contribution is added, the doses become as follows):

	STARDOSE (Appendix E)	STARDOSE (Appendix C)
CR	1.24E+0	1.94E+0
EAB	9.72E-1	1.69E+0
LPZ	1.26E+0	2.47E+0

The Appendix C results include the Unit 1 impact of reduced secondary containment volume and higher turbine building release X/Qs. Appendix H establishes for the Appendix D/E case, a Unit 1 "delta" (i.e., dose increase) of 0.12 rem TEDE for the immersion and inhalation doses calculated by STARDOSE, ~10% for the EAB dose (0.10 rem TEDE), and ~5% for the LPZ dose (0.06 rem TEDE). These absolute corrections would apply equally well (approximately) to the Appendix C case because the increased doses of Appendix C are due to (1) an increase in ESF leakage, (2) an increase in base of stack leakage, and (3) not taking credit for control room particulate filters. None of these increases would be greatly exaggerated by the decreased hold-up or higher turbine building X/Qs associated with Unit 1, but one could anticipate a greater impact than than the 0.12 rem. Therefore, one can project the Unit 2/3 "version" of Appendix C to be approximately as follows (doses in rem TEDE):

	STARDOSE (Appendix E)	STARDOSE (Appendix C for Unit 2/3)
CR	1.24E+0	< 1.82E+0
EAB	9.72E-1	< 1.59E+0
LPZ	1.26E+0	< 2.41E+0

The Appendix E-based margins are as follows:

- For control room dose, the limit is 5 rem TEDE and the Appendix E dose is 1.24 rem TEDE. Therefore, the margin is 3.76 rem, 10 percent of this margin is 0.38 rem; and if added to the current dose, the control room dose could be as high as 1.62 rem TEDE without reducing the margin by more than 10 percent.
- For EAB dose, the limit is 25 rem TEDE and the Appendix E dose is 0.97 rem TEDE. Therefore, the margin is 24.03 rem, 10 percent of this margin is 2.40 rem; and if added to the current dose, the control room dose could be as high as 3.27 rem TEDE without reducing the margin by more than 10 percent.
- For LPZ dose, the limit is 25 rem TEDE and the Appendix E dose is 1.26 rem TEDE. Therefore, the margin is 23.74 rem, 10 percent of this margin is 2.37 rem; and if added to the current dose, the control room dose could be as high as 3.63 rem TEDE without reducing the margin by more than 10 percent.

It is clear from the above bulleted items that the EAB and LPZ dose increases (Appendix C vs. Appendix E) can be readily accommodated within ten percent of the available Appendix E margin. However, the "Unit 2/3" Appendix C dose for the control room is estimated to be < 1.82 rem TEDE in the above table while more than ten percent of the available Appendix E control room dose margin would be used if the control room dose exceeded 1.62 rem TEDE. So the question is how much lower than 1.82 rem TEDE would the "Unit 2/3" Appendix C dose be?

In Appendix C, no credit is taken for control room particulate filtration and stack bypass is a factor of two greater than in Appendix E. If 90% effective filters operated on 3000 cfm of control room make-up flow in parallel with 3717 cfm of unfiltered inleakage, the reduction in particulate entering the control room (as compared to no filteration) would be 40%. From Appendix C2, one may observe that 0.31 rem TEDE (one half of the 0.61 rem TEDE seen in the output) out of a total Appendix C "Unit 2/3" control room dose of < 1.82 rem TEDE is due to particulate. A 40% reduction in this 0.31 rem TEDE contribution is 0.12 rem TEDE. Therefore, if the control room particulate filtration had been credited in an Appendix C "Unit 2/3" calculation, one would expect the control room dose to be reduced from < 1.82 rem TEDE to < 1.70 rem TEDE.

The stack bypass impact can be assessed by observing the dose contribution of stack bypass from Appendix B (since the RADTRAD analyses presented in Appendix B provide individual pathway dose results). The result is 0.1 rem TEDE; and thus the dose reduction associated with only half of this bypass would be approximately 0.05 rem TEDE. Thus, one can project that if the Appendix C calculation were to be repeated using the Unit 2/3 secondary containment volume and turbine building release X/Qs, and if the control room make-up particulate filters were credited, and if the stack bypass were 10 cfm instead of 20 cfm, then the control room dose (as compared to the Appendix E result) would be < 1.65 rem TEDE and within 2% of the threshold of acceptability for not reducing margin by more than 10% (i.e., 1.62 rem TEDE). Since so much conservatism exists in the 0.76 rem shine dose contribution, one can be certain that a control room dose of 1.62 rem TEDE would not be exceeded for a case like that analyzed in Appendix C but (1) for Units 2 and 3, (2) with credit for control room particulate filters, and (3) with 10 cfm of stack bypass.

Checker's Note

One item not formally addressed in Appendix B (the RADTRAD analysis) is the dose impact of coolant activity being released to the drywell well in advance of the fuel damage leading to the gap release and the early in-vessel release. An upper bound estimate of this coolant release activity can be made by assuming the entire reactor coolant mass (Item 6.9 of Reference C-4 = 1.226E6 lbm) is at 10 times the normal operating Technical Specification value of 3.2 uCi/gram dose equivalent I-131 (Reference C-5) for a total of 17811 Ci. This amount of I-131 activity can be added if the STARDOSE input file of Appendix C2 is modified to add 0.1 core inventories per hour of iodine over a six seconds (0.00167 hour) period to an intermediate volume and then to purge that volume of 95% of the activity at a rate of 7.5 volumes per minute for the next 24 seconds (to simulate a 30 second blowdown). To ensure that the iodine is gaseous, the addition rate could be increased to 20 times the 0.1 core inventories per hour (i.e., to 2.0 inventories per hour) with the particulate iodine then being completely filtered during the 30-second introduction into the drywell. (Note that this works because 5% of the iodine in the core is specified to be gaseous. Note also that this approach adds I-132, I-133, I-134, I-135 in proportion to the I-131 which is even more conservative). If this amount of gaseous iodine activity is released to the containment at the start of the accident, the doses are as follows (based on Appendix C4 and not including shine for the control room):

	STARDOSE (with coolant activity)	STARDOSE (no coolant activtiy)
CR	1.18E+0	1.18E+0
EAB	1.70E+0	1.69E+0
LPZ	2.48E+0	2.47E+0

As can be seen, the results are negligibly greater with the coolant activity included. Therefore, having not included coolant activity in the Appendix B (RADTRAD) dose analysis is acceptable.

For more detail, refer to Appendix C4. This appendix shows the iodine activity in the "Coolant" control volume at the end of six seconds and the iodine activity in the drywell at the end of 30 seconds, as well as the doses at 720 hours.

References for Appendix C (in addition to several Appendix B references)

C-1 STARDOSE Executable file dated 3/21/97, PSAT CI09.03, Rev. 0, "STARDOSE Model Report", January 31, 1997

C-2 NUREG/CR-5106, "Manual for TACT5", Version SAIC 9/23/1987

C-3 Federal Guide 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion", 1988

C-4 PSAT 04000U.03, "Design Data Base for Application of the Revised DBA Source Term to the TVA Browns Ferry Nuclear Power Plant", Revision 7, RIMS # R05020325113

C-5 BFN Unit 2 and Unit 3 Technical Specification 3.4.6

Appendix C1
STARDOSE Library File

Same File as LIBFILE1.TXT of Appendix E1

Appendix C2
STARDOSE Main Input File

```
edit_time
0       2.0333      2       4       8       24      96      720
end_edit_time

participating_isotopes
Kr83m   Kr85m   Kr85    Kr87    Kr88    Kr89
Xe131m  Xe133m  Xe133   Xe135m  Xe135   Xe137   Xe138
I131Org I131Elem        I131Part
I132Org I132Elem        I132Part
I133Org I133Elem        I133Part
I134Org I134Elem        I134Part
I135Org I135Elem        I135Part
Rb86    Cs134   Cs136   Cs137
Sb127   Sb129   Te127m  Te127   Te129m  Te129   Te131m  Te132
Ba137m  Ba139   Ba140
Mo99    Tc99m   Ru103   Ru105   Ru106   Rh105
Y90     Y91     Y92     Y93     Zr95    Zr97    Nb95
La140   La141   La142   Pr143   Nd147   Am241   Cm242   Cm244
Ce141   Ce143   Ce144   Np239   Pu238   Pu239   Pu240   Pu241
Sr89    Sr90    Sr91    Sr92
end_participating_isotopes

core
thermal_power                   4031
elemental_iodine_frac           0.0485
organic_iodine_frac             0.0015
particulate_iodine_frac         0.95
release_frac
to_control_volume DW
Time   N_Gas  I_Grp  CsGrp  TeGrp  BaGrp  NMtls  CeGrp  LaGrp  SrGrp
0.0333      0      0      0      0      0      0      0      0      0
0.5333      0.1    0.1    0.1    0      0      0      0      0      0
2.0333      0.63   0.166  0.133  0.033  0.013  0.0017        0.00033     0.00013     0.013
720    0      0      0      0      0      0      0      0      0
end_to_control_volume
to_control_volume SP
Time   N_Gas  I_Grp  CsGrp  TeGrp  BaGrp  NMtls  CeGrp  LaGrp  SrGrp
0.0333      0      0      0      0      0      0      0      0      0
0.5333      0      0.2    0      0      0      0      0      0      0
2.0333      0      0.332  0      0      0      0      0      0      0
720    0      0      0      0      0      0      0      0      0
end_to_control_volume
end_release_frac
end_core

control_volume
obj_type                        OBJ_CV
name                            DW
air_volume                      1.59e+005
water_volume                    0
```

```
surface_area                  1
has_recirc_filter             false
removal_rate_to_surface
Time   NobleGas    ElemIodine   OrgIodine    PartIodine   Solubles    Insolubles
0.033       0      0      0     0      0      0
0.533       0      0.75   0     0.75   0.75   0.75
2.033       0      0.37   0     0.37   0.37   0.37
5.033       0      1.06   0     1.06   1.06   1.06
8.367       0      0.64   0     0.64   0.64   0.64
12.033      0      0.56   0     0.56   0.56   0.56
19.478      0      0.53   0     0.53   0.53   0.53
24.033      0      0.51   0     0.51   0.51   0.51
720         0      0      0     0      0      0
end_removal_rate_to_surface
frac_4_daughter_resusp_from_surface
Time   NobleGas    ElemIodine   OrgIodine    PartIodine   Solubles    Insolubles
720    0      0      0      0      0      0
end_frac_4_daughter_resusp_from_surface
end_control_volume

control_volume
obj_type                      OBJ_CV
name                          WW
air_volume                    1.194e+005
water_volume                  1.215e+005
surface_area                  0
has_recirc_filter             false
end_control_volume

control_volume
obj_type                      OBJ_CV
name                          RB
air_volume                    1.311e+006
water_volume                  0
surface_area                  0
has_recirc_filter             false
end_control_volume

control_volume
obj_type                      OBJ_CV
name                          SR
air_volume                    3.456e+004
water_volume                  0
surface_area                  0
has_recirc_filter             false
end_control_volume

control_volume
obj_type                      OBJ_CV
name                          MC
air_volume                    1.224e+005
water_volume                  0
surface_area                  0
has_recirc_filter             false
```

```
end_control_volume

control_volume
obj_type                     OBJ_CV
name                         SP
air_volume                   1.215e+005
water_volume                 0
surface_area                 0
has_recirc_filter            false
end_control_volume

junction
junction_type                AIR_JUNCTION
downstream_location          AIR_SPACE
upstream                     CORE
downstream                   DW
has_filter                   false
flow_rate
Time   (hr)   Value (cfm)
720           1
end_flow_rate
end_junction

junction
junction_type                AIR_JUNCTION
downstream_location          AIR_SPACE
upstream                     CORE
downstream                   SP
has_filter                   false
flow_rate
Time   (hr)   Value (cfm)
720           1
end_flow_rate
end_junction

junction
junction_type                AIR_JUNCTION
downstream_location          AIR_SPACE
upstream                     DW
downstream                   WW
has_filter                   false
flow_rate
Time   (hr)   Value (cfm)
2.034         0
720           119400
end_flow_rate
end_junction

junction
junction_type                AIR_JUNCTION
downstream_location          AIR_SPACE
upstream                     DW
downstream                   MC
has_filter                   true
```

```
flow_rate
Time  (hr)  Value (cfm)
720         1.3
end_flow_rate
filter_efficiency
Time  NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720   0     0.9901      0     0.9987      0.9987      0.9987
end_filter_efficiency
frac_4_daughter_resusp
Time  NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720   0     0     0     0     0     0
end_frac_4_daughter_resusp
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      RB
downstream                    SR
has_filter                    true
flow_rate
Time  (hr)  Value (cfm)
720         20
end_flow_rate
filter_efficiency
Time  NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720   0     0     0     0.9   0.9   0.9
end_filter_efficiency
frac_4_daughter_resusp
Time  NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720   1     1     0     0     0     0
end_frac_4_daughter_resusp
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      MC
downstream                    environment
has_filter                    false
flow_rate
Time  (hr)  Value (cfm)
720         3.97
end_flow_rate
X_over_Q_4_ctrl_room
Time  (hr)  Value (s/m*3)
2     0.000322
8     0.000277
24    0.000131
96    0.0000791
720   0.0000610
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time  (hr)  Value (s/m*3)
```

```
2      0
4      0.000262
24     0
96     0
720    0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time   (hr)  Value (s/m*3)
2      0.000131
8      0.0000661
24     0.0000469
96     0.0000223
720    0.00000796
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      DW
downstream                    environment
has_filter                    true
flow_rate
Time   (hr)  Value (cfm)
720          0.0065
end_flow_rate
filter_efficiency
Time   NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720    0     0.1637     0      0.8933      0.8933      0.8933
end_filter_efficiency
frac_4_daughter_resusp
Time   NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720    0     0     0     0     0     0
end_frac_4_daughter_resusp
X_over_Q_4_ctrl_room
Time   (hr)  Value (s/m*3)
2      0.000322
8      0.000277
24     0.000131
96     0.0000791
720    0.0000610
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time   (hr)  Value (s/m*3)
2      0
4      0.000262
24     0
96     0
720    0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time   (hr)  Value (s/m*3)
2      0.000131
8      0.0000661
```

```
24     0.0000469
96     0.0000223
720    0.00000796
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type                  AIR_JUNCTION
downstream_location            AIR_SPACE
upstream                       WW
downstream                     SR
has_filter                     true
flow_rate
Time   (hr)  Value (cfm)
240          0
264          0.0562
480          0
504          0.0562
696          0
720          0.0562
end_flow_rate
filter_efficiency
Time   NobleGas     ElemIodine   OrgIodine    PartIodine   Solubles     Insolubles
720    0     0      0      0.9   0.9    0.9
end_filter_efficiency
frac_4_daughter_resusp
Time   NobleGas     ElemIodine   OrgIodine    PartIodine   Solubles     Insolubles
720    0     0      0      0     0      0
end_frac_4_daughter_resusp
end_junction

junction
junction_type                  AIR_JUNCTION
downstream_location            AIR_SPACE
upstream                       WW
downstream                     RB
has_filter                     false
flow_rate
Time   (hr)  Value (cfm)
720          1.66
end_flow_rate
end_junction

junction
junction_type                  AIR_JUNCTION
downstream_location            AIR_SPACE
upstream                       DW
downstream                     RB
has_filter                     false
flow_rate
Time   (hr)  Value (cfm)
720          2.21
end_flow_rate
end_junction
```

```
junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      SP
downstream                    RB
has_filter                    true
flow_rate
Time  (hr)  Value (cfm)
720         2.672
end_flow_rate
filter_efficiency
Time  NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720   0.5   0     0     0.999 0     0
end_filter_efficiency
frac_4_daughter_resusp
Time  NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720   0     0     0     0     0     0
end_frac_4_daughter_resusp
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      WW
downstream                    environment
has_filter                    false
flow_rate
Time  (hr)  Value (cfm)
8           0
720         0.167
end_flow_rate
X_over_Q_4_ctrl_room
Time  (hr)  Value (s/m*3)
2     1.41e-007
3.5   4.50e-008
4     3.40e-005
8     4.50e-008
24    2.54e-008
96    7.36e-009
720   1.24e-009
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time  (hr)  Value (s/m*3)
2     0
3.5   1.19e-006
4     2.35e-005
24    0
96    0
720   0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time  (hr)  Value (s/m*3)
2     1.13e-006
```

```
3.5    5.75e-007
4      1.26e-005
8      5.75e-007
24     4.10e-007
96     1.97e-007
720    6.88e-008
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type                  AIR_JUNCTION
downstream_location            AIR_SPACE
upstream                       WW
downstream                     environment
has_filter                     true
flow_rate
Time   (hr)   Value (cfm)
240           0
264           139
480           0
504           139
696           0
720           139
end_flow_rate
filter_efficiency
Time   NobleGas     ElemIodine   OrgIodine    PartIodine   Solubles     Insolubles
720    0     0      0     0.9    0.9    0.9
end_filter_efficiency
frac_4_daughter_resusp
Time   NobleGas     ElemIodine   OrgIodine    PartIodine   Solubles     Insolubles
720    0     0      0     0      0      0
end_frac_4_daughter_resusp
X_over_Q_4_ctrl_room
Time   (hr)   Value (s/m*3)
2      1.41e-007
3.5    4.50e-008
4      3.40e-005
8      4.50e-008
24     2.54e-008
96     7.36e-009
720    1.24e-009
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time   (hr)   Value (s/m*3)
2      0
3.5    1.19e-006
4      2.35e-005
24     0
96     0
720    0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time   (hr)   Value (s/m*3)
2      1.13e-006
```

```
3.5    5.75e-007
4      1.26e-005
8      5.75e-007
24     4.10e-007
96     1.97e-007
720    6.88e-008
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      SR
downstream                    environment
has_filter                    false
flow_rate
Time  (hr)  Value (cfm)
720         20
end_flow_rate
X_over_Q_4_ctrl_room
Time  (hr)  Value (s/m*3)
2      0.0002
8      0.000128
24     0.0000572
96     0.0000405
720    0.0000309
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time  (hr)  Value (s/m*3)
2      0
4      0.000262
8      0
24     0
96     0
720    0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time  (hr)  Value (s/m*3)
2      0.000131
8      0.0000661
24     0.0000469
96     0.0000223
720    0.00000796
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      RB
downstream                    environment
has_filter                    true
flow_rate
Time  (hr)  Value (cfm)
```

```
720         2.473e+004
end_flow_rate
filter_efficiency
Time  NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720   0     0     0     0.9   0.9   0.9
end_filter_efficiency
frac_4_daughter_resusp
Time  NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720   0     0     0     0     0     0
end_frac_4_daughter_resusp
X_over_Q_4_ctrl_room
Time  (hr)  Value (s/m*3)
2     1.41e-007
3.5   4.50e-008
4     3.40e-005
8     4.50e-008
24    2.54e-008
96    7.36e-009
720   1.24e-009
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time  (hr)  Value (s/m*3)
2     0
3.5   1.19e-006
4     2.35e-005
24    0
96    0
720   0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time  (hr)  Value (s/m*3)
2     1.13e-006
3.5   5.75e-007
4     1.26e-005
8     5.75e-007
24    4.10e-007
96    1.97e-007
720   6.88e-008
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type               AIR_JUNCTION
downstream_location         AIR_SPACE
upstream                    WW
downstream                  DW
has_filter                  false
flow_rate
Time  (hr)  Value (cfm)
2.035       0
720         119400
end_flow_rate
end_junction
```

```
environment
breathing_rate_sb
Time  (hr)  Value (cfm)
8     0.00035
24    0.00018
720   0.00023
end_breathing_rate_sb
breathing_rate_lpz
Time  (hr)  Value (frac)
8     0.00035
24    0.00018
720   0.00023
end_breathing_rate_lpz
end_environment

control_volume
obj_type                      OBJ_CR
name                          Control_Room
air_volume                    2.1e+005
water_volume                  0
surface_area                  0
has_recirc_filter             false
breathing_rate
Time  (hr)  Value (cfm)
720         0.00035
end_breathing_rate
occupancy_factor
Time  (hr)  Value (frac)
24          1
96          0.6
720         0.4
end_occupancy_factor
end_control_volume

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      Control_Room
downstream                    environment
has_filter                    false
flow_rate
Time  (hr)  Value (cfm)
720         6717
end_flow_rate
X_over_Q_4_ctrl_room
Time  (hr)  Value (s/m*3)
720   0
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time  (hr)  Value (s/m*3)
720   0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time  (hr)  Value (s/m*3)
```

```
720   0
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type                  AIR_JUNCTION
downstream_location            AIR_SPACE
upstream                       environment
downstream                     Control_Room
has_filter                     false
flow_rate
Time   (hr)   Value (cfm)
720           6717
end_flow_rate
end_junction
```

Appendix C3
STARDOSE Result File (Excerpts)

edit time 720.000000

Control_Room

	thyroid	wbody	skin	CEDE
Total dose:	6.63E+001	4.69E-002	1.12E+000	2.31E+000
Noble gas	0.00E+000	4.27E-002	1.08E+000	0.00E+000
Org iodine	1.03E+001	2.08E-004	2.07E-003	3.15E-001
Elem iodine	4.46E+001	3.10E-003	2.85E-002	1.39E+000
Part iodine	1.08E+001	9.18E-004	8.07E-003	3.38E-001
Cesium	9.12E-002	0.00E+000	0.00E+000	1.02E-001
Tellurium	4.65E-001	0.00E+000	0.00E+000	2.25E-002
Barium	9.28E-004	0.00E+000	0.00E+000	3.68E-003
Noble metal	3.83E-004	0.00E+000	0.00E+000	2.05E-002
Lanthanides	7.68E-005	0.00E+000	0.00E+000	8.96E-003
Cerium	3.16E-005	0.00E+000	0.00E+000	9.04E-002
Strontinum	1.60E-003	0.00E+000	0.00E+000	1.97E-002

environment

	thyroid	wbody	skin	CEDE
EAB dose:	3.94E+001	2.89E-001	1.88E-001	1.40E+000
LPZ dose:	6.09E+001	4.64E-001	5.55E-001	2.01E+000

STARDOSE 1.01 (c) 1996-2002 Polestar Applied Technology, Inc.
Fri Jul 28 15:07:06 2006
Total elapsed hours: 0, mins: 2, secs: 9

Appendix C4
STARDOSE (with coolant activity) Result File (Excerpts)

edit time 0.001670

Coolant

I131Org	5.39E+02
I132Org	7.85E+02
I133Org	1.12E+03
I134Org	1.24E+03
I135Org	1.06E+03
I131Elem	1.74E+04
I132Elem	2.54E+04
I133Elem	3.61E+04
I134Elem	4.00E+04
I135Elem	3.43E+04
I131Part	3.42E+05
I132Part	4.97E+05
I133Part	7.07E+05
I134Part	7.84E+05
I135Part	6.71E+05

edit time 0.008330

DW

I131Org	5.12E+02
I132Org	7.45E+02
I133Org	1.06E+03
I134Org	1.17E+03
I135Org	1.01E+03
I131Elem	1.66E+04
I132Elem	2.41E+04
I133Elem	3.43E+04
I134Elem	3.78E+04
I135Elem	3.25E+04
I131Part	0.00E+00
I132Part	0.00E+00
I133Part	0.00E+00
I134Part	0.00E+00
I135Part	0.00E+00

edit time 720.000000

Control_Room

	thyroid	wbody	skin	CEDE
Total dose:	6.64E+001	4.69E-002	1.12E+000	2.31E+000
Noble gas	0.00E+000	4.27E-002	1.08E+000	0.00E+000
Org iodine	1.04E+001	2.09E-004	2.09E-003	3.18E-001
Elem iodine	4.46E+001	3.10E-003	2.85E-002	1.39E+000
Part iodine	1.08E+001	9.18E-004	8.07E-003	3.38E-001
Cesium	9.12E-002	0.00E+000	0.00E+000	1.02E-001
Tellurium	4.65E-001	0.00E+000	0.00E+000	2.25E-002
Barium	9.28E-004	0.00E+000	0.00E+000	3.68E-003
Noble metal	3.83E-004	0.00E+000	0.00E+000	2.05E-002
Lanthanides	7.68E-005	0.00E+000	0.00E+000	8.96E-003
Cerium	3.16E-005	0.00E+000	0.00E+000	9.04E-002

```
Strontinum   1.60E-003  0.00E+000  0.00E+000  1.97E-002


environment

            thyroid    wbody      skin       CEDE
EAB dose:   3.94E+001  2.89E-001  1.88E-001  1.41E+000
LPZ dose:   6.10E+001  4.65E-001  5.55E-001  2.01E+000

STARDOSE 1.01 (c) 1996-2002 Polestar Applied Technology, Inc.
Wed Aug 09 13:32:58 2006
Total elapsed hours: 0, mins: 2, secs: 39
```

Appendix D
Application of the Alternative Source Term (AST) to TVA/BFN LOCA Analysis Using RADTRAD, Without Credit for Drywell Sprays

Approach

Application of the AST to the TVA/BFN LOCA analysis involves the following steps:

- Review Regulatory Guide 1.183 (Reference D-1) to ensure that methods being applied to the TVA/BFN LOCA analysis conform to the requirements of that document.
- Calculate removal rates for iodine and particulates to be credited in the drywell (no credit is taken for drywell sprays).
- Using the calculated removal rates and other input data compiled in Reference D-2, prepare a RADTRAD (Reference D-3) analysis of the TVA/BFN LOCA radiation doses for offsite (EAB and LPZ) as well as for control room.
- Obtain the dose contribution to control room personnel from radiation sources outside the control room.
- Prepare an independent review of the overall AST dose analysis (Appendix E).

Assumptions

1. No credit is taken for spray removal in the drywell. Credit is taken for natural removal.

2. Natural removal rates for particulate in the drywell are to be based on the Powers model described in NUREG/CR-6604 (Reference D-4).

Justification: This method is an acceptable approach identified in Reference D-1.

3. At the end of the release phase, it is assumed that complete mixing between the drywell and the torus will commence. Suppression pool scrubbing is neglected.

Justification: Because of steam and hydrogen produced during and after the core quench, a rapid exchange of drywell and torus gas space is expected. A mixing rate of one torus volume per minute is assumed. Suppression pool scrubbing is neglected even though Reference D-1 states that it may be acceptable on a case-by-case basis.

4. Assume that the inboard MSIV in one steam line fails to close, that two steam lines are assumed to be leak tight, and that the total steam line leakage is divided between the two other lines such that the maximum single-line leakage occurs in the line with the failed-open MSIV and the remainder occurs in the second line.

Justification: This single-failure/leakage combination conservatively reduces the residence time and activity removal in the steam lines.

5. No credit is taken for holdup and mixing in the turbine building volume.

Justification: This assumption is made to conform to Reference D-1.

6. The assumption is made that the elemental iodine will deposit preferentially on the aerosol rather than on the structure and will be removed at the lower aerosol removal rates.

Justification: Reference D-5 establishes that even before the start of the in-vessel release phase (and even for a smaller, pre-uprate core power involving a smaller fission product mass release) the minimum surface area of the dispersed aerosol would be approximately six times the 3409 m^2 deposition area (Reference D-2, Item 7.10 for elemental iodine given in the same reference.

Design Input

Power Level, Core Inventory

- Core power level:
  - For removal lambda calculation = 3952 MWt (No 1.02 factor used because low power is conservative.) (Reference D-2, Item 8.1
  - Core power level for dose calculation = 4031 MWt (1.02 factor included) (Reference D-2, Items 1.2 & 8.1
- Core inventory associated with Power Uprate and 24 month fuel cycles obtained using the ORIGEN computer code at the 4031 MWt power level (1.02 x 3952 MWt), compiled in Item 1.1 of Reference D-2, on a per MWt basis. The subject analysis makes use of 60 dose significant radionuclides (the default nuclides for RADTRAD).

Isotopes	Ci/MWt at t = 0	Isotopes	Ci/MWt at t = 0
CO58	1.430E+02	TE131M	5.155E+03
CO60	1.425E+02	I131	2.669E+04
KR85	3.601E+02	TE132	3.829E+04
KR85M	7.329E+03	I132	3.885E+04
RB86	6.372E+01	I133	5.534E+04
KR87	1.446E+04	XE133	5.504E+04
KR88	2.009E+04	I134	6.141E+04
SR89	2.786E+04	CS134	5.703E+03
SR90	3.165E+03	I135	5.250E+04
Y90	3.283E+03	XE135	1.971E+04
SR91	3.487E+04	CS136	1.941E+03
Y91	3.583E+04	CS137	4.037E+03
SR92	3.677E+04	BA139	4.930E+04
Y92	3.696E+04	BA140	4.909E+04
Y93	4.147E+04	LA140	5.231E+04
ZR95	4.880E+04	LA141	4.498E+04
NB95	4.897E+04	CE141	4.535E+04
ZR97	4.953E+04	LA142	4.397E+04
MO99	5.088E+04	CE143	4.245E+04
TC99M	4.454E+04	PR143	4.113E+04
RU103	4.094E+04	CE144	3.810E+04
RU105	2.710E+04	ND147	1.806E+04
RH105	2.559E+04	NP239	5.201E+05
RU106	1.488E+04	PU238	2.805E+02
SB127	2.796E+03	PU239	1.234E+01
TE127	2.773E+03	PU240	1.730E+01
TE127M	3.721E+02	PU241	4.450E+03
SB129	8.457E+03	AM241	5.449E+00
TE129	8.326E+03	CM242	1.234E+03
TE129M	1.615E+03	CM244	5.697E+01

Activity Releases to the Containment

- Per Reference D-1, all activity is initially assumed to be released to the drywell. The release rates, per Reference D-2, Items 2.1 through 2.3, are as follows:

Release Time Frame	Fraction of Core Inventory Released	
0 – 0.033 hours	No Release	
0.033 - 0.533 hours	Gases	Xe, Kr – 0.1/hr (0.05 total) Elemental I – 4.9E-3/hr (2.4E-3 total) Organic I – 1.5E-4/hr (7.5E-5 total)
	Aerosols	I, Br – 0.095/hr (0.0475 total) Cs, Rb – 0.1/hr (0.05 total)
0.533 –2.033 hours	Gases	Xe, Kr – 0.63/hr (0.95 total) Elemental I – 8.1E-3/hr (1.2E-2 total) Organic I – 2.5E-4/hr (3.8E-4 total)
	Aerosols	I, Br – 0.158/hr (0.2375 total) Cs, Rb – 0.133/hr (0.2 total) Te Group – 0.033/hr (0.05 total) Ba, Sr – 0.013/hr (0.02 total) Noble Metals – 1.7E-3/hr (2.5E-3 total) La Group – 1.3E-4/hr (2E-4 total) Ce Group – 3.3E-4/hr (5E-4 total)

Volumes

- Drywell Free Volume: 159,000 ft3 (min of Item 3.1 of Reference D-2)
- Torus Airspace Free Volume: 119,400 ft3 (min of Item 3.2 of Reference D-2)
- Suppression Pool Volume plus Reactor Coolant Mass: 141,051 ft^3 as the sum of 121,500 ft^3 (min of Item 3.3 of Reference D-2) and 19,551 ft^3 (Item 6.7of Reference D-2 assuming a water density of 62.4 lbm/ft^3)
- Effective Condenser Volume: 122,400 cuft, (Reference D-6)
- Stack Room Free Volume: 69,120 cuft (Reference D-2, Item 12.5), with only 50% of this volume credited for incomplete mixing.
- Low Pressure Turbine Volume: 568.6 cuft (Reference D-2, Item 3.13)
- Reactor Building Free Volume: 1,931,502 cuft (Reference D-2, Item 3.4). This value assumed 50% mixing.
- Control Room Free Volume: 210,000 cuft (Reference D-2, Item 12.8)

Exchange Rates, Leakage Rates

- Primary Containment Leak Rate to Reactor Building: 2%/day for 30 days, i.e., 132.5 cfh from the DW and 99.5 cfh from the Torus air space (Reference D-2, Items 3.5 & 3.6).
- SGTS exhaust Flow: 24,750 cfm (Reference D-2, Item 12.13)
- Hardened Wetwell Vent (HWWV) Valve Leakage: 10 cfh with a delay of 8 hours before the start of the leakage (Reference D-2, Item 12.6)
- Base of Stack Leakage (stack bypass): 10 cfm (Reference D-2, Item 12.2)
- Control Room Makeup Flow Rate: 3000 cfm (Reference D-2, Item 12.4)
- Control Room Unfiltered Inleakage: 3717 cfm (Reference D-2, Item 12.10)
- Containment Atmospheric Dilution (CAD) System Flow Rate: 139 cfm for 24 hrs at 10 days, 20 days, 29 days, (Reference D-2, Item 12.3)
- MSIV leakage: 150 scfh total (Reference D-2, Item 3.9)
- Maximum per MSIV leakage: 100 scfh (Reference D-2, Item 3.10)
- Turbine Roof Exhaust Rate: 144,000 cfm (Reference D-2, Item 12.1)
- ESF (ECCS) Leakage Into Reactor Building: 5 gpm (Reference D-2, Item 12.7), 10% of the coolant iodine is assumed to become airborne (Reference D-2, Item 4.3)

- Volumetric flowrate, Drywell to Main Condenser (MSIV leakage): 1.30 cfm (Reference D-2, Item 3.7)
- Volumetric flowrate, Drywell to Environment (MSIV leakage Main Condenser bypass): 0.0067 cfm (=0.5% x 1.30 cfm per Reference D-2, Items 3.7 & 3.14)
- Volumetric flowrate, Main Condenser to Environment: 3.97 cfm (Reference D-2, Item 3.8)

Occupancy Factors, Breathing Rates

- Control Room Occupancy Factors: 100% 0-24 hours, 60% 1-4 days, 40% 4-30 days (Reference D-2, Item 5.2)
- Control Room Breathing Rate: 3.5E-4 m^3/s for 0 to 30 days (Reference D-2, Item 5.1)
- Offsite Breathing Rate: 3.5E-4 m^3/s for 0 to 8 hours (Reference D-2, Item 5.1)
  1.8E-4 m^3/s for 8 to 24 hours
  2.3E-4 m^3/s for 1 to 30 days

Note that the occupancy factors are very conservative given actual plant staffing and monitoring of operator accumulated doses. However, use of such occupancy factors serves to account for operator ingress and egress at the time of shift changes.

Dispersion Coefficients

The following are the X/Q values (Reference D-2, Items 12.12 through 12.14) used in this analysis (all units in sec/m^3). Note that the Control Room X/Q values **do not** include the factor of 2 reduction allowed by the Standard Review Plan section 6.4 (intakes on opposite sides of the building).

- X/Q for EAB

	0 – 2 hr
Fumig. Top of Stack:	2.35E-5
Top of Stack Release:	1.19E-6
Base of Stack Release:	2.62E-4
Building Release:	2.62E-4

- X/Q for LPZ

	0-2 hr	2-8 hr	8-24 hr	1-4 days	4-30 days
Fumigation Top of Stack:	1.26E-5				
Top of Stack Release:	1.13E-6	5.75E-7	4.10E-7	1.97E-7	6.88E-8
Base of Stack Release:	1.31E-4	6.61E-5	4.69E-5	2.23E-5	7.96E-6
Building Releases:	1.31E-4	6.61E-5	4.69E-5	2.23E-5	7.96E-6

- X/Q for Control Room (does not include a 50% reduction allowed by SRP Section 6.4)

	0-2 hr	2-8 hr	8-24 hr	1-4 days	4-30 days
Fumig. Top of Stack:	3.40E-5				
Top of Stack Release:	1.41E-7	4.50E-8	2.54E-8	7.36E-9	1.24E-9
Base of Stack Release:	2.00E-4	1.28E-4	5.72E-5	4.05E-5	3.09E-5
Turbine Building Roof Ventilators Release:	2.17E-4	1.64E-4	7.89E-5	4.33E-5	3.35E-5

Filter Efficiencies, Removal Coefficients

- SGTS HEPA Filter Efficiency: 90% (Reference D-2, Item 4.1)
- CREVS HEPA Filter Efficiency: 90% (Reference D-2, Item 4.1)
- Delay for CREVS filter credit: 10 minutes (Reference D-2, Item 4.2)
- Removal Efficiencies in the Steam Lines and Main Condenser (Reference D-2, Item 4.4)

	Removal Efficiency for Aerosol Particles	Removal Efficiency for Elemental Iodine
Steam Line Leakage * (Drywell to Main Condenser)	99.87%	99.01%
MC Bypass (Drywell to Environment)	89.33%	16.37%

(*) These removal efficiencies applied to a leakage entering the main condenser volume include removal in the condenser downstream.

Calculation of Removal Rates for the Drywell

Removal rates are calculated in two sections: (1) particulate removal, (2) elemental iodine removal.

Drywell Particulate Removal (Natural Removal Coefficients for Particulate)

The BWR natural removal coefficients for particulate from Reference D-4 are used. These correlations are based on reactor power, the reactor power on which this calculation is based in 3952 MWt. The correlations are defined in Reference D-4 as follows (Table 2.2.2.1-3, 10th percentile):

For gap release, from t = 0 to t = 1800 seconds after start of gap release (t = 120 to t = 1920 seconds accident time)

λ = 1.285[exp(-2111/P(MWt)] = 1.285[exp(-2111/3952)] = 0.75 per hour

For gap release, from t = 1800 to t = 7200 seconds after start of gap release (t = 1920 to t = 7320 seconds accident time)

λ = 1.161[exp(-2274/P(MWt)] = 1.161[exp(-2274/3952)] = 0.65 per hour

For early in-vessel release, from t = 1800 to t = 7200 seconds after start of gap release (t = 1920 to t = 7320 seconds accident time)

λ = 0.520[exp(-2173/P(MWt)] = 0.520[exp(-2173/3952)] = 0.3 per hour

For gap + early in-vessel release, from t = 7200 to t = 18000 seconds (after start of gap release, t = 7320 to t = 18120 seconds accident time)

λ = 1.551[exp(-1507/P(MWt)] = 1.551[exp(-1507/3952)] = 1.06 per hour

For gap + early in-vessel release, from t = 18000 to t = 30000 seconds (after start of gap release, t = 18120 to t = 30120 seconds accident time)

λ = 0.836[exp(-1051/P(MWt)] = 0.836[exp(-1051/3952)] = 0.64 per hour

For gap + early in-vessel release, from t = 30000 to t = 43200 seconds (after start of gap release, t = 30120 to t = 43320 seconds accident time)

λ = 0.780[exp(-1316/P(MWt)] = 0.780[exp(-1316/3952)] = 0.56 per hour

For gap + early in-vessel release, from t = 43200 to t = 70000 seconds (after start of gap release, t = 43320 to t = 70120 seconds accident time)

λ = 0.778[exp(-1548/P(MWt)] = 0.778[exp(-1548/3952)] = 0.53 per hour

For gap + early in-vessel release, from t = 70000 to t = 86400 seconds (after start of gap release, t = 70120 to t = 86520 seconds accident time)

λ = 0.780[exp(-1686/P(MWt)] = 0.780[exp(-1686/3952)] = 0.51 per hour

To combine the removal rates for the gap and early in-vessel, the two rates can be weighted by the relative release magnitudes. Since most of the fission product mass is made up of cesium, and since the cesium release during the early in-vessel release phase is four times that during the gap release phase (Reference D-1), the "effective" removal rate would be:

λ(effective) = (4*0.3 + 0.65)/5 = 0.37.

Using this effective value, the BFN natural removal rates for particulate are:

t = 0 to t = 120 seconds -	0 per hour
t = 120 seconds to t = 1920 seconds -	0.75 per hour
t = 1920 seconds to t = 7320 seconds -	0.37 per hour
t = 7320 seconds to t = 18120 seconds -	1.06 per hour
t = 18120 seconds to t = 30120 seconds -	0.64 per hour
t = 30120 seconds to t = 43320 seconds -	0.56 per hour
t = 43320 seconds to t = 70120 seconds -	0.53 per hour
t = 70120 seconds to t = 86520 seconds -	0.51 per hour

Drywell Elemental Iodine Removal (Natural Removal Coefficients for Elemental Iodine)

SRP 6.5.2 (Reference D-7, Revision 2) provides the following expression for elemental iodine removal by plateout:

λ_w = A*k/V where A = deposition area for elemental iodine = 36694 ft^2 = 3409 m^2 (Item 7.10 of Reference D-2)
k = elemental iodine deposition velocity = 4.9 m/hour (from Reference D-7)
V = drywell volume = 171,000 ft^3 (max - Item 3.1 of Reference D-2) = 4846 m^3

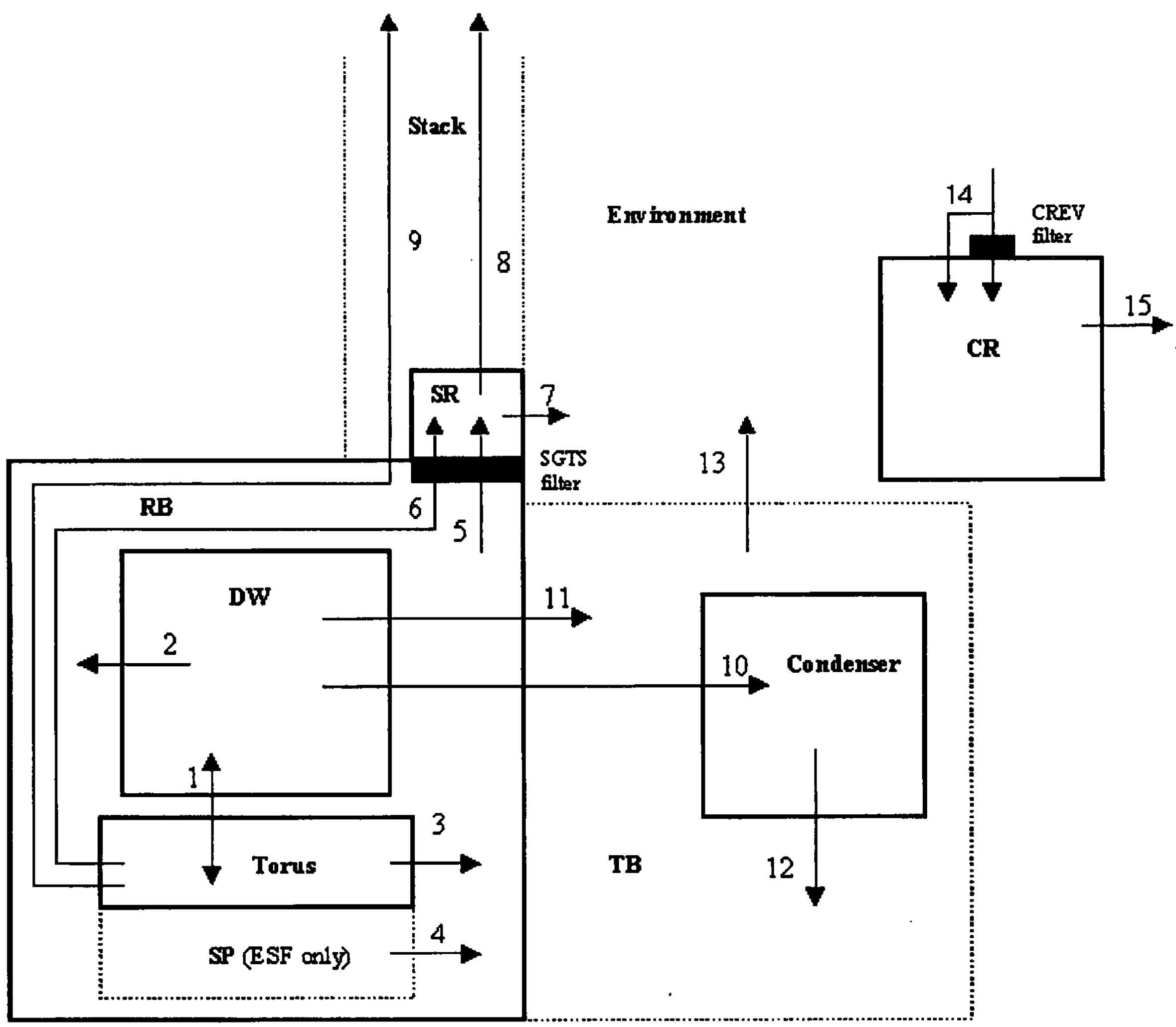
Therefore:

λ_w = 3409*4.9/4846 = 3.4 per hour

Per Assumption 6, the lower more conservative particulate removal rates are used for elemental iodine as well.

RADTRAD Analysis of the TVA/BFN LOCA Using AST

Figure D-1



Plant Model Description

Volumes

Drywell (DW):	159,000 ft^3
Torus Air Space (Torus):	119,400 ft^3
Suppression Pool (SP):	141,051 ft^3
Reactor Building (RB):	1,932,000 ft^3
Steam Lines:	N/A (no holdup, modeled as a filter)
Stack Room (SR):	34,560 ft^3
Stack:	N/A
Main Condenser (MC):	122,400 ft^3
Turbine Building (TB):	1 ft^3 (no credit taken for mixing in the TB)
Control Room (CR):	210,000 ft^3

Junctions

#	From	To	Description
1	DW/Torus	Torus/DW	Mixing flow rate of one torus air volume per minute (119,400 cfm) starting at the end of the release phase (t = 2.033 hours).
2	DW	RB	Primary containment leakage of 2%/day = 2.208 cfm
3	Torus	RB	Primary containment leakage of 2%/day = 1.658 cfm
4	SP	RB	ESF (ECCS) leakage of 5 gpm (0.668 cfm) assumed to start at t = 0. 10% of the ESF (ECCS) leakage iodine inventory reaches the RB atmosphere. This junction is used only in RADTRAD runs 4 and 5 (see below).
5	RB	SR	SGTS exhaust flow rate of 24,750 cfm (filter 90% efficient for aerosols)
6	Torus	SR	CAD release of 139 cfm during one hour at t = 10, 20 and 29 days (filter 90% efficient for aerosols)
7	SR	Environment	SGTS flow bypassing the stack: 10 cfm
8	SR	Environment	SGTS flow released through the stack: 24,740 cfm
9	Torus	Environment	HWWV leakage of 0.167 cfm starting at t = 8 hours (non filtered)
10	DW	Condenser	Leakage through two steam lines: 150 scfh ~ 1.30 cfm with use of a filter to account for deposition
11	DW	TB	Condenser bypass flowpath, corresponding to 0.5% of the steam line leakage flowrate (0.0067 cfm)
12	Condenser	TB	Condenser to turbine building leakage: 3.97 cfm
13	TB	Environment	No credit taken for holdup in the TB: use of a high turbine building exhaust of 100 volumes/minute (i.e., 100 cfm from a 1 ft^3-volume)
14	Environment	CR	Control room inleakage of 6717 cfm: unfiltered inleakage of 3717 cfm + filtered inleakage of 3000 cfm (90% for aerosols) combined into one junction (overall filtration efficiency of 40.2% for aerosols, filter credit taken after a 10 minute delay)
15	CR	Environment	Control room exhaust of 6717 cfm.

The dose calculation model consists of eight control volumes representing the drywell portion of the primary containment (DW), the torus portion of the primary containment (torus), the suppression pool (SP), the reactor building (RB), the stack room (SR), the main condenser (MC), the turbine building (TB) and finally, the control room (CR). Note that since no credit is taken for mixing or holdup in the turbine building, the latter volume is set to 1 ft^3.

All the control volumes are arranged as shown on Figure D-1 with the various junctions that connect them. These junctions are associated with volumetric flows which determine the rate at which radioactivity is exchanged between the control volumes. In addition, removal processes such as sedimentation in pipes and filtration are modeled within and between the control volumes, as appropriate.

The RADTRAD computer code is used to perform this dose calculation.

Multiple runs

Each release pathway to the environment has its own set of X/Qs and needs to be treated separately. Indeed, in RADTRAD, control room X/Q input is part of the control room volume input, not part of the release pathway description. Consequently, to each of the three X/Q sets corresponds one different RADTRAD run.

Run D1: Release from the base of the stack
Run D2: Release from the top of the stack

Run D3: Release from the TB roof

Important note: For each run, the inactive release pathways to the environment are redirected to a dummy volume so that the flow paths are not set to zero. Shutting down completely the inactive junctions would have an impact on the activity present in each control volume over time and would not give correct results. Here is a summary table showing the active/inactive pathways for each run.

Run	Active Pathway (to enviro.)	Inactive Pathways (to dummy)
D1	7	8 ,9, 13
D2	8, 9	7, 13
D3	13	7, 8, 9

ESF (ECCS) Leakage Treatment

Background

Per RG 1.183 (Reference D-1), 10% of the core inventory of iodine (as 97% elemental and 3% organic) must be released to the RB. However, the partitioning of iodine in RG 1.183 amounts to only 5% of elemental and organic iodine (and 95% particulate). Consequently, in order to retrieve the correct amount of iodine in the RB with the correct species, one models the ESF (ECCS) leakage as follows: (1) Twice the core inventory of iodine is placed into the suppression pool so that the pool inventory of elemental and organic iodine corresponds to 10% of the initial inventory, (2) The 5 gpm leakage from the SP to the RB is filtered with a filter efficiency of 100% for the particulate specie so that only the elemental and organic species enter the RB.

Application to RADTRAD

In RADTRAD, releases from the core into a control volume are modeled by directing a fraction of an entire core inventory file into that specific volume. However, it is not possible to distinguish between nuclides, that is to say it is not possible to affect all the AST nuclides to the DW and some additional iodine nuclides to the SP for ESF (ECCS) treatment purposes. Moreover, the code accepts only one inventory file at a time.

One easiest way to model the ESF (ECCS) release would have been to double the initial core inventory and to put 50% of it into the drywell and 50% of it into the suppression pool in the same run. However, this option would have put noble gases in the suppression pool control volume in addition to the iodine and other particle isotopes. While the latter isotopes could be filtered out when modeling the leakage to the reactor building, noble gases cannot be removed. Therefore, this option was abandoned, as it would have tripled the noble gas inventory in the problem. (Note that some noble gases are actually produced, resulting from decay of iodine isotopes in the suppression pool, but there should not be any noble gases in the suppression pool in the first place.)

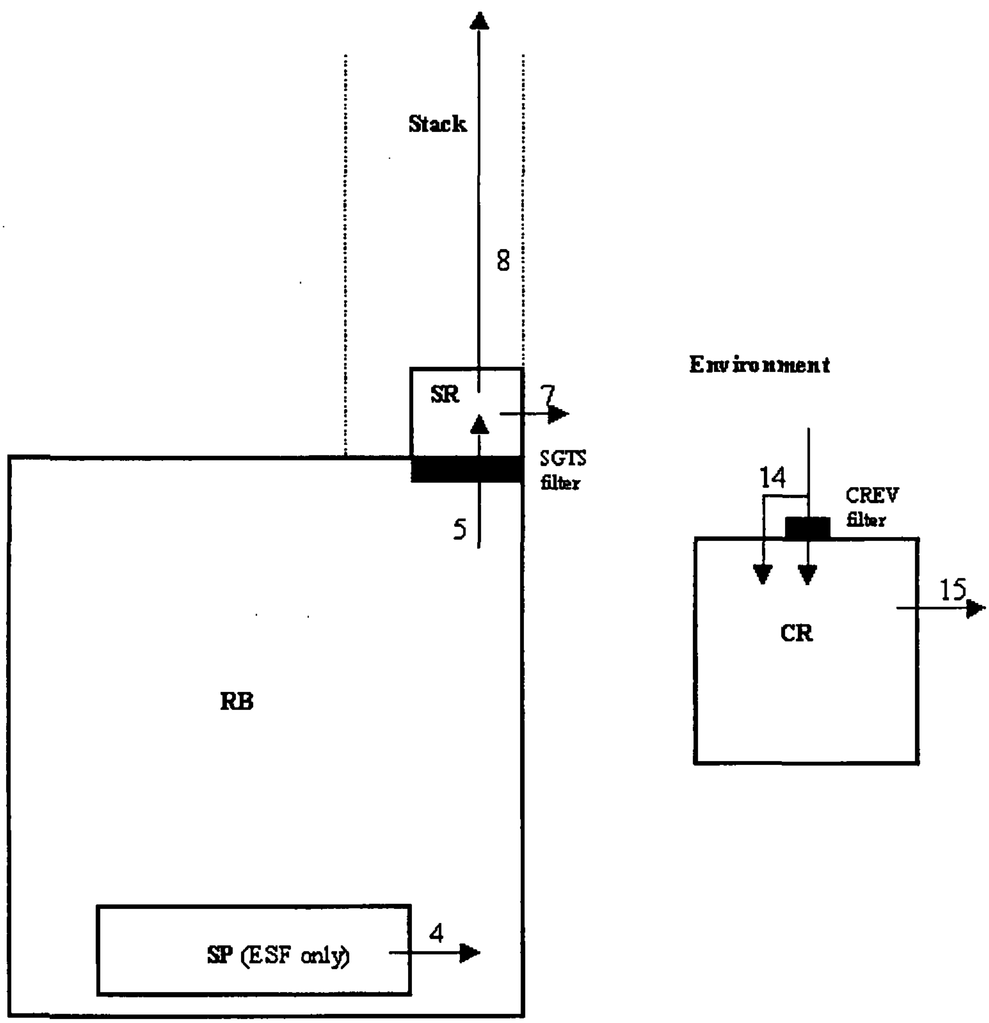
Consequently, a specific nuclide inventory file (named BFNESF.NIF) was prepared. It includes iodine nuclides (with a doubled inventory to reach the 10% release level) and all other nuclides of the original file (but with their inventories set to zero). Two additional RADTRAD runs were then performed with this specific "ESF" source term: one for the ESF (ECCS) activity leaking out to the environment from the base of the stack, one for the leakage out of the stack.

Run D4: ESF Case - Release from the base of the stack
Run D5: ESF Case - Release from the top of the stack

Note that the plant model shown on Figure D-1 was simplified for the ESF runs (D4 & D5). Because the activity from the ESF (ECCS) leakage goes directly from the SP to the reactor building, the following control volumes were removed from the model: DW, Torus, MC, TB. The remaining junctions are 4, 5, 7, 8, 14 and 15. The simplified model for ESF (ECCS) treatment is shown on Figure D-2. The summary table of active/inactive junctions is shown below.

Run	Active Pathway (to enviro.)	Inactive Pathways (to dummy)
D4	7	8
D5	8	7

Figure D-2



RADTRAD Input Files

Main Input Files

Each of the five RADTRAD runs uses a specific main input file (.PSF). These files are the key input files as they contain most the key information related to the run: control volumes, junctions, filter efficiencies, X/Qs etc.

Nuclide Information Files

The 60 isotopes used in RADTRAD are listed in the BFN.NIF or BFNESF.NIF files. One will find the radionuclide inventories listed as Ci/MWt in these two files. As explained in the ESF Leakage Treatment section above, two files were created. The first one called

BFN.NIF is used for the three "main" runs, i.e., runs D1, D2 and D3. The inventory input is the exact inventory of Reference D-2, Item 1.1. The second file called BFNESF.NIF is used for the two ESF runs (D4 & D5). In this file, the iodine isotopes are the only isotopes with a non zero inventory. Actually, the Ci/MWt values in that file correspond to two times the inventory of iodine of Reference D-2, Item 1.1 so that 10% of the core inventory of iodine can be released to the reactor building, as stated in RG 1.183.

Dose Conversion Factors File

The Dose Conversion Factors file used for these RADTRAD runs is based on the Federal Guide Reports 11 and 12. The file used is the default RADTRAD file called FGR11&12.INP.

Release Fraction File

The file called BFN.RFT contains information specific to the AST source term, i.e., the fraction and timing of each release phases. A delay of two minutes is credited before the 30-minute gap release starts, followed by a 1.5-hour early in vessel release phase. The release is complete after 2 hours and 2 minutes (2.033 hr) accident time. This file is in agreement with Reference D-2, Items 2.1 through 2.3.

Matrix of RADTRAD Runs

The table below summarizes the characteristics of each of the five RADTRAD runs performed for this analysis.

RADTRAD Cases

Run #	Release Pathways to the Environment	PSF File	NIF File	DCF File	RFT File
D1	Base of Stack Release (activity in DW)	Nosprays_Stackbase.psf	Bfn.nif	Fgr11&12.inp	Bfn.rft
D2	Top of Stack Release (activity in DW)	Nosprays_Stacktop.psf	Bfn.nif	Fgr11&12.inp	Bfn.rft
D3	TB Roof Release (activity in DW)	Nosprays_Tbroof.psf	Bfn.nif	Fgr11&12.inp	Bfn.rft
D4	Base of Stack Release (iodine ESF activity in SP)	Nosprays_Stackbase_esf.ps f	Bfnesf.nif	Fgr11&12.inp	Bfn.rft
D5	Top of Stack Release (iodine ESF activity in SP)	Nosprays_Stacktop_esf.psf	Bfnesf.nif	Fgr11&12.inp	Bfn.rft

The TEDE value for the control room and offsite will be obtained by adding up the doses of each of these five RADTRAD runs.

Fumigation Time Interval

In order to retrieve the most conservative dose, the half-hour period when fumigation is occurring must correspond to the time interval when the control room dose accumulation rate is maximum. In order to know about this time interval, two additional RADTRAD runs with the Top of Stack release active (runs # D2 and D5) were rerun with the fumigation X/Q applied from start to finish (these new runs are numbered D2' and D5'). The control room dose accumulation rates were retrieved as a function of time, added to one another at each time step so that the peak control room dose accumulation rate could be obtained.

The Appendix D4 spreadsheet shows a peak at about 3.8 hours. Thus, the fumigation X/Q was used in runs D2 and D5 from t = 3.5 to t = 4.0 hours accident time.

Maximum Two-Hour EAB TEDE

The maximum two-hour EAB dose of one complete set of five runs is not the sum of the five maximum two-hour EAB doses of each of the five runs. Consequently, a spreadsheet (Appendix D5) was used to add up the EAB TEDE at each time step for each of the five runs and subsequently retrieve the maximum TEDE over a two-hour period.

Documentation of Runs

- Appendix D1: Seven main input files (.PSF) - runs D1, D2, D2', D3, D4, D5, D5'
- Appendix D2: Four secondary input files - two .NIF, one .RFT, one .INP
- Appendix D3: Five output excerpts are shown – runs D1, D2, D3, D4, D5
- Appendix D4: Fumigation Spreadsheet
- Appendix D5: Max 2-hour EAB TEDE Spreadsheet

Results

In the table below, the CR TEDE reflects a 50% reduction allowed per SRP 6.4. Therefore, these CR doses are half of those documented in Appendix D3.

RADTRAD Results(3)

Run #	Release Pathway	30-d CR TEDE (rem)	Max 2-h EAB TEDE (rem)	30-d LPZ TEDE (rem)
D1	Base of Stack	4.49E-3	(1)	1.08E-2
D2	Top of Stack	2.43E-1	(1)	5.68E-1
D3	TB Roof	1.13E-1	(1)	3.02E-1
D4	ESF (ECCS) - Base of Stack	1.21E-2	(1)	1.25E-2
D5	ESF (ECCS) – Top of Stack	1.12E-1	(1)	3.52E-1
Ref D-8	External Shine	7.62E-1	(2)	(2)
Total	All Pathways	1.25E+0	1.02E+0	1.25E+0

(1) Not Applicable – See Appendix D5
(2) Not applicable for offsite dose
(3) Shine from ND-Q0000-890013, Revision 5 – Not calculated with RADTRAD

Note that additional sensitivity study cases regarding filtered makeup flowrates are discussed and presented in Appendix G.

References

D-1 "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors", US NRC Regulatory Guide 1.183, Revision 0, July 2000
D-2 TVA Calculation ND-Q0999-980016, "Parameters Used in Dose Analysis", Revision 6
D-3 RADTRAD Executable Version 3.02a, January 5, 2000
D-4 US NRC NUREG/CR-6604, "RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation", December 1997
D-5 Attachment 11 to "Calculation Package for Application of the Revised Source Term to the Browns Ferry Nuclear Power Plant", PSAT 04000U.04, Revision 2, June 27, 1996, RIMS # R92960718850
D-6 TVA Calculation NDQ0-999-2001-0019, "Ex-Containment Removal Coefficients for Alternative Source Term Analyses", Revision 2
D-7 Standard Review Plan, Section 6.5.2
D-8 TVA Calculation ND-Q0000-890013, "Post-LOCA Control Room Gamma Dose form Secondary Containment and Core Spray Piping", Revision 5
D-9 0-TI-578, Revision 0004 "Minimizing Primary Coolant Sources Outside Containment" R22

Appendix D1
RADTRAD Main Input Files

RUN D1 – NOSPRAYS_STACKBASE.PSF

```
Radtrad 3.02 1/5/2000
 No DW Sprays - Base of Stack Release
 Nuclide Inventory File:
 c:\polestar\tva\loca ast\radtrad\bfn.nif
 Plant Power Level:
  4.0310E+03
 Compartments:
   9
 Compartment 1:
 DW
   3
  1.5900E+05
   0
   0
   0
   1
   0
 Compartment 2:
 Torus
   3
  1.1940E+05
   0
   0
   0
   0
   0
 Compartment 3:
 RB
   3
  1.9320E+06
   0
   0
   0
   0
   0
 Compartment 4:
 SR
   3
  3.4560E+04
   0
   0
   0
   0
   0
 Compartment 5:
 Condenser
   3
  1.2240E+05
   0
   0
   0
   0
   0
 Compartment 6:
 TB
   3
  1.0000E+00
   0
   0
   0
   0
   0
 Compartment 7:
 Dummy
   3
  1.0000E+06
   0
   0
   0
   0
   0
 Compartment 8:
 CR
   1
  2.1000E+05
   0
   0
   0
   0
   0
 Compartment 9:
 Environment
   2
  0.0000E+00
   0
   0
   0
   0
   0
 Pathways:
  15
 Pathway 1:
 DW to Torus
   1
   2
   2
 Pathway 2:
 Torus to DW
   2
   1
   2
 Pathway 3:
 DW to RB
   1
   3
   2
 Pathway 4:
 Torus to RB
   2
   3
   2
 Pathway 5:
 RB to SR
   3
   4
   2
 Pathway 6:
 Torus to  SR
   2
   4
   2
 Pathway 7:
 Torus to Dummy
   2
   7
   2
 Pathway 8:
 SR to Environment
   4
   9
   2
 Pathway 9:
 SR to Dummy
   4
```

```
  7
  2
Pathway 10:
DW to Condenser
  1
  5
  2
Pathway 11:
DW to TB
  1
  6
  2
Pathway 12:
Condenser to TB
  5
  6
  2
Pathway 13:
TB to Dummy
  6
  7
  2
Pathway 14:
Environment to CR
  9
  8
  2
Pathway 15:
CR to Environment
  8
  9
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\radtrad3.02a\defaults\fgr11&12.inp
c:\polestar\tva\loca ast\radtrad\bfn.rft
  0.0000E+00
  1
  9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  9
Compartment 1:
  0
  1
  0
  0
  0
  0
  0
  1
 10
  0.0000E+00   0.0000E+00
  3.3000E-02   7.5000E-01
  5.3300E-01   3.7000E-01
  2.0330E+00   1.0600E+00
  5.0330E+00   6.4000E-01
  8.3670E+00   5.6000E-01
  1.2033E+01   5.3000E-01
  1.9478E+01   5.1000E-01
  2.4033E+01   0.0000E+00
  7.2000E+02   0.0000E+00
  1
 10
  0.0000E+00   0.0000E+00
  3.3000E-02   7.5000E-01
  5.3300E-01   3.7000E-01
  2.0330E+00   1.0600E+00
  5.0330E+00   6.4000E-01
  8.3670E+00   5.6000E-01
  1.2033E+01   5.3000E-01
  1.9478E+01   5.1000E-01
  2.4033E+01   0.0000E+00
  7.2000E+02   0.0000E+00
Compartment 2:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 3:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 4:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 5:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 6:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 7:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 8:
  0
  1
  0
  0
  0
```

```
 0
 0
 0
 0
Compartment 9:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Pathways:
 15
Pathway 1:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 2.0330E+00   1.1940E+05   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 2:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 2.0330E+00   1.1940E+05   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 3:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   2.2080E+00   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   1.6580E+00   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   2.4750E+04   9.0000E+01   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 6:
 3
 0
 0
 0
 0
 1
 7
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 2.4000E+02   1.3900E+02   9.0000E+01   0.0000E+00
0.0000E+00
 2.6400E+02   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 4.8000E+02   1.3900E+02   9.0000E+01   0.0000E+00
0.0000E+00
 5.0400E+02   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 6.9600E+02   1.3900E+02   9.0000E+01   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 7:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 8.0000E+00   1.6700E-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
Pathway 8:
 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
Pathway 9:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   2.4740E+04   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 10:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   1.3000E+00   9.9870E+01   9.9010E+01
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 11:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   6.7000E-03   8.9330E+01   1.6370E+01
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 12:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   3.9700E+00   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 13:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   1.0000E+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 14:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   6.7170E+03   0.0000E+00   0.0000E+00
0.0000E+00
 1.6700E-01   6.7170E+03   4.0200E+01   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 15:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   6.7170E+03   1.0000E+02   1.0000E+02
1.0000E+02
 7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 0
 0
 0
 0
```

```
 0
Dose Locations:
 3
Location 1:
Control_Room
 8
 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
Location 2:
EAB
 9
 1
 2
 0.0000E+00   2.6200E-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 3:
LPZ
 9
 1
 6
 0.0000E+00   1.3100E-04
 2.0000E+00   6.6100E-05
 8.0000E+00   4.6900E-05
 2.4000E+01   2.2300E-05
 9.6000E+01   7.9600E-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
Effective Volume Location:
 1
 6
 0.0000E+00   2.0000E-04
 2.0000E+00   1.2800E-04
 8.0000E+00   5.7200E-05
 2.4000E+01   4.0500E-05
 9.6000E+01   3.0900E-05
 7.2000E+02   0.0000E+00
Simulation Parameters:
 4
 0.0000E+00   1.0000E-01
 8.0000E+00   1.0000E+00
 2.4000E+01   2.4000E+01
 7.2000E+02   0.0000E+00
Output Filename:
C:\Polestar\TVA\LOCA
AST\Radtrad\Nosprays_stackbase.o0
 1
 1
 1
 1
 1
End of Scenario File
```

RUN D2 – NOSPRAYS_STACKTOP.PSF

```
Radtrad 3.02 1/5/2000
 No DW Sprays - Top of Stack Release
 Nuclide Inventory File:
 c:\polestar\tva\loca ast\radtrad\bfn.nif
 Plant Power Level:
  4.0310E+03
 Compartments:
   9
 Compartment 1:
 DW
   3
  1.5900E+05
   0
   0
   0
   1
   0
 Compartment 2:
 Torus
   3
  1.1940E+05
   0
   0
   0
   0
   0
 Compartment 3:
 RB
   3
  1.9320E+06
   0
   0
   0
   0
   0
 Compartment 4:
 SR
   3
  3.4560E+04
   0
   0
   0
   0
   0
 Compartment 5:
 Condenser
   3
  1.2240E+05
   0
   0
   0
   0
   0
 Compartment 6:
 TB
   3
  1.0000E+00
   0
   0
   0
   0
   0
 Compartment 7:
 Dummy
   3
  1.0000E+06
   0
   0
```

```
  0
  0
  0
Compartment 8:
CR
  1
 2.1000E+05
  0
  0
  0
  0
  0
Compartment 9:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Pathways:
 15
Pathway 1:
DW to Torus
  1
  2
  2
Pathway 2:
Torus to DW
  2
  1
  2
Pathway 3:
DW to RB
  1
  3
  2
Pathway 4:
Torus to RB
  2
  3
  2
Pathway 5:
RB to SR
  3
  4
  2
Pathway 6:
Torus to  SR
  2
  4
  2
Pathway 7:
Torus to Environment
  2
  9
  2
Pathway 8:
SR to Dummy
  4
  7
  2
Pathway 9:
SR to Environment
  4
  9
  2
Pathway 10:
DW to Condenser
  1
  5
  2
Pathway 11:
DW to TB
  1
  6
  2
Pathway 12:
Condenser to TB
  5
  6
  2
Pathway 13:
TB to Dummy
  6
  7
  2
Pathway 14:
Environment to CR
  9
  8
  2
Pathway 15:
CR to Environment
  8
  9
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\radtrad3.02a\defaults\fgr11&12.inp
c:\polestar\tva\loca ast\radtrad\bfn.rft
  0.0000E+00
  1
  9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  9
Compartment 1:
  0
  1
  0
  0
  0
  0
  0
  1
 10
  0.0000E+00   0.0000E+00
  3.3000E-02   7.5000E-01
  5.3300E-01   3.7000E-01
  2.0330E+00   1.0600E+00
  5.0330E+00   6.4000E-01
  8.3670E+00   5.6000E-01
  1.2033E+01   5.3000E-01
  1.9478E+01   5.1000E-01
  2.4033E+01   0.0000E+00
  7.2000E+02   0.0000E+00
  1
 10
  0.0000E+00   0.0000E+00
  3.3000E-02   7.5000E-01
  5.3300E-01   3.7000E-01
  2.0330E+00   1.0600E+00
  5.0330E+00   6.4000E-01
  8.3670E+00   5.6000E-01
  1.2033E+01   5.3000E-01
  1.9478E+01   5.1000E-01
  2.4033E+01   0.0000E+00
  7.2000E+02   0.0000E+00
```

```
Compartment 2:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 3:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 4:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 5:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 6:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 7:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 8:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 9:
 0
 1
 0
 0
 0
```

```
   0
   0
   0
   0
 Pathways:
  15
 Pathway 1:
   0
   0
   0
   0
   0
   1
   3
   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
   2.0330E+00   1.1940E+05   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 2:
   0
   0
   0
   0
   0
   1
   3
   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
   2.0330E+00   1.1940E+05   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 3:
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   2.2080E+00   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   1.6580E+00   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  2.4750E+04  9.0000E+01  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 6:
 3
 0
 0
 0
 0
 1
 7
 0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
0.0000E+00
 2.4000E+02  1.3900E+02  9.0000E+01  0.0000E+00
0.0000E+00
 2.6400E+02  0.0000E+00  0.0000E+00  0.0000E+00
0.0000E+00
 4.8000E+02  1.3900E+02  9.0000E+01  0.0000E+00
0.0000E+00
 5.0400E+02  0.0000E+00  0.0000E+00  0.0000E+00
0.0000E+00
 6.9600E+02  1.3900E+02  9.0000E+01  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 7:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
0.0000E+00
 8.0000E+00  1.6700E-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
Pathway 8:
 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
Pathway 9:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00  2.4740E+04  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 10:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00  1.3000E+00  9.9870E+01  9.9010E+01
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 11:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00  6.7000E-03  8.9330E+01  1.6370E+01
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 12:
 0
 0
 0
 0
 0
 1
 2
```

```
  0.0000E+00   3.9700E+00   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 13:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   1.0000E+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 14:
  0
  0
  0
  0
  0
  1
  3
  0.0000E+00   6.7170E+03   0.0000E+00   0.0000E+00
0.0000E+00
  1.6700E-01   6.7170E+03   4.0200E+01   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 15:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   6.7170E+03   1.0000E+02   1.0000E+02
1.0000E+02
  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:
 Control_Room
  8
  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
 Location 2:
 EAB
  9
  1
  4
  0.0000E+00   1.1900E-06
  3.5000E+00   2.3500E-05
  4.0000E+00   1.1900E-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:
 LPZ
  9
  1
  8
  0.0000E+00   1.1300E-06
  2.0000E+00   5.7500E-07
  3.5000E+00   1.2600E-05
  4.0000E+00   5.7500E-07
  8.0000E+00   4.1000E-07
  2.4000E+01   1.9700E-07
  9.6000E+01   6.8800E-08
  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
 Effective Volume Location:
  1
  8
  0.0000E+00   1.4100E-07
  2.0000E+00   4.5000E-08
  3.5000E+00   3.4000E-05
  4.0000E+00   4.5000E-08
  8.0000E+00   2.5400E-08
  2.4000E+01   7.3600E-09
  9.6000E+01   1.2400E-09
  7.2000E+02   0.0000E+00
 Simulation Parameters:
  4
  0.0000E+00   1.0000E-01
  8.0000E+00   1.0000E+00
  2.4000E+01   2.4000E+01
  7.2000E+02   0.0000E+00
 Output Filename:
 C:\Polestar\TVA\LOCA
AST\Radtrad\Nosprays_stacktop.o0
  1
  1
  1
  1
  1
 End of Scenario File
```

RUN D2' – NOSPRAYS_STACKTOP_FUMIGATION.PSF

```
Radtrad 3.02 1/5/2000
 No DW Sprays - Top of Stack Release - CR Fumigation
X/Q
 Nuclide Inventory File:
 c:\polestar\tva\loca ast\radtrad\bfn.nif
 Plant Power Level:
  4.0310E+03
 Compartments:
   9
 Compartment 1:
 DW
   3
  1.5900E+05
   0
   0
   0
   1
   0
 Compartment 2:
 Torus
   3
  1.1940E+05
   0
   0
   0
   0
   0
 Compartment 3:
 RB
   3
  1.9320E+06
   0
   0
   0
   0
   0
 Compartment 4:
 SR
   3
  3.4560E+04
   0
   0
   0
   0
   0
 Compartment 5:
 Condenser
   3
  1.2240E+05
   0
   0
   0
   0
   0
 Compartment 6:
 TB
   3
  1.0000E+00
   0
   0
   0
   0
   0
 Compartment 7:
 Dummy
   3
  1.0000E+06
   0
   0
   0
   0
   0
 Compartment 8:
CR
  1
 2.1000E+05
  0
  0
  0
  0
  0
Compartment 9:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Pathways:
 15
Pathway 1:
DW to Torus
  1
  2
  2
Pathway 2:
Torus to DW
  2
  1
  2
Pathway 3:
DW to RB
  1
  3
  2
Pathway 4:
Torus to RB
  2
  3
  2
Pathway 5:
RB to SR
  3
  4
  2
Pathway 6:
Torus to  SR
  2
  4
  2
Pathway 7:
Torus to Environment
  2
  9
  2
Pathway 8:
SR to Dummy
  4
  7
  2
Pathway 9:
SR to Environment
  4
  9
  2
Pathway 10:
DW to Condenser
  1
  5
  2
Pathway 11:
DW to TB
  1
  6
```

```
2
Pathway 12:
Condenser to TB
 5
 6
 2
Pathway 13:
TB to Dummy
 6
 7
 2
Pathway 14:
Environment to CR
 9
 8
 2
Pathway 15:
CR to Environment
 8
 9
 2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
 1
 1   1.0000E+00
c:\radtrad3.02a\defaults\fgr11&12.inp
c:\polestar\tva\loca ast\radtrad\bfn.rft
 0.0000E+00
 1
 9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
Overlying Pool:
 0
 0.0000E+00
 0
 0
 0
 0
Compartments:
 9
Compartment 1:
 0
 1
 0
 0
 0
 0
 0
 1
 10
 0.0000E+00   0.0000E+00
 3.3000E-02   7.5000E-01
 5.3300E-01   3.7000E-01
 2.0330E+00   1.0600E+00
 5.0330E+00   6.4000E-01
 8.3670E+00   5.6000E-01
 1.2033E+01   5.3000E-01
 1.9478E+01   5.1000E-01
 2.4033E+01   0.0000E+00
 7.2000E+02   0.0000E+00
 1
 10
 0.0000E+00   0.0000E+00
 3.3000E-02   7.5000E-01
 5.3300E-01   3.7000E-01
 2.0330E+00   1.0600E+00
 5.0330E+00   6.4000E-01
 8.3670E+00   5.6000E-01
 1.2033E+01   5.3000E-01
 1.9478E+01   5.1000E-01
 2.4033E+01   0.0000E+00
 7.2000E+02   0.0000E+00
Compartment 2:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 3:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 4:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 5:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 6:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 7:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 8:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 9:
 0
 1
 0
 0
 0
 0
```

```
 0
 0
 0
Pathways:
 15
Pathway 1:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 2.0330E+00   1.1940E+05   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 2:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 2.0330E+00   1.1940E+05   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 3:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   2.2080E+00   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   1.6580E+00   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   2.4750E+04   9.0000E+01   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 6:
 3
 0
 0
 0
 0
 1
 7
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 2.4000E+02   1.3900E+02   9.0000E+01   0.0000E+00
0.0000E+00
 2.6400E+02   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 4.8000E+02   1.3900E+02   9.0000E+01   0.0000E+00
0.0000E+00
 5.0400E+02   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 6.9600E+02   1.3900E+02   9.0000E+01   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 7:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
 8.0000E+00   1.6700E-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
Pathway 8:
 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
Pathway 9:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   2.4740E+04   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 10:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   1.3000E+00   9.9870E+01   9.9010E+01
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 11:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   6.7000E-03   8.9330E+01   1.6370E+01
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 12:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   3.9700E+00   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 13:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   1.0000E+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 14:
 0
 0
 0
 0
 0
 1
 3
 0.0000E+00   6.7170E+03   0.0000E+00   0.0000E+00
0.0000E+00
 1.6700E-01   6.7170E+03   4.0200E+01   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 15:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00   6.7170E+03   1.0000E+02   1.0000E+02
1.0000E+02
 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:
Control_Room
 8
 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
Location 2:
EAB
  9
  1
  4
  0.0000E+00   1.1900E-06
  4.2000E+00   2.3500E-05
  4.7000E+00   1.1900E-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:
LPZ
  9
  1
  8
  0.0000E+00   1.1300E-06
  2.0000E+00   5.7500E-07
  4.2000E+00   1.2600E-C5
  4.7000E+00   5.7500E-07
  8.0000E+00   4.1000E-07
  2.4000E+01   1.9700E-07
  9.6000E+01   6.8800E-08
  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
Effective Volume Location:
  1
  2
  0.0000E+00   3.4000E-05
  7.2000E+02   0.0000E+00
Simulation Parameters:
  4
  0.0000E+00   1.0000E-01
  8.0000E+00   1.0000E+00
  2.4000E+01   2.4000E+01
  7.2000E+02   0.0000E+00
Output Filename:
C:\Polestar\TVA\LOCA
AST\Radtrad\Nosprays_stacktop_fumigation.o0
  1
  1
  1
  1
  1
End of Scenario File
```

RUN D3 – NOSPRAYS_TBROOF.PSF

```
Radtrad 3.02 1/5/2000
 No DW Sprays - Turbine Building Roof Release
 Nuclide Inventory File:
 c:\polestar\tva\loca ast\radtrad\bfn.nif
 Plant Power Level:
  4.0310E+03
 Compartments:
   9
 Compartment 1:
 DW
   3
  1.5900E+05
   0
   0
   0
   1
   0
 Compartment 2:
 Torus
   3
  1.1940E+05
   0
   0
   0
   0
   0
 Compartment 3:
 RB
   3
  1.9320E+06
   0
   0
   0
   0
   0
 Compartment 4:
 SR
   3
  3.4560E+04
   0
   0
   0
   0
   0
 Compartment 5:
 Condenser
   3
  1.2240E+05
   0
   0
   0
   0
   0
 Compartment 6:
 TB
   3
  1.0000E+00
   0
   0
   0
   0
   0
 Compartment 7:
 Dummy
   3
  1.0000E+06
   0
   0
   0
   0
   0
 Compartment 8:
 CR
   1
  2.1000E+05
   0
   0
   0
```

```
  0
  0
Compartment 9:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Pathways:
 15
Pathway 1:
DW to Torus
  1
  2
  2
Pathway 2:
Torus to DW
  2
  1
  2
Pathway 3:
DW to RB
  1
  3
  2
Pathway 4:
Torus to RB
  2
  3
  2
Pathway 5:
RB to SR
  3
  4
  2
Pathway 6:
Torus to  SR
  2
  4
  2
Pathway 7:
Torus to Dummy
  2
  7
  2
Pathway 8:
SR to Dummy
  4
  7
  2
Pathway 9:
SR to Dummy
  4
  7
  2
Pathway 10:
DW to Condenser
  1
  5
  2
Pathway 11:
DW to TB
  1
  6
  2
Pathway 12:
Condenser to TB
  5
  6
  2
Pathway 13:
TB to Environment
  6
  9
  2
Pathway 14:
Environment to CR
  9
  8
  2
Pathway 15:
CR to Environment
  8
  9
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\radtrad3.02a\defaults\fgr11&12.inp
c:\polestar\tva\loca ast\radtrad\bfn.rft
  0.0000E+00
  1
  9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  9
Compartment 1:
  0
  1
  0
  0
  0
  0
  0
  1
 10
  0.0000E+00   0.0000E+00
  3.3000E-02   7.5000E-01
  5.3300E-01   3.7000E-01
  2.0330E+00   1.0600E+00
  5.0330E+00   6.4000E-01
  8.3670E+00   5.6000E-01
  1.2033E+01   5.3000E-01
  1.9478E+01   5.1000E-01
  2.4033E+01   0.0000E+00
  7.2000E+02   0.0000E+00
  1
 10
  0.0000E+00   0.0000E+00
  3.3000E-02   7.5000E-01
  5.3300E-01   3.7000E-01
  2.0330E+00   1.0600E+00
  5.0330E+00   6.4000E-01
  8.3670E+00   5.6000E-01
  1.2033E+01   5.3000E-01
  1.9478E+01   5.1000E-01
  2.4033E+01   0.0000E+00
  7.2000E+02   0.0000E+00
Compartment 2:
  0
  1
  0
  0
  0
  0
  0
  0
  0
```

```
Compartment 3:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 4:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 5:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 6:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 7:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 8:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Compartment 9:
 0
 1
 0
 0
 0
 0
 0
 0
 0
Pathways:
 15
Pathway 1:
 0
 0
 0
```

```
    0
    0
    1
    3
    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
    2.0330E+00   1.1940E+05   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 2:
    0
    0
    0
    0
    0
    1
    3
    0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
0.0000E+00
    2.0330E+00   1.1940E+05   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 3:
    0
    0
    0
    0
    0
    1
    2
    0.0000E+00   2.2080E+00   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   1.6580E+00   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    2.4750E+04    9.0000E+01    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 6:
  3
  0
  0
  0
  0
  1
  7
  0.0000E+00    0.0000E+00    0.0000E+00    0.0000E+00
0.0000E+00
  2.4000E+02    1.3900E+02    9.0000E+01    0.0000E+00
0.0000E+00
  2.6400E+02    0.0000E+00    0.0000E+00    0.0000E+00
0.0000E+00
  4.8000E+02    1.3900E+02    9.0000E+01    0.0000E+00
0.0000E+00
  5.0400E+02    0.0000E+00    0.0000E+00    0.0000E+00
0.0000E+00
  6.9600E+02    1.3900E+02    9.0000E+01    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 7:
  0
  0
  0
  0
  0
  1
  3
  0.0000E+00    0.0000E+00    0.0000E+00    0.0000E+00
0.0000E+00
  8.0000E+00    1.6700E-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
 Pathway 8:
  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
 Pathway 9:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00    2.4740E+04    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 10:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00    1.3000E+00    9.9870E+01    9.9010E+01
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 11:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00    6.7000E-03    8.9330E+01    1.6370E+01
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 12:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00    3.9700E+00    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 13:
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   1.0000E+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 14:
   0
   0
   0
   0
   0
   1
   3
   0.0000E+00   6.7170E+03   0.0000E+00   0.0000E+00
0.0000E+00
   1.6700E-01   6.7170E+03   4.0200E+01   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 15:
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   6.7170E+03   1.0000E+02   1.0000E+02
1.0000E+02
   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:
 Control_Room
   8
   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
Location 2:
EAB
   9
   1
   2
   0.0000E+00   2.6200E-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 3:
LPZ
   9
   1
   6
   0.0000E+00   1.3100E-04
   2.0000E+00   6.6100E-05
   8.0000E+00   4.6900E-05
   2.4000E+01   2.2300E-05
   9.6000E+01   7.9600E-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
Effective Volume Location:
   1
   6
   0.0000E+00   2.1700E-04
   2.0000E+00   1.6400E-04
   8.0000E+00   7.8900E-05
   2.4000E+01   4.3300E-05
   9.6000E+01   3.3500E-05
   7.2000E+02   0.0000E+00
Simulation Parameters:
   4
   0.0000E+00   1.0000E-01
   8.0000E+00   1.0000E+00
   2.4000E+01   2.4000E+01
   7.2000E+02   0.0000E+00
Output Filename:
C:\Polestar\TVA\LOCA AST\Radtrad\Nosprays_TBroof.o0
   1
   1
   1
   1
   1
End of Scenario File
```

RUN D4 – NOSPRAYS_STACKBASE_ESF.PSF

```
Radtrad 3.02 1/5/2000
 Base of Stack - ESF
 Nuclide Inventory File:
c:\polestar\tva\loca ast\radtrad\bfnesf.nif
 Plant Power Level:
  4.0310E+03
 Compartments:
   6
Compartment 1:
SP
   3
  1.4105E+05
   0
   0
```

```
  0
  0
  0
Compartment 2:
RB
  3
 1.9320E+06
  0
  0
  0
  0
  0
Compartment 3:
SR
  3
 3.4560E+04
  0
  0
  0
  0
  0
Compartment 4:
CR
  1
 2.1000E+05
  0
  0
  0
  0
  0
Compartment 5:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Compartment 6:
Dummy
  3
 1.0000E+06
  0
  0
  0
  0
  0
Pathways:
  6
Pathway 1:
SP to RB
  1
  2
  2
Pathway 2:
RB to SR
  2
  3
  2
Pathway 3:
SR to Environment
  3
  5
  2
Pathway 4:
SR to Dummy
  3
  6
  2
Pathway 5:
Environment to CR
  5
  4
  2
Pathway 6:
CR to Environment
  4
  5
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\radtrad3.02a\defaults\fgr11&12.inp
c:\polestar\tva\loca ast\radtrad\bfn.rft
  0.0000E+00
  1
  9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  6
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
Compartment 4:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 5:
  0
  1
  0
  0
  0
  0
  0
  0
  0
```

```
Compartment 6:
  0
  1
  0
  0
  0
  0
  0
  0
  0
 Pathways:
  6
 Pathway 1:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   6.6800E-01   1.0000E+02   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 2:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   2.4750E+04   9.0000E+01   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 3:
  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
 Pathway 4:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   2.4740E+04   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
  3
  0.0000E+00   6.7170E+03   0.0000E+00   0.0000E+00
0.0000E+00
  1.6700E-01   6.7170E+03   4.0200E+01   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 6:
  1
  0
  0
  0
  0
  1
  2
  0.0000E+00   6.7170E+03   1.0000E+02   1.0000E+02
1.0000E+02
  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:
 Control_Room
  4
  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
 Location 2:
 EAB
  5
  1
  2
  0.0000E+00   2.6200E-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 3:
 LPZ
  5
  1
  6
  0.0000E+00   1.3100E-04
  2.0000E+00   6.6100E-05
  8.0000E+00   4.6900E-05
  2.4000E+01   2.2300E-05
  9.6000E+01   7.9600E-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
 Effective Volume Location:
  1
  6
  0.0000E+00   2.0000E-04
  2.0000E+00   1.2800E-04
  8.0000E+00   5.7200E-05
  2.4000E+01   4.0500E-05
  9.6000E+01   3.0900E-05
  7.2000E+02   0.0000E+00
 Simulation Parameters:
  4
  0.0000E+00   1.0000E-01
  8.0000E+00   1.0000E+00
  2.4000E+01   2.4000E+01
  7.2000E+02   0.0000E+00
 Output Filename:
 C:\Polestar\TVA\LOCA AST\Radtrad\stackbase_esf.o0
  1
  1
  1
  1
  1
 End of Scenario File
```

RUN D5 – NOSPRAYS_STACKTOP_ESF.PSF

```
Radtrad 3.02 1/5/2000
 No DW Sprays - Top of Stack - ESF
 Nuclide Inventory File:
 c:\polestar\tva\loca ast\radtrad\bfnesf.nif
 Plant Power Level:
  4.0310E+03
 Compartments:
  6
 Compartment 1:
 SP
  3
  1.4105E+05
  0
  0
  0
  0
  0
 Compartment 2:
 RB
  3
  1.9320E+06
  0
  0
  0
  0
  0
 Compartment 3:
 SR
  3
  3.4560E+04
  0
  0
  0
  0
  0
 Compartment 4:
 CR
  1
  2.1000E+05
  0
  0
  0
  0
  0
 Compartment 5:
 Environment
  2
  0.0000E+00
  0
  0
  0
  0
  0
 Compartment 6:
 Dummy
  3
  1.0000E+06
  0
  0
  0
  0
  0
 Pathways:
  6
 Pathway 1:
 SP to RB
  1
  2
  2
 Pathway 2:
 RB to SR
  2
  3
  2
 Pathway 3:
 SR to Dummy
  3
  6
  2
 Pathway 4:
 SR to Environment
  3
  5
  2
 Pathway 5:
 Environment to CR
  5
  4
  2
 Pathway 6:
```

```
CR to Environment
  4
  5
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\radtrad3.02a\defaults\fgr11&12.inp
c:\polestar\tva\loca ast\radtrad\bfn.rft
  0.0000E+00
  1
  9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  6
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
Compartment 4:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 5:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 6:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Pathways:
  6
Pathway 1:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   6.6800E-01   1.0000E+02   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 2:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   2.4750E+04   9.0000E+01   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 3:
  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
Pathway 4:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   2.4740E+04   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
  3
  0.0000E+00   6.7170E+03   0.0000E+00   0.0000E+00
0.0000E+00
  1.6700E-01   6.7170E+03   4.0200E+01   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 6:
  1
  0
  0
  0
  0
  1
  2
  0.0000E+00   6.7170E+03   1.0000E+02   1.0000E+02
1.0000E+02
  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:
 Control_Room
  4
  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
 Location 2:
 EAB
  5
  1
  4
  0.0000E+00   1.1900E-06
  3.5000E+00   2.3500E-05
  4.0000E+00   1.1900E-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:
 LPZ
  5
  1
  8
  0.0000E+00   1.1300E-06
  2.0000E+00   5.7500E-07
  3.5000E+00   1.2600E-05
  4.0000E+00   5.7500E-07
  8.0000E+00   4.1000E-07
  2.4000E+01   1.9700E-07
  9.6000E+01   6.8800E-08
  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
 Effective Volume Location:
  1
  8
  0.0000E+00   1.4100E-07
  2.0000E+00   4.5000E-08
  3.5000E+00   3.4000E-05
  4.0000E+00   4.5000E-08
  8.0000E+00   2.5400E-08
  2.4000E+01   7.3600E-09
  9.6000E+01   1.2400E-09
  7.2000E+02   0.0000E+00
 Simulation Parameters:
  4
  0.0000E+00   1.0000E-01
  8.0000E+00   1.0000E+00
  2.4000E+01   2.4000E+01
  7.2000E+02   0.0000E+00
 Output Filename:
 C:\Polestar\TVA\LOCA
AST\Radtrad\Nosprays_stacktop_esf.o0
  1
  1
  1
  1
  1
 End of Scenario File
```

RUN D5' – NOSPRAYS_STACKTOP_ESF_FUMIGATION.PSF

```
Radtrad 3.02 1/5/2000
 Top of Stack - ESF - CR Fumigation X/Q
 Nuclide Inventory File:
 c:\polestar\tva\loca ast\radtrad\bfnesf.nif
 Plant Power Level:
  4.0310E+03
 Compartments:
  6
 Compartment 1:
 SP
  3
  1.4105E+05
  0
  0
  0
  0
```

```
  0
Compartment 2:
RB
  3
 1.9320E+06
  0
  0
  0
  0
  0
Compartment 3:
SR
  3
 3.4560E+04
  0
  0
  0
  0
  0
Compartment 4:
CR
  1
 2.1000E+05
  0
  0
  0
  0
  0
Compartment 5:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Compartment 6:
Dummy
  3
 1.0000E+06
  0
  0
  0
  0
  0
Pathways:
  6
Pathway 1:
SP to RB
  1
  2
  2
Pathway 2:
RB to SR
  2
  3
  2
Pathway 3:
SR to Dummy
  3
  6
  2
Pathway 4:
SR to Environment
  3
  5
  2
Pathway 5:
Environment to CR
  5
  4
  2
Pathway 6:
CR to Environment
  4
  5
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\radtrad3.02a\defaults\fgr11&12.inp
c:\polestar\tva\loca ast\radtrad\bfn.rft
  0.0000E+00
  1
  9.5000E-01   4.8500E-02   1.5000E-03   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  6
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
Compartment 4:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 5:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 6:
  0
```

```
 1
 0
 0
 0
 0
 0
 0
 0
Pathways:
 6
Pathway 1:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00  6.6800E-01  1.0000E+02  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 2:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00  2.4750E+04  9.0000E+01  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 3:
 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
Pathway 4:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00  2.4740E+04  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
 3
 0.0000E+00  6.7170E+03  0.0000E+00  0.0000E+00
0.0000E+00
 1.6700E-01  6.7170E+03  4.0200E+01  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 6:
 1
 0
 0
 0
 0
 1
 2
 0.0000E+00  6.7170E+03  1.0000E+02  1.0000E+02
1.0000E+02
 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:
Control_Room
 4
 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
Location 2:
EAB
 5
 1
 4
 0.0000E+00  1.1900E-06
 4.2000E+00  2.3500E-05
 4.7000E+00  1.1900E-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:
LPZ
  5
  1
  8
  0.0000E+00   1.1300E-06
  2.0000E+00   5.7500E-07
  4.2000E+00   1.2600E-05
  4.7000E+00   5.7500E-07
  8.0000E+00   4.1000E-07
  2.4000E+01   1.9700E-07
  9.6000E+01   6.8800E-08
  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
Effective Volume Location:
  1
  2
  0.0000E+00   3.4000E-05
  7.2000E+02   0.0000E+00
Simulation Parameters:
  4
  0.0000E+00   1.0000E-01
  8.0000E+00   1.0000E+00
  2.4000E+01   2.4000E+01
  7.2000E+02   0.0000E+00
Output Filename:
C:\Polestar\TVA\LOCA
AST\Radtrad\stacktop_esf_fumigation.o0
  1
  1
  1
  1
  1
End of Scenario File
```

Appendix D2
RADTRAD Secondary Input Files

BFN.NIF

```
Nuclide Inventory Name:
 TVA BFN 4031 MWt
 BWR Core Inventory
 Power Level:
  0.1000E+01
 Nuclides:
  60
 Nuclide 001:
 Co-58
   7
  0.6117120000E+07
  0.5800E+02
  0.1430E+03
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 002:
 Co-60
   7
  0.1663401096E+09
  0.6000E+02
  0.1425E+03
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 003:
 Kr-85
   1
  0.3382974720E+09
  0.8500E+02
  0.3601E+03
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 004:
 Kr-85m
   1
  0.1612800000E+05
  0.8500E+02
  0.7329E+04
 Kr-85     0.2100E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 005:
 Kr-87
   1
  0.4578000000E+04
  0.8700E+02
  0.1446E+05
 Rb-87     0.1000E+01
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 006:
 Kr-88
   1
  0.1022400000E+05
  0.8800E+02
  0.2009E+05
 Rb-88     0.1000E+01
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 007:
 Rb-86
   3
  0.1612224000E+07
  0.8600E+02
  0.6372E+02
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 008:
 Sr-89
   5
  0.4363200000E+07
  0.8900E+02
  0.2786E+05
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 009:
 Sr-90
   5
  0.9189573120E+09
  0.9000E+02
  0.3165E+04
 Y-90      0.1000E+01
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 010:
 Sr-91
   5
  0.3420000000E+05
  0.9100E+02
  0.3487E+05
 Y-91m     0.5800E+00
 Y-91      0.4200E+00
 none      0.0000E+00
 Nuclide 011:
 Sr-92
   5
  0.9756000000E+04
  0.9200E+02
  0.3677E+05
 Y-92      0.1000E+01
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 012:
 Y-90
   9
  0.2304000000E+06
  0.9000E+02
  0.3293E+04
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 013:
 Y-91
   9
  0.5055264000E+07
  0.9100E+02
  0.3583E+05
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 014:
 Y-92
   9
  0.1274400000E+05
  0.9200E+02
  0.3696E+05
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 015:
 Y-93
   9
  0.3636000000E+05
  0.9300E+02
  0.4147E+05
 Zr-93     0.1000E+01
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 016:
 Zr-95
   9
  0.5527872000E+07
  0.9500E+02
  0.4880E+05
 Nb-95m    0.7000E-02
 Nb-95     0.9900E+00
 none      0.0000E+00
 Nuclide 017:
 Zr-97
   9
  0.6084000000E+05
  0.9700E+02
  0.4953E+05
 Nb-97m    0.9500E+00
 Nb-97     0.5300E-01
 none      0.0000E+00
 Nuclide 018:
 Nb-95
   9
  0.3036960000E+07
  0.9500E+02
  0.4897E+05
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 019:
 Mo-99
   7
  0.2376000000E+06
  0.9900E+02
  0.5088E+05
 Tc-99m    0.8800E+00
 Tc-99     0.1200E+00
 none      0.0000E+00
 Nuclide 020:
 Tc-99m
   7
  0.2167200000E+05
  0.9900E+02
  0.4454E+05
 Tc-99     0.1000E+01
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 021:
 Ru-103
   7
  0.3393792000E+07
  0.1030E+03
  0.4094E+05
 Rh-103m   0.1000E+01
 none      0.0000E+00
```

```
none      0.0000E+00
Nuclide 022:
Ru-105
  7
 0.1598400000E+05
 0.1050E+03
 0.2710E+05
Rh-105    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 023:
Ru-106
  7
 0.3181248000E+08
 0.1060E+03
 0.1488E+05
Rh-106    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 024:
Rh-105
  7
 0.1272960000E+06
 0.1050E+03
 0.2559E+05
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 025:
Sb-127
  4
 0.3326400000E+06
 0.1270E+03
 0.2796E+04
Te-127m   0.1800E+00
Te-127    0.8200E+00
none      0.0000E+00
Nuclide 026:
Sb-129
  4
 0.1555200000E+05
 0.1290E+03
 0.8457E+04
Te-129m   0.2200E+00
Te-129    0.7700E+00
none      0.0000E+00
Nuclide 027:
Te-127
  4
 0.3366000000E+05
 0.1270E+03
 0.2773E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 028:
Te-127m
  4
 0.9417600000E+07
 0.1270E+03
 0.3721E+03
Te-127    0.9800E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 029:
Te-129
  4
 0.4176000000E+04
 0.1290E+03
 0.8326E+04
I-129     0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 030:
Te-129m
  4
 0.2903040000E+07
 0.1290E+03
 0.1615E+04
Te-129    0.6500E+00
I-129     0.3500E+00
none      0.0000E+00
Nuclide 031:
Te-131m
  4
 0.1080000000E+06
 0.1310E+03
 0.5155E+04
Te-131    0.2200E+00
I-131     0.7800E+00
none      0.0000E+00
Nuclide 032:
Te-132
  4
 0.2815200000E+06
 0.1320E+03
 0.3829E+05
I-132     0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 033:
I-131
  2
 0.6946560000E+06
 0.1310E+03
 0.2669E+05
Xe-131m   0.1100E-01
none      0.0000E+00
none      0.0000E+00
Nuclide 034:
I-132
  2
 0.8280000000E+04
 0.1320E+03
 0.3885E+05
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 035:
I-133
  2
 0.7488000000E+05
 0.1330E+03
 0.5534E+05
Xe-133m   0.2900E-01
Xe-133    0.9700E+00
none      0.0000E+00
Nuclide 036:
I-134
  2
 0.3156000000E+04
 0.1340E+03
 0.6141E+05
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 037:
I-135
  2
 0.2379600000E+05
 0.1350E+03
 0.5250E+05
Xe-135m   0.1500E+00
Xe-135    0.8500E+00
none      0.0000E+00
Nuclide 038:
Xe-133
  1
 0.4531680000E+06
 0.1330E+03
 0.5504E+05
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 039:
Xe-135
  1
 0.3272400000E+05
 0.1350E+03
 0.1971E+05
Cs-135    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 040:
Cs-134
  3
 0.6507177120E+08
 0.1340E+03
 0.5703E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 041:
Cs-136
  3
 0.1131840000E+07
 0.1360E+03
 0.1941E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 042:
Cs-137
  3
 0.9467280000E+09
 0.1370E+03
 0.4037E+04
Ba-137m   0.9500E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 043:
Ba-139
  6
 0.4962000000E+04
 0.1390E+03
 0.4930E+05
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 044:
Ba-140
  6
 0.1100736000E+07
 0.1400E+03
 0.4909E+05
La-140    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 045:
La-140
  9
 0.1449792000E+06
 0.1400E+03
 0.5231E+05
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 046:
La-141
  9
 0.1414800000E+05
 0.1410E+03
 0.4498E+05
Ce-141    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 047:
La-142
```

```
9
 0.5550000000E+04
 0.1420E+03
 0.4397E+05
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 048:
Ce-141
 8
 0.2808086400E+07
 0.1410E+03
 0.4535E+05
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 049:
Ce-143
 8
 0.1188000000E+06
 0.1430E+03
 0.4245E+05
Pr-143    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 050:
Ce-144
 8
 0.2456352000E+08
 0.1440E+03
 0.3810E+05
Pr-144m   0.1800E-01
Pr-144    0.9800E+00
none      0.0000E+00
Nuclide 051:
Pr-143
 9
 0.1171584000E+07
 0.1430E+03
 0.4113E+05
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 052:
Nd-147
 9
 0.9486720000E+06
 0.1470E+03
 0.1806E+05
Pm-147    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 053:
Np-239
 8
 0.2034720000E+06
 0.2390E+03
 0.5201E+06
Pu-239    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 054:
Pu-238
 8
 0.2768863824E+10
 0.2380E+03
 0.2805E+03
U-234     0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 055:
Pu-239
 8
 0.7594336440E+12
 0.2390E+03
 0.1234E+02
U-235     0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 056:
Pu-240
 8
 0.2062920312E+12
 0.2400E+03
 0.1730E+02
U-236     0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 057:
Pu-241
 8
 0.4544294400E+09
 0.2410E+03
 0.4450E+04
U-237     0.2400E-04
Am-241    0.1000E+01
none      0.0000E+00
Nuclide 058:
Am-241
 9
 0.1363919472E+11
 0.2410E+03
 0.5449E+01
Np-237    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 059:
Cm-242
 9
 0.1406592000E+08
 0.2420E+03
 0.1234E+04
Pu-238    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 060:
Cm-244
 9
 0.5715081360E+09
 0.2440E+03
 0.5697E+02
Pu-240    0.1000E+01
none      0.0000E+00
none      0.0000E+00
End of Nuclear Inventory File
```

BFNESF.NIF

```
Nuclide Inventory Name:
 TVA BFN 4031 MWt
 BWR Core Inventory
 Power Level:
  0.1000E+01
 Nuclides:
  60
 Nuclide 001:
 Co-58
  7
  0.6117120000E+07
  0.5800E+02
  0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 002:
 Co-60
  7
  0.1663401096E+09
  0.6000E+02
  0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 003:
 Kr-85
  1
  0.3382974720E+09
  0.8500E+02
  0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 004:
 Kr-85m
  1
  0.1612800000E+05
  0.8500E+02
  0.0000E+00
 Kr-85     0.2100E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 005:
 Kr-87
  1
  0.4578000000E+04
  0.8700E+02
  0.0000E+00
 Rb-87     0.1000E+01
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 006:
 Kr-88
  1
  0.1022400000E+05
  0.8800E+02
  0.0000E+00
 Rb-88     0.1000E+01
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 007:
 Rb-86
  3
  0.1612224000E+07
  0.8600E+02
  0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 008:
 Sr-89
  5
  0.4363200000E+07
  0.8900E+02
  0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 009:
 Sr-90
  5
  0.9189573120E+09
  0.9000E+02
  0.0000E+00
 Y-90      0.1000E+01
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 010:
 Sr-91
```

```
 5
 0.3420000000E+05
 0.9100E+02
 0.0000E+00
Y-91m    0.5800E+00
Y-91     0.4200E+00
none     0.0000E+00
Nuclide 011:
Sr-92
 5
 0.9756000000E+04
 0.9200E+02
 0.0000E+00
Y-92     0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 012:
Y-90
 9
 0.2304000000E+06
 0.9000E+02
 0.0000E+00
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 013:
Y-91
 9
 0.5055264000E+07
 0.9100E+02
 0.0000E+00
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 014:
Y-92
 9
 0.1274400000E+05
 0.9200E+02
 0.0000E+00
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 015:
Y-93
 9
 0.3636000000E+05
 0.9300E+02
 0.0000E+00
Zr-93    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 016:
Zr-95
 9
 0.5527872000E+07
 0.9500E+02
 0.0000E+00
Nb-95m   0.7000E-02
Nb-95    0.9900E+00
none     0.0000E+00
Nuclide 017:
Zr-97
 9
 0.6084000000E+05
 0.9700E+02
 0.0000E+00
Nb-97m   0.9500E+00
Nb-97    0.5300E-01
none     0.0000E+00
Nuclide 018:
Nb-95
 9
 0.3036960000E+07
 0.9500E+02
 0.0000E+00
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 019:
Mo-99
 7
 0.2376000000E+06
 0.9900E+02
 0.0000E+00
Tc-99m   0.8800E+00
Tc-99    0.1200E+00
none     0.0000E+00
Nuclide 020:
Tc-99m
 7
 0.2167200000E+05
 0.9900E+02
 0.0000E+00
Tc-99    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 021:
Ru-103
 7
 0.3393792000E+07
 0.1030E+03
 0.0000E+00
Rh-103m  0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 022:
Ru-105
 7
 0.1598400000E+05
 0.1050E+03
 0.0000E+00
Rh-105   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 023:
Ru-106
 7
 0.3181248000E+08
 0.1060E+03
 0.0000E+00
Rh-106   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 024:
Rh-105
 7
 0.1272960000E+06
 0.1050E+03
 0.0000E+00
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 025:
Sb-127
 4
 0.3326400000E+06
 0.1270E+03
 0.0000E+00
Te-127m  0.1800E+00
Te-127   0.8200E+00
none     0.0000E+00
Nuclide 026:
Sb-129
 4
 0.1555200000E+05
 0.1290E+03
 0.0000E+00
Te-129m  0.2200E+00
Te-129   0.7700E+00
none     0.0000E+00
Nuclide 027:
Te-127
 4
 0.3366000000E+05
 0.1270E+03
 0.0000E+00
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 028:
Te-127m
 4
 0.9417600000E+07
 0.1270E+03
 0.0000E+00
Te-127   0.9800E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 029:
Te-129
 4
 0.4176000000E+04
 0.1290E+03
 0.0000E+00
I-129    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 030:
Te-129m
 4
 0.2903040000E+07
 0.1290E+03
 0.0000E+00
Te-129   0.6500E+00
I-129    0.3500E+00
none     0.0000E+00
Nuclide 031:
Te-131m
 4
 0.1080000000E+06
 0.1310E+03
 0.0000E+00
Te-131   0.2200E+00
I-131    0.7800E+00
none     0.0000E+00
Nuclide 032:
Te-132
 4
 0.2815200000E+06
 0.1320E+03
 0.0000E+00
I-132    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 033:
I-131
 2
 0.6946560000E+06
 0.1310E+03
 0.5338E+05
Xe-131m  0.1100E-01
none     0.0000E+00
none     0.0000E+00
Nuclide 034:
I-132
 2
 0.8280000000E+04
 0.1320E+03
 0.7770E+05
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 035:
I-133
 2
 0.7488000000E+05
 0.1330E+03
```

```
 0.1107E+06
Xe-133m  0.2900E-01
Xe-133   0.9700E+00
none     0.0000E+00
Nuclide 036:
I-134
  2
 0.3156000000E+04
 0.1340E+03
 0.1228E+06
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 037:
I-135
  2
 0.2379600000E+05
 0.1350E+03
 0.1050E+06
Xe-135m  0.1500E+00
Xe-135   0.8500E+00
none     0.0000E+00
Nuclide 038:
Xe-133
  1
 0.4531680000E+06
 0.1330E+03
 0.0000E+00
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 039:
Xe-135
  1
 0.3272400000E+05
 0.1350E+03
 0.0000E+00
Cs-135   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 040:
Cs-134
  3
 0.6507177120E+08
 0.1340E+03
 0.0000E+00
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 041:
Cs-136
  3
 0.1131840000E+07
 0.1360E+03
 0.0000E+00
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 042:
Cs-137
  3
 0.9467280000E+09
 0.1370E+03
 0.0000E+00
Ba-137m  0.9500E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 043:
Ba-139
  6
 0.4962000000E+04
 0.1390E+03
 0.0000E+00
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 044:
Ba-140
  6
 0.1100736000E+07
 0.1400E+03
 0.0000E+00
La-140   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 045:
La-140
  9
 0.1449792000E+06
 0.1400E+03
 0.0000E+00
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 046:
La-141
  9
 0.1414800000E+05
 0.1410E+03
 0.0000E+00
Ce-141   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 047:
La-142
  9
 0.5550000000E+04
 0.1420E+03
 0.0000E+00
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 048:
Ce-141
  8
 0.2808086400E+07
 0.1410E+03
 0.0000E+00
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 049:
Ce-143
  8
 0.1188000000E+06
 0.1430E+03
 0.0000E+00
Pr-143   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 050:
Ce-144
  8
 0.2456352000E+08
 0.1440E+03
 0.0000E+00
Pr-144m  0.1800E-01
Pr-144   0.9800E+00
none     0.0000E+00
Nuclide 051:
Pr-143
  9
 0.1171584000E+07
 0.1430E+03
 0.0000E+00
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 052:
Nd-147
  9
 0.9486720000E+06
 0.1470E+03
 0.0000E+00
Pm-147   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 053:
Np-239
  8
 0.2034720000E+06
 0.2390E+03
 0.0000E+00
Pu-239   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 054:
Pu-238
  8
 0.2768863824E+10
 0.2380E+03
 0.0000E+00
U-234    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 055:
Pu-239
  8
 0.7594336440E+12
 0.2390E+03
 0.0000E+00
U-235    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 056:
Pu-240
  8
 0.2062920312E+12
 0.2400E+03
 0.0000E+00
U-236    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 057:
Pu-241
  8
 0.4544294400E+09
 0.2410E+03
 0.0000E+00
U-237    0.2400E-04
Am-241   0.1000E+01
none     0.0000E+00
Nuclide 058:
Am-241
  9
 0.1363919472E+11
 0.2410E+03
 0.0000E+00
Np-237   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 059:
Cm-242
  9
 0.1406592000E+08
 0.2420E+03
 0.0000E+00
Pu-238   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 060:
Cm-244
  9
 0.5715081360E+09
 0.2440E+03
 0.0000E+00
Pu-240   0.1000E+01
none     0.0000E+00
```

```
none      0.0000E+00                    End of Nuclear Inventory File
```

BFN.RFT

```
Release Fraction and Timing Name:
 BFN, NUREG-1465
 Duration (h): Design Basis Accident
  0.3333E-01  0.5000E+00  0.1500E+01  0.0000E+00
 Noble Gases:
  0.0000E+00  0.5000E-01  0.9500E+00  0.0000E+00
 Iodine:
  0.0000E+00  0.5000E-01  0.2500E+00  0.0000E+00
 Cesium:
  0.0000E+00  0.5000E-01  0.2000E+00  0.0000E+00
 Tellurium:
  0.0000E+00  0.0000E+00  0.5000E-01  0.0000E+00
 Strontium:
  0.0000E+00  0.0000E+00  0.2000E-01  0.0000E+00
 Barium:
  0.0000E+00  0.0000E+00  0.2000E-01  0.0000E+00
 Ruthenium:
  0.0000E+00  0.0000E+00  0.2500E-02  0.0000E+00
 Cerium:
  0.0000E+00  0.0000E+00  0.5000E-03  0.0000E+00
 Lanthanum:
  0.0000E+00  0.0000E+00  0.2000E-03  0.0000E+00
 Non-Radioactive Aerosols (kg):
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 End of Release File
```

FGR11&12.INP

```
FGRDCF 10/24/95   03:24:50   beta-test version 1.10, minor FORTRAN fixes 5/4/95
Implicit daughter halflives (m) less than  90 and less than 0.100 of parent
         9 ORGANS DEFINED IN THIS FILE:
GONADS
BREAST
LUNGS
RED MARR
BONE SUR
THYROID
REMAINDER
EFFECTIVE
SKIN(FGR)
        60 NUCLIDES DEFINED IN THIS FILE:
Co-58      Y
Co-60      Y
Kr-85
Kr-85m
Kr-87
Kr-88
Rb-86      D
Sr-89      Y
Sr-90      Y
Sr-91      Y      Including:Y-91m
Sr-92      Y
Y-90       Y
Y-91       Y
Y-92       Y
Y-93       Y
Zr-95      D
Zr-97      Y      Including:Nb-97m , Including:Nb-97
Nb-95      Y
Mo-99      Y
Tc-99m     D
Ru-103     Y      Including:Rh-103m
Ru-105     Y
Ru-106     Y      Including:Rh-106
Rh-105     Y
Sb-127     W
Sb-129     W
Te-127     W
Te-127m    W
Te-129     W
```

Te-129m	W	Including:Te-129
Te-131m	W	Including:Te-131
Te-132	W	
I-131	D	
I-132	D	
I-133	D	
I-134	D	
I-135	D	Including:Xe-135m
Xe-133		
Xe-135		
Cs-134	D	
Cs-136	D	
Cs-137	D	Including:Ba-137m
Ba-139	D	
Ba-140	D	
La-140	W	
La-141	D	
La-142	D	
Ce-141	Y	
Ce-143	Y	
Ce-144	Y	Including:Pr-144m, Including:Pr-144
Pr-143	Y	
Nd-147	Y	
Np-239	W	
Pu-238	Y	
Pu-239	Y	
Pu-240	Y	
Pu-241	Y	
Am-241	W	
Cm-242	W	
Cm-244	W	

	CLOUDSHINE	GROUND SHINE 8HR	GROUND SHINE 7DAY	GROUND SHINE RATE	INHALED ACUTE	INHALED CHRONIC	INGESTION
Co-58							
GONADS	4.660E-14	2.867E-11	5.828E-10	9.970E-16	-1.000E+00	6.170E-10	1.040E-09
BREAST	5.300E-14	2.737E-11	5.565E-10	9.520E-16	-1.000E+00	9.370E-10	1.790E-10
LUNGS	4.640E-14	2.617E-11	5.319E-10	9.100E-16	-1.000E+00	1.600E-08	8.530E-11
RED MARR	4.530E-14	2.671E-11	5.430E-10	9.290E-16	-1.000E+00	9.230E-10	2.600E-10
BONE SUR	7.410E-14	3.795E-11	7.716E-10	1.320E-15	-1.000E+00	6.930E-10	1.250E-10
THYROID	4.770E-14	2.720E-11	5.530E-10	9.460E-16	-1.000E+00	8.720E-10	6.310E-11
REMAINDER	4.440E-14	2.585E-11	5.255E-10	8.990E-16	-1.000E+00	1.890E-09	1.580E-09
EFFECTIVE	4.760E-14	2.732E-11	5.553E-10	9.500E-16	-1.000E+00	2.940E-09	8.090E-10
SKIN(FGR)	5.580E-14	3.278E-11	6.664E-10	1.140E-15	-1.000E+00	0.000E+00	0.000E+00
Co-60							
GONADS	1.230E-13	7.056E-11	1.480E-09	2.450E-15	-1.000E+00	4.760E-09	3.190E-09
BREAST	1.390E-13	6.739E-11	1.413E-09	2.340E-15	-1.000E+00	1.840E-08	1.100E-09
LUNGS	1.240E-13	6.537E-11	1.371E-09	2.270E-15	-1.000E+00	3.450E-07	8.770E-10
RED MARR	1.230E-13	6.710E-11	1.407E-09	2.330E-15	-1.000E+00	1.720E-08	1.320E-09
BONE SUR	1.780E-13	8.956E-11	1.879E-09	3.110E-15	-1.000E+00	1.350E-08	9.390E-10
THYROID	1.270E-13	6.480E-11	1.359E-09	2.250E-15	-1.000E+00	1.620E-08	7.880E-10
REMAINDER	1.200E-13	6.508E-11	1.365E-09	2.260E-15	-1.000E+00	3.600E-08	4.970E-09
EFFECTIVE	1.260E-13	6.768E-11	1.419E-09	2.350E-15	-1.000E+00	5.910E-08	2.770E-09
SKIN(FGR)	1.450E-13	7.948E-11	1.667E-09	2.760E-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
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
Rb-86						
GONADS	4.710E-15	2.788E-12	5.187E-11	9.740E-17-1.000E+00	1.340E-09	2.150E-09
BREAST	5.340E-15	2.662E-12	4.953E-11	9.300E-17-1.000E+00	1.330E-09	2.140E-09
LUNGS	4.710E-15	2.553E-12	4.750E-11	8.920E-17-1.000E+00	3.300E-09	2.140E-09
RED MARR	4.640E-15	2.619E-12	4.873E-11	9.150E-17-1.000E+00	2.320E-09	3.720E-09
BONE SUR	7.050E-15	3.635E-12	6.764E-11	1.270E-16-1.000E+00	4.270E-09	6.860E-09
THYROID	4.840E-15	2.599E-12	4.836E-11	9.080E-17-1.000E+00	1.330E-09	2.140E-09
REMAINDER	4.520E-15	2.542E-12	4.729E-11	8.880E-17-1.000E+00	1.380E-09	2.330E-09
EFFECTIVE	4.810E-15	2.665E-12	4.958E-11	9.310E-17-1.000E+00	1.790E-09	2.530E-09
SKIN(FGR)	4.850E-14	2.210E-10	4.111E-09	7.720E-15-1.000E+00	0.000E+00	0.000E+00
Sr-89						
GONADS	7.730E-17	7.155E-14	1.436E-12	2.490E-18-1.000E+00	7.950E-12	8.050E-12
BREAST	9.080E-17	7.212E-14	1.447E-12	2.510E-18-1.000E+00	7.960E-12	7.980E-12
LUNGS	7.080E-17	5.689E-14	1.142E-12	1.980E-18-1.000E+00	8.350E-08	7.970E-12
RED MARR	6.390E-17	5.345E-14	1.073E-12	1.860E-18-1.000E+00	1.070E-10	1.080E-10
BONE SUR	1.940E-16	1.560E-13	3.131E-12	5.430E-18-1.000E+00	1.590E-10	1.610E-10
THYROID	7.600E-17	6.063E-14	1.217E-12	2.110E-18-1.000E+00	7.960E-12	7.970E-12
REMAINDER	6.710E-17	5.603E-14	1.124E-12	1.950E-18-1.000E+00	3.970E-09	8.250E-09
EFFECTIVE	7.730E-17	6.523E-14	1.309E-12	2.270E-18-1.000E+00	1.120E-08	2.500E-09
SKIN(FGR)	3.690E-14	1.914E-10	3.841E-09	6.660E-15-1.000E+00	0.000E+00	0.000E+00
Sr-90						
GONADS	7.780E-18	9.590E-15	2.014E-13	3.330E-19-1.000E+00	2.690E-10	5.040E-11
BREAST	9.490E-18	1.008E-14	2.116E-13	3.500E-19-1.000E+00	2.690E-10	5.040E-11
LUNGS	6.440E-18	6.307E-15	1.324E-13	2.190E-19-1.000E+00	2.860E-06	5.040E-11
RED MARR	5.440E-18	5.558E-15	1.167E-13	1.930E-19-1.000E+00	3.280E-08	6.450E-09
BONE SUR	2.280E-17	2.393E-14	5.025E-13	8.310E-19-1.000E+00	7.090E-08	1.390E-08
THYROID	7.330E-18	7.171E-15	1.506E-13	2.490E-19-1.000E+00	2.690E-10	5.040E-11
REMAINDER	6.110E-18	6.422E-15	1.348E-13	2.230E-19-1.000E+00	5.730E-09	6.700E-09
EFFECTIVE	7.530E-18	8.179E-15	1.717E-13	2.840E-19-1.000E+00	3.510E-07	3.230E-09
SKIN(FGR)	9.200E-15	4.032E-12	8.465E-11	1.400E-16-1.000E+00	0.000E+00	0.000E+00
Sr-91						
GONADS	4.819E-14	2.155E-11	5.062E-11	1.026E-15-1.000E+00	5.669E-11	2.520E-10
BREAST	5.477E-14	2.059E-11	4.838E-11	9.806E-16-1.000E+00	1.775E-11	3.676E-11
LUNGS	4.803E-14	1.970E-11	4.626E-11	9.376E-16-1.000E+00	2.170E-09	1.055E-11
RED MARR	4.691E-14	2.011E-11	4.722E-11	9.570E-16-1.000E+00	2.275E-11	5.659E-11
BONE SUR	7.674E-14	2.852E-11	6.709E-11	1.360E-15-1.000E+00	1.306E-11	2.070E-11
THYROID	4.938E-14	2.035E-11	4.782E-11	9.693E-16-1.000E+00	9.930E-12	1.968E-12
REMAINDER	4.610E-14	1.948E-11	4.573E-11	9.268E-16-1.000E+00	5.802E-10	2.557E-09
EFFECTIVE	4.924E-14	2.057E-11	4.832E-11	9.793E-16-1.000E+00	4.547E-10	8.455E-10
SKIN(FGR)	9.938E-14	1.748E-10	3.987E-10	8.080E-15-1.000E+00	0.000E+00	0.000E+00
Sr-92						
GONADS	6.610E-14	1.593E-11	1.830E-11	1.300E-15-1.000E+00	1.020E-11	8.180E-11
BREAST	7.480E-14	1.520E-11	1.745E-11	1.240E-15-1.000E+00	6.490E-12	1.700E-11
LUNGS	6.670E-14	1.483E-11	1.703E-11	1.210E-15-1.000E+00	1.050E-09	7.220E-12
RED MARR	6.620E-14	1.520E-11	1.745E-11	1.240E-15-1.000E+00	6.980E-12	2.290E-11
BONE SUR	9.490E-14	2.010E-11	2.308E-11	1.640E-15-1.000E+00	4.360E-12	8.490E-12
THYROID	6.820E-14	1.446E-11	1.661E-11	1.180E-15-1.000E+00	3.920E-12	1.300E-12
REMAINDER	6.450E-14	1.471E-11	1.689E-11	1.200E-15-1.000E+00	2.900E-10	1.720E-09
EFFECTIVE	6.790E-14	1.532E-11	1.759E-11	1.250E-15-1.000E+00	2.180E-10	5.430E-10
SKIN(FGR)	8.560E-14	2.280E-11	2.618E-11	1.860E-15-1.000E+00	0.000E+00	0.000E+00
Y-90						
GONADS	1.890E-16	1.586E-13	1.601E-12	5.750E-18-1.000E+00	5.170E-13	1.430E-14
BREAST	2.200E-16	1.578E-13	1.593E-12	5.720E-18-1.000E+00	5.170E-13	1.270E-14
LUNGS	1.770E-16	1.313E-13	1.326E-12	4.760E-18-1.000E+00	9.310E-09	1.260E-14
RED MARR	1.620E-16	1.261E-13	1.273E-12	4.570E-18-1.000E+00	1.520E-11	3.700E-13
BONE SUR	4.440E-16	3.228E-13	3.259E-12	1.170E-17-1.000E+00	1.510E-11	3.670E-13
THYROID	1.870E-16	1.385E-13	1.398E-12	5.020E-18-1.000E+00	5.170E-13	1.260E-14
REMAINDER	1.680E-16	1.291E-13	1.303E-12	4.680E-18-1.000E+00	3.870E-09	9.680E-09
EFFECTIVE	1.900E-16	1.468E-13	1.482E-12	5.320E-18-1.000E+00	2.280E-09	2.910E-09

SKIN(FGR)	6.240E-14	2.897E-10	2.924E-09	1.050E-14-1.000E+00	0.000E+00	0.000E+00
Y-91						
GONADS	2.560E-16	1.756E-13	3.546E-12	6.110E-18-1.000E+00	8.200E-12	3.540E-12
BREAST	2.930E-16	1.713E-13	3.459E-12	5.960E-18-1.000E+00	8.920E-12	5.540E-13
LUNGS	2.500E-16	1.526E-13	3.082E-12	5.310E-18-1.000E+00	9.870E-08	2.020E-13
RED MARR	2.410E-16	1.521E-13	3.070E-12	5.290E-18-1.000E+00	3.190E-10	6.590E-12
BONE SUR	4.560E-16	2.903E-13	5.862E-12	1.010E-17-1.000E+00	3.180E-10	6.130E-12
THYROID	2.600E-16	1.564E-13	3.157E-12	5.440E-18-1.000E+00	8.500E-12	1.290E-13
REMAINDER	2.390E-16	1.509E-13	3.047E-12	5.250E-18-1.000E+00	4.200E-09	8.570E-09
EFFECTIVE	2.600E-16	1.650E-13	3.332E-12	5.740E-18-1.000E+00	1.320E-08	2.570E-09
SKIN(FGR)	3.850E-14	1.989E-10	4.016E-09	6.920E-15-1.000E+00	0.000E+00	0.000E+00
Y-92						
GONADS	1.270E-14	3.855E-12	4.872E-12	2.650E-16-1.000E+00	2.610E-12	1.960E-11
BREAST	1.440E-14	3.680E-12	4.652E-12	2.530E-16-1.000E+00	1.500E-12	3.550E-12
LUNGS	1.270E-14	3.535E-12	4.468E-12	2.430E-16-1.000E+00	1.240E-09	1.390E-12
RED MARR	1.250E-14	3.608E-12	4.560E-12	2.480E-16-1.000E+00	2.070E-12	4.910E-12
BONE SUR	1.950E-14	5.091E-12	6.435E-12	3.500E-16-1.000E+00	1.510E-12	1.750E-12
THYROID	1.300E-14	3.579E-12	4.523E-12	2.460E-16-1.000E+00	1.050E-12	1.770E-13
REMAINDER	1.220E-14	3.506E-12	4.431E-12	2.410E-16-1.000E+00	2.030E-10	1.700E-09
EFFECTIVE	1.300E-14	3.680E-12	4.652E-12	2.530E-16-1.000E+00	2.110E-10	5.150E-10
SKIN(FGR)	1.140E-13	2.022E-10	2.556E-10	1.390E-14-1.000E+00	0.000E+00	0.000E+00
Y-93						
GONADS	4.670E-15	2.108E-12	4.989E-12	9.510E-17-1.000E+00	5.310E-12	2.200E-11
BREAST	5.300E-15	2.026E-12	4.794E-12	9.140E-17-1.000E+00	1.740E-12	3.130E-12
LUNGS	4.680E-15	1.937E-12	4.585E-12	8.740E-17-1.000E+00	2.520E-09	8.670E-13
RED MARR	4.580E-15	1.972E-12	4.669E-12	8.900E-17-1.000E+00	4.040E-12	4.930E-12
BONE SUR	7.580E-15	2.948E-12	6.977E-12	1.330E-16-1.000E+00	3.140E-12	1.730E-12
THYROID	4.790E-15	1.908E-12	4.516E-12	8.610E-17-1.000E+00	9.260E-13	1.260E-13
REMAINDER	4.510E-15	1.919E-12	4.543E-12	8.660E-17-1.000E+00	9.250E-10	4.090E-09
EFFECTIVE	4.800E-15	2.021E-12	4.784E-12	9.120E-17-1.000E+00	5.820E-10	1.230E-09
SKIN(FGR)	8.500E-14	2.726E-10	6.452E-10	1.230E-14-1.000E+00	0.000E+00	0.000E+00
Zr-95						
GONADS	3.530E-14	2.182E-11	4.421E-10	7.590E-16-1.000E+00	1.880E-09	8.160E-10
BREAST	4.010E-14	2.084E-11	4.223E-10	7.250E-16-1.000E+00	1.910E-09	1.050E-10
LUNGS	3.510E-14	1.989E-11	4.030E-10	6.920E-16-1.000E+00	2.170E-09	2.340E-11
RED MARR	3.430E-14	2.030E-11	4.112E-10	7.060E-16-1.000E+00	1.300E-08	2.140E-10
BONE SUR	5.620E-14	2.875E-11	5.824E-10	1.000E-15-1.000E+00	1.030E-07	4.860E-10
THYROID	3.610E-14	2.076E-11	4.205E-10	7.220E-16-1.000E+00	1.440E-09	8.270E-12
REMAINDER	3.360E-14	1.963E-11	3.978E-10	6.830E-16-1.000E+00	2.280E-09	2.530E-09
EFFECTIVE	3.600E-14	2.078E-11	4.211E-10	7.230E-16-1.000E+00	6.390E-09	1.020E-09
SKIN(FGR)	4.500E-14	2.561E-11	5.190E-10	8.910E-16-1.000E+00	0.000E+00	0.000E+00
Zr-97						
GONADS	4.331E-14	2.179E-11	7.799E-11	9.253E-16-1.000E+00	1.840E-10	6.228E-10
BREAST	4.928E-14	2.083E-11	7.455E-11	8.846E-16-1.000E+00	4.706E-11	8.137E-11
LUNGS	4.322E-14	1.992E-11	7.127E-11	8.456E-16-1.000E+00	4.108E-09	1.770E-11
RED MARR	4.224E-14	2.034E-11	7.279E-11	8.634E-16-1.000E+00	6.376E-11	1.302E-10
BONE SUR	6.897E-14	2.881E-11	1.031E-10	1.224E-15-1.000E+00	3.504E-11	4.558E-11
THYROID	4.443E-14	2.061E-11	7.377E-11	8.755E-16-1.000E+00	2.315E-11	2.671E-12
REMAINDER	4.139E-14	1.966E-11	7.035E-11	8.345E-16-1.000E+00	2.041E-09	6.990E-09
EFFECTIVE	4.432E-14	2.078E-11	7.438E-11	8.824E-16-1.000E+00	1.171E-09	2.283E-09
SKIN(FGR)	9.835E-14	2.281E-10	8.148E-10	9.587E-15-1.000E+00	0.000E+00	0.000E+00
Nb-95						
GONADS	3.660E-14	2.253E-11	4.435E-10	7.850E-16-1.000E+00	4.320E-10	8.050E-10
BREAST	4.160E-14	2.150E-11	4.231E-10	7.490E-16-1.000E+00	4.070E-10	1.070E-10
LUNGS	3.650E-14	2.055E-11	4.045E-10	7.160E-16-1.000E+00	8.320E-09	2.740E-11
RED MARR	3.560E-14	2.101E-11	4.135E-10	7.320E-16-1.000E+00	4.420E-10	1.990E-10
BONE SUR	5.790E-14	2.957E-11	5.819E-10	1.030E-15-1.000E+00	5.130E-10	2.940E-10
THYROID	3.750E-14	2.144E-11	4.220E-10	7.470E-16-1.000E+00	3.580E-10	1.180E-11
REMAINDER	3.490E-14	2.032E-11	4.000E-10	7.080E-16-1.000E+00	1.070E-09	1.470E-09
EFFECTIVE	3.740E-14	2.147E-11	4.226E-10	7.480E-16-1.000E+00	1.570E-09	6.950E-10
SKIN(FGR)	4.300E-14	2.598E-11	5.112E-10	9.050E-16-1.000E+00	0.000E+00	0.000E+00
Mo-99						
GONADS	7.130E-15	4.282E-12	4.403E-11	1.550E-16-1.000E+00	9.510E-11	2.180E-10
BREAST	8.130E-15	4.116E-12	4.233E-11	1.490E-16-1.000E+00	2.750E-11	3.430E-11
LUNGS	7.060E-15	3.867E-12	3.977E-11	1.400E-16-1.000E+00	4.290E-09	1.510E-11
RED MARR	6.820E-15	3.923E-12	4.034E-11	1.420E-16-1.000E+00	5.240E-11	8.320E-11
BONE SUR	1.240E-14	6.105E-12	6.278E-11	2.210E-16-1.000E+00	4.130E-11	6.320E-11
THYROID	7.270E-15	4.033E-12	4.147E-11	1.460E-16-1.000E+00	1.520E-11	1.030E-11
REMAINDER	6.740E-15	3.812E-12	3.920E-11	1.380E-16-1.000E+00	1.740E-09	4.280E-09
EFFECTIVE	7.280E-15	4.061E-12	4.176E-11	1.470E-16-1.000E+00	1.070E-09	1.360E-09
SKIN(FGR)	3.140E-14	1.039E-10	1.068E-09	3.760E-15-1.000E+00	0.000E+00	0.000E+00
Tc-99m						
GONADS	5.750E-15	2.334E-12	3.877E-12	1.240E-16-1.000E+00	2.770E-12	9.750E-12
BREAST	6.650E-15	2.258E-12	3.752E-12	1.200E-16-1.000E+00	2.150E-12	3.570E-12
LUNGS	5.490E-15	2.127E-12	3.533E-12	1.130E-16-1.000E+00	2.280E-11	3.140E-12
RED MARR	4.910E-15	2.070E-12	3.439E-12	1.100E-16-1.000E+00	3.360E-12	6.290E-12

BONE SUR	1.630E-14	5.383E-12	8.942E-12	2.860E-16	-1.000E+00	2.620E-12	4.060E-12
THYROID	5.750E-15	2.145E-12	3.564E-12	1.140E-16	-1.000E+00	5.010E-11	8.460E-11
REMAINDER	5.150E-15	2.070E-12	3.439E-12	1.100E-16	-1.000E+00	1.020E-11	3.340E-11
EFFECTIVE	5.890E-15	2.277E-12	3.783E-12	1.210E-16	-1.000E+00	8.800E-12	1.680E-11
SKIN(FGR)	7.140E-15	2.710E-12	4.502E-12	1.440E-16	-1.000E+00	0.000E+00	0.000E+00
Ru-103							
GONADS	2.191E-14	1.404E-11	2.783E-10	4.892E-16	-1.000E+00	3.070E-10	5.720E-10
BREAST	2.512E-14	1.350E-11	2.677E-10	4.705E-16	-1.000E+00	3.110E-10	1.200E-10
LUNGS	2.180E-14	1.273E-11	2.522E-10	4.432E-16	-1.000E+00	1.561E-08	7.310E-11
RED MARR	2.100E-14	1.287E-11	2.551E-10	4.483E-16	-1.000E+00	3.190E-10	1.660E-10
BONE SUR	3.892E-14	1.958E-11	3.882E-10	6.823E-16	-1.000E+00	2.370E-10	9.631E-11
THYROID	2.241E-14	1.331E-11	2.639E-10	4.638E-16	-1.000E+00	2.570E-10	6.250E-11
REMAINDER	2.080E-14	1.248E-11	2.472E-10	4.346E-16	-1.000E+00	1.250E-09	2.110E-09
EFFECTIVE	2.251E-14	1.332E-11	2.641E-10	4.642E-16	-1.000E+00	2.421E-09	8.271E-10
SKIN(FGR)	2.774E-14	1.785E-11	3.543E-10	6.229E-16	-1.000E+00	0.000E+00	0.000E+00
Ru-105							
GONADS	3.720E-14	1.327E-11	1.861E-11	8.070E-16	-1.000E+00	1.590E-11	9.670E-11
BREAST	4.240E-14	1.271E-11	1.783E-11	7.730E-16	-1.000E+00	6.610E-12	1.590E-11
LUNGS	3.700E-14	1.210E-11	1.697E-11	7.360E-16	-1.000E+00	5.730E-10	6.210E-12
RED MARR	3.590E-14	1.230E-11	1.725E-11	7.480E-16	-1.000E+00	7.700E-12	2.350E-11
BONE SUR	6.280E-14	1.809E-11	2.537E-11	1.100E-15	-1.000E+00	4.620E-12	8.890E-12
THYROID	3.800E-14	1.260E-11	1.766E-11	7.660E-16	-1.000E+00	4.150E-12	1.820E-12
REMAINDER	3.540E-14	1.189E-11	1.667E-11	7.230E-16	-1.000E+00	1.610E-10	8.540E-10
EFFECTIVE	3.810E-14	1.265E-11	1.773E-11	7.690E-16	-1.000E+00	1.230E-10	2.870E-10
SKIN(FGR)	6.730E-14	7.368E-11	1.033E-10	4.480E-15	-1.000E+00	0.000E+00	0.000E+00
Ru-106							
GONADS	1.010E-14	6.411E-12	1.340E-10	2.230E-16	-1.000E+00	1.300E-09	1.640E-09
BREAST	1.160E-14	6.152E-12	1.286E-10	2.140E-16	-1.000E+00	1.780E-09	1.440E-09
LUNGS	1.010E-14	5.836E-12	1.220E-10	2.030E-16	-1.000E+00	1.040E-06	1.420E-09
RED MARR	9.750E-15	5.893E-12	1.232E-10	2.050E-16	-1.000E+00	1.760E-09	1.460E-09
BONE SUR	1.720E-14	8.883E-12	1.856E-10	3.090E-16	-1.000E+00	1.610E-09	1.430E-09
THYROID	1.030E-14	6.066E-12	1.268E-10	2.110E-16	-1.000E+00	1.720E-09	1.410E-09
REMAINDER	9.630E-15	5.721E-12	1.196E-10	1.990E-16	-1.000E+00	1.200E-08	2.110E-08
EFFECTIVE	1.040E-14	6.095E-12	1.274E-10	2.120E-16	-1.000E+00	1.290E-07	7.400E-09
SKIN(FGR)	1.090E-13	4.082E-10	8.531E-09	1.420E-14	-1.000E+00	0.000E+00	0.000E+00
Rh-105							
GONADS	3.640E-15	2.127E-12	1.411E-11	7.980E-17	-1.000E+00	2.110E-11	5.800E-11
BREAST	4.160E-15	2.063E-12	1.369E-11	7.740E-17	-1.000E+00	5.610E-12	8.970E-12
LUNGS	3.570E-15	1.935E-12	1.284E-11	7.260E-17	-1.000E+00	9.580E-10	3.860E-12
RED MARR	3.380E-15	1.946E-12	1.291E-11	7.300E-17	-1.000E+00	7.770E-12	1.470E-11
BONE SUR	7.530E-15	3.332E-12	2.210E-11	1.250E-16	-1.000E+00	4.460E-12	6.750E-12
THYROID	3.680E-15	1.983E-12	1.316E-11	7.440E-17	-1.000E+00	2.880E-12	2.910E-12
REMAINDER	3.390E-15	1.885E-12	1.250E-11	7.070E-17	-1.000E+00	4.530E-10	1.270E-09
EFFECTIVE	3.720E-15	2.031E-12	1.347E-11	7.620E-17	-1.000E+00	2.580E-10	3.990E-10
SKIN(FGR)	1.070E-14	4.691E-12	3.112E-11	1.760E-16	-1.000E+00	0.000E+00	0.000E+00
Sb-127							
GONADS	3.260E-14	1.985E-11	2.441E-10	7.100E-16	-1.000E+00	2.520E-10	6.140E-10
BREAST	3.720E-14	1.904E-11	2.341E-10	6.810E-16	-1.000E+00	9.120E-11	7.600E-11
LUNGS	3.240E-14	1.809E-11	2.224E-10	6.470E-16	-1.000E+00	6.940E-09	1.570E-11
RED MARR	3.140E-14	1.834E-11	2.255E-10	6.560E-16	-1.000E+00	1.610E-10	1.330E-10
BONE SUR	5.520E-14	2.720E-11	3.345E-10	9.730E-16	-1.000E+00	1.340E-10	5.240E-11
THYROID	3.330E-14	1.884E-11	2.317E-10	6.740E-16	-1.000E+00	6.150E-11	4.640E-12
REMAINDER	3.090E-14	1.775E-11	2.183E-10	6.350E-16	-1.000E+00	2.330E-09	5.870E-09
EFFECTIVE	3.330E-14	1.890E-11	2.324E-10	6.760E-16	-1.000E+00	1.630E-09	1.950E-09
SKIN(FGR)	5.580E-14	7.967E-11	9.799E-10	2.850E-15	-1.000E+00	0.000E+00	0.000E+00
Sb-129							
GONADS	6.970E-14	2.336E-11	3.231E-11	1.440E-15	-1.000E+00	2.150E-11	1.510E-10
BREAST	7.910E-14	2.222E-11	3.074E-11	1.370E-15	-1.000E+00	1.280E-11	2.560E-11
LUNGS	6.980E-14	2.141E-11	2.962E-11	1.320E-15	-1.000E+00	8.980E-10	9.390E-12
RED MARR	6.860E-14	2.190E-11	3.029E-11	1.350E-15	-1.000E+00	1.700E-11	3.670E-11
BONE SUR	1.070E-13	3.033E-11	4.196E-11	1.870E-15	-1.000E+00	1.460E-11	1.340E-11
THYROID	7.160E-14	2.174E-11	3.007E-11	1.340E-15	-1.000E+00	9.720E-12	1.470E-12
REMAINDER	6.710E-14	2.125E-11	2.939E-11	1.310E-15	-1.000E+00	1.870E-10	1.450E-09
EFFECTIVE	7.140E-14	2.238E-11	3.096E-11	1.380E-15	-1.000E+00	1.740E-10	4.840E-10
SKIN(FGR)	1.050E-13	8.273E-11	1.144E-10	5.100E-15	-1.000E+00	0.000E+00	0.000E+00
Te-127							
GONADS	2.370E-16	1.191E-13	2.661E-13	5.480E-18	-1.000E+00	2.020E-12	4.020E-12
BREAST	2.730E-16	1.158E-13	2.588E-13	5.330E-18	-1.000E+00	1.880E-12	3.000E-12
LUNGS	2.320E-16	1.060E-13	2.370E-13	4.880E-18	-1.000E+00	4.270E-10	2.890E-12
RED MARR	2.210E-16	1.058E-13	2.365E-13	4.870E-18	-1.000E+00	4.090E-12	6.570E-12
BONE SUR	4.650E-16	1.862E-13	4.162E-13	8.570E-18	-1.000E+00	4.090E-12	6.460E-12
THYROID	2.400E-16	1.106E-13	2.472E-13	5.090E-18	-1.000E+00	1.840E-12	2.860E-12
REMAINDER	2.210E-16	1.036E-13	2.316E-13	4.770E-18	-1.000E+00	1.110E-10	6.130E-10
EFFECTIVE	2.420E-16	1.125E-13	2.515E-13	5.180E-18	-1.000E+00	8.600E-11	1.870E-10
SKIN(FGR)	1.140E-14	1.173E-11	2.622E-11	5.400E-16	-1.000E+00	0.000E+00	0.000E+00

Te-127m							
GONADS	1.900E-16	4.689E-13	9.642E-12	1.630E-17	-1.000E+00	1.100E-10	1.250E-10
BREAST	2.690E-16	5.150E-13	1.059E-11	1.790E-17	-1.000E+00	1.100E-10	9.740E-11
LUNGS	7.620E-17	1.602E-13	3.295E-12	5.570E-18	-1.000E+00	3.340E-08	9.620E-11
RED MARR	6.430E-17	1.249E-13	2.567E-12	4.340E-18	-1.000E+00	5.360E-09	5.430E-09
BONE SUR	3.940E-16	9.005E-13	1.852E-11	3.130E-17	-1.000E+00	2.040E-08	2.070E-08
THYROID	1.500E-16	2.779E-13	5.714E-12	9.660E-18	-1.000E+00	9.660E-11	9.430E-11
REMAINDER	8.640E-17	1.999E-13	4.111E-12	6.950E-18	-1.000E+00	1.660E-09	2.980E-09
EFFECTIVE	1.470E-16	3.251E-13	6.684E-12	1.130E-17	-1.000E+00	5.810E-09	2.230E-09
SKIN(FGR)	8.490E-16	1.496E-12	3.076E-11	5.200E-17	-1.000E+00	0.000E+00	0.000E+00
Te-129							
GONADS	2.710E-15	3.889E-13	3.922E-13	6.510E-17	-1.000E+00	5.050E-13	1.590E-12
BREAST	3.120E-15	3.800E-13	3.832E-13	6.360E-17	-1.000E+00	5.390E-13	6.050E-13
LUNGS	2.640E-15	3.298E-13	3.326E-13	5.520E-17	-1.000E+00	1.530E-10	4.910E-13
RED MARR	2.540E-15	3.298E-13	3.326E-13	5.520E-17	-1.000E+00	6.190E-13	7.640E-13
BONE SUR	4.880E-15	5.753E-13	5.802E-13	9.630E-17	-1.000E+00	6.220E-13	5.400E-13
THYROID	2.740E-15	3.525E-13	3.555E-13	5.900E-17	-1.000E+00	5.090E-13	3.360E-13
REMAINDER	2.520E-15	3.262E-13	3.289E-13	5.460E-17	-1.000E+00	7.280E-12	1.790E-10
EFFECTIVE	2.750E-15	3.590E-13	3.621E-13	6.010E-17	-1.000E+00	2.090E-11	5.450E-11
SKIN(FGR)	3.570E-14	3.429E-11	3.458E-11	5.740E-15	-1.000E+00	0.000E+00	0.000E+00
Te-129m							
GONADS	3.321E-15	2.206E-12	4.799E-11	8.561E-17	-1.000E+00	1.783E-10	2.420E-10
BREAST	3.838E-15	2.181E-12	4.739E-11	8.454E-17	-1.000E+00	1.694E-10	1.664E-10
LUNGS	3.176E-15	1.741E-12	3.815E-11	6.808E-17	-1.000E+00	4.040E-08	1.593E-10
RED MARR	3.071E-15	1.729E-12	3.793E-11	6.768E-17	-1.000E+00	3.100E-09	3.500E-09
BONE SUR	5.772E-15	3.287E-12	7.147E-11	1.275E-16	-1.000E+00	7.050E-09	7.990E-09
THYROID	3.341E-15	1.923E-12	4.201E-11	7.495E-17	-1.000E+00	1.563E-10	1.572E-10
REMAINDER	3.048E-15	1.746E-12	3.822E-11	6.819E-17	-1.000E+00	3.275E-09	7.196E-09
EFFECTIVE	3.337E-15	1.974E-12	4.308E-11	7.686E-17	-1.000E+00	6.484E-09	2.925E-09
SKIN(FGR)	3.811E-14	1.501E-10	3.360E-09	6.001E-15	-1.000E+00	0.000E+00	0.000E+00
Te-131m							
GONADS	7.292E-14	4.020E-11	2.343E-10	1.535E-15	-1.000E+00	2.345E-10	7.415E-10
BREAST	8.286E-14	3.853E-11	2.246E-10	1.472E-15	-1.000E+00	9.309E-11	1.361E-10
LUNGS	7.265E-14	3.657E-11	2.131E-10	1.397E-15	-1.000E+00	2.296E-09	6.335E-11
RED MARR	7.097E-14	3.736E-11	2.178E-10	1.427E-15	-1.000E+00	1.417E-10	2.435E-10
BONE SUR	1.174E-13	5.467E-11	3.189E-10	2.090E-15	-1.000E+00	2.276E-10	3.248E-10
THYROID	7.471E-14	3.741E-11	2.181E-10	1.429E-15	-1.000E+00	3.669E-08	4.383E-08
REMAINDER	6.965E-14	3.626E-11	2.113E-10	1.385E-15	-1.000E+00	9.509E-10	3.153E-09
EFFECTIVE	7.463E-14	3.825E-11	2.229E-10	1.461E-15	-1.000E+00	1.758E-09	2.514E-09
SKIN(FGR)	1.038E-13	1.033E-10	6.188E-10	4.056E-15	-1.000E+00	0.000E+00	0.000E+00
Te-132							
GONADS	1.020E-14	6.812E-12	7.706E-11	2.450E-16	-1.000E+00	4.150E-10	5.410E-10
BREAST	1.180E-14	6.756E-12	7.643E-11	2.430E-16	-1.000E+00	3.630E-10	3.500E-10
LUNGS	9.650E-15	5.727E-12	6.479E-11	2.060E-16	-1.000E+00	1.670E-09	3.300E-10
RED MARR	8.950E-15	5.588E-12	6.322E-11	2.010E-16	-1.000E+00	4.270E-10	4.440E-10
BONE SUR	2.420E-14	1.273E-11	1.441E-10	4.580E-16	-1.000E+00	7.120E-10	8.300E-10
THYROID	1.020E-14	5.978E-12	6.762E-11	2.150E-16	-1.000E+00	6.280E-08	5.950E-08
REMAINDER	9.160E-15	5.644E-12	6.385E-11	2.030E-16	-1.000E+00	7.890E-10	1.490E-09
EFFECTIVE	1.030E-14	6.339E-12	7.171E-11	2.280E-16	-1.000E+00	2.550E-09	2.540E-09
SKIN(FGR)	1.390E-14	8.313E-12	9.405E-11	2.990E-16	-1.000E+00	0.000E+00	0.000E+00
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-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-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
Cs-134							
GONADS	7.400E-14	4.607E-11	9.646E-10	1.600E-15	-1.000E+00	1.300E-08	2.060E-08
BREAST	8.430E-14	4.406E-11	9.224E-10	1.530E-15	-1.000E+00	1.080E-08	1.720E-08
LUNGS	7.370E-14	4.204E-11	8.802E-10	1.460E-15	-1.000E+00	1.180E-08	1.760E-08
RED MARR	7.190E-14	4.262E-11	8.922E-10	1.480E-15	-1.000E+00	1.180E-08	1.870E-08
BONE SUR	1.200E-13	6.105E-11	1.278E-09	2.120E-15	-1.000E+00	1.100E-08	1.740E-08
THYROID	7.570E-14	4.377E-11	9.163E-10	1.520E-15	-1.000E+00	1.110E-08	1.760E-08
REMAINDER	7.060E-14	4.147E-11	8.681E-10	1.440E-15	-1.000E+00	1.390E-08	2.210E-08
EFFECTIVE	7.570E-14	4.377E-11	9.163E-10	1.520E-15	-1.000E+00	1.250E-08	1.980E-08
SKIN(FGR)	9.450E-14	6.249E-11	1.308E-09	2.170E-15	-1.000E+00	0.000E+00	0.000E+00
Cs-136							
GONADS	1.040E-13	6.223E-11	1.102E-09	2.180E-15	-1.000E+00	1.880E-09	3.040E-09
BREAST	1.180E-13	5.966E-11	1.056E-09	2.090E-15	-1.000E+00	1.670E-09	2.650E-09
LUNGS	1.040E-13	5.710E-11	1.011E-09	2.000E-15	-1.000E+00	2.320E-09	2.620E-09
RED MARR	1.010E-13	5.824E-11	1.031E-09	2.040E-15	-1.000E+00	1.860E-09	2.950E-09
BONE SUR	1.660E-13	8.422E-11	1.491E-09	2.950E-15	-1.000E+00	1.700E-09	2.710E-09
THYROID	1.070E-13	5.852E-11	1.036E-09	2.050E-15	-1.000E+00	1.730E-09	2.740E-09
REMAINDER	9.950E-14	5.652E-11	1.001E-09	1.980E-15	-1.000E+00	2.190E-09	3.520E-09
EFFECTIVE	1.060E-13	5.966E-11	1.056E-09	2.090E-15	-1.000E+00	1.980E-09	3.040E-09
SKIN(FGR)	1.250E-13	7.251E-11	1.284E-09	2.540E-15	-1.000E+00	0.000E+00	0.000E+00
Cs-137							
GONADS	2.669E-14	1.669E-11	3.530E-10	5.840E-16	-1.000E+00	8.760E-09	1.390E-08
BREAST	3.047E-14	1.596E-11	3.376E-10	5.585E-16	-1.000E+00	7.840E-09	1.240E-08
LUNGS	2.649E-14	1.517E-11	3.209E-10	5.309E-16	-1.000E+00	8.820E-09	1.270E-08
RED MARR	2.583E-14	1.542E-11	3.260E-10	5.394E-16	-1.000E+00	8.300E-09	1.320E-08
BONE SUR	4.382E-14	2.238E-11	4.734E-10	7.832E-16	-1.000E+00	7.940E-09	1.260E-08
THYROID	2.725E-14	1.588E-11	3.358E-10	5.556E-16	-1.000E+00	7.930E-09	1.260E-08
REMAINDER	2.536E-14	1.490E-11	3.152E-10	5.215E-16	-1.000E+00	9.120E-09	1.450E-08
EFFECTIVE	2.725E-14	1.585E-11	3.353E-10	5.546E-16	-1.000E+00	8.630E-09	1.350E-08
SKIN(FGR)	4.392E-14	5.253E-11	1.110E-09	1.836E-15	-1.000E+00	0.000E+00	0.000E+00
Ba-139							
GONADS	2.130E-15	3.368E-13	3.429E-13	4.790E-17	-1.000E+00	2.560E-12	1.560E-12

BREAST	2.450E-15	3.297E-13	3.357E-13	4.690E-17-1.000E+00	2.460E-12	5.170E-13
LUNGS	2.030E-15	3.002E-13	3.057E-13	4.270E-17-1.000E+00	2.530E-10	3.890E-13
RED MARR	1.870E-15	2.932E-13	2.985E-13	4.170E-17-1.000E+00	3.410E-12	8.590E-13
BONE SUR	5.290E-15	6.841E-13	6.965E-13	9.730E-17-1.000E+00	2.490E-12	4.380E-13
THYROID	2.130E-15	3.044E-13	3.100E-13	4.330E-17-1.000E+00	2.400E-12	2.660E-13
REMAINDER	1.920E-15	2.932E-13	2.985E-13	4.170E-17-1.000E+00	4.820E-11	3.570E-10
EFFECTIVE	2.170E-15	3.227E-13	3.286E-13	4.590E-17-1.000E+00	4.640E-11	1.080E-10
SKIN(FGR)	6.160E-14	7.241E-11	7.373E-11	1.030E-14-1.000E+00	0.000E+00	0.000E+00
Ba-140						
GONADS	8.410E-15	5.451E-12	9.607E-11	1.910E-16-1.000E+00	4.300E-10	9.960E-10
BREAST	9.640E-15	5.280E-12	9.305E-11	1.850E-16-1.000E+00	2.870E-10	1.590E-10
LUNGS	8.270E-15	4.852E-12	8.550E-11	1.700E-16-1.000E+00	1.660E-09	6.630E-11
RED MARR	7.930E-15	4.880E-12	8.601E-11	1.710E-16-1.000E+00	1.290E-09	4.390E-10
BONE SUR	1.550E-14	8.020E-12	1.413E-10	2.810E-16-1.000E+00	2.410E-09	5.530E-10
THYROID	8.530E-15	5.109E-12	9.003E-11	1.790E-16-1.000E+00	2.560E-10	5.250E-11
REMAINDER	7.890E-15	4.766E-12	8.399E-11	1.670E-16-1.000E+00	1.410E-09	7.370E-09
EFFECTIVE	8.580E-15	5.137E-12	9.053E-11	1.800E-16-1.000E+00	1.010E-09	2.560E-09
SKIN(FGR)	2.520E-14	5.565E-11	9.808E-10	1.950E-15-1.000E+00	0.000E+00	0.000E+00
La-140						
GONADS	1.140E-13	6.027E-11	4.425E-10	2.240E-15-1.000E+00	4.540E-10	1.340E-09
BREAST	1.290E-13	5.758E-11	4.228E-10	2.140E-15-1.000E+00	1.450E-10	1.800E-10
LUNGS	1.150E-13	5.596E-11	4.109E-10	2.080E-15-1.000E+00	4.210E-09	4.010E-11
RED MARR	1.140E-13	5.731E-11	4.208E-10	2.130E-15-1.000E+00	2.140E-10	2.810E-10
BONE SUR	1.690E-13	7.776E-11	5.709E-10	2.890E-15-1.000E+00	1.410E-10	9.770E-11
THYROID	1.180E-13	5.462E-11	4.010E-10	2.030E-15-1.000E+00	6.870E-11	6.400E-12
REMAINDER	1.110E-13	5.569E-11	4.089E-10	2.070E-15-1.000E+00	2.120E-09	6.260E-09
EFFECTIVE	1.170E-13	5.812E-11	4.267E-10	2.160E-15-1.000E+00	1.310E-09	2.280E-09
SKIN(FGR)	1.660E-13	2.217E-10	1.628E-09	8.240E-15-1.000E+00	0.000E+00	0.000E+00
La-141						
GONADS	2.330E-15	7.315E-13	9.675E-13	4.740E-17-1.000E+00	1.010E-11	3.770E-12
BREAST	2.640E-15	7.007E-13	9.267E-13	4.540E-17-1.000E+00	9.840E-12	7.070E-13
LUNGS	2.340E-15	6.713E-13	8.879E-13	4.350E-17-1.000E+00	6.460E-10	2.720E-13
RED MARR	2.310E-15	6.852E-13	9.063E-13	4.440E-17-1.000E+00	2.930E-11	1.070E-12
BONE SUR	3.490E-15	9.923E-13	1.312E-12	6.430E-17-1.000E+00	1.200E-10	6.060E-13
THYROID	2.390E-15	6.590E-13	8.716E-13	4.270E-17-1.000E+00	9.400E-12	5.290E-14
REMAINDER	2.260E-15	6.682E-13	8.838E-13	4.330E-17-1.000E+00	2.280E-10	1.240E-09
EFFECTIVE	2.390E-15	7.007E-13	9.267E-13	4.540E-17-1.000E+00	1.570E-10	3.740E-10
SKIN(FGR)	6.580E-14	1.667E-10	2.204E-10	1.080E-14-1.000E+00	0.000E+00	0.000E+00
La-142						
GONADS	1.400E-13	1.978E-11	2.034E-11	2.540E-15-1.000E+00	1.660E-11	6.990E-11
BREAST	1.570E-13	1.885E-11	1.938E-11	2.420E-15-1.000E+00	1.130E-11	1.540E-11
LUNGS	1.420E-13	1.846E-11	1.898E-11	2.370E-15-1.000E+00	3.010E-10	8.400E-12
RED MARR	1.420E-13	1.900E-11	1.954E-11	2.440E-15-1.000E+00	1.360E-11	1.930E-11
BONE SUR	1.950E-13	2.484E-11	2.554E-11	3.190E-15-1.000E+00	1.110E-11	7.400E-12
THYROID	1.450E-13	1.768E-11	1.818E-11	2.270E-15-1.000E+00	8.740E-12	1.160E-12
REMAINDER	1.380E-13	1.853E-11	1.906E-11	2.380E-15-1.000E+00	8.070E-11	5.200E-10
EFFECTIVE	1.440E-13	1.916E-11	1.970E-11	2.460E-15-1.000E+00	6.840E-11	1.790E-10
SKIN(FGR)	2.160E-13	9.111E-11	9.368E-11	1.170E-14-1.000E+00	0.000E+00	0.000E+00
Ce-141						
GONADS	3.380E-15	2.213E-12	4.332E-11	7.710E-17-1.000E+00	5.540E-11	1.080E-10
BREAST	3.930E-15	2.170E-12	4.247E-11	7.560E-17-1.000E+00	4.460E-11	1.110E-11
LUNGS	3.170E-15	1.951E-12	3.820E-11	6.800E-17-1.000E+00	1.670E-08	1.430E-12
RED MARR	2.830E-15	1.860E-12	3.641E-11	6.480E-17-1.000E+00	8.960E-11	3.390E-11
BONE SUR	9.410E-15	5.166E-12	1.011E-10	1.800E-16-1.000E+00	2.540E-10	2.300E-11
THYROID	3.350E-15	2.003E-12	3.922E-11	6.980E-17-1.000E+00	2.550E-11	1.800E-13
REMAINDER	2.980E-15	1.894E-12	3.708E-11	6.600E-17-1.000E+00	1.260E-09	2.500E-09
EFFECTIVE	3.430E-15	2.118E-12	4.146E-11	7.380E-17-1.000E+00	2.420E-09	7.830E-10
SKIN(FGR)	1.020E-14	3.788E-12	7.416E-11	1.320E-16-1.000E+00	0.000E+00	0.000E+00
Ce-143						
GONADS	1.280E-14	7.900E-12	4.958E-11	2.980E-16-1.000E+00	7.530E-11	2.120E-10
BREAST	1.470E-14	7.688E-12	4.825E-11	2.900E-16-1.000E+00	1.660E-11	2.320E-11
LUNGS	1.230E-14	6.893E-12	4.325E-11	2.600E-16-1.000E+00	3.880E-09	3.820E-12
RED MARR	1.170E-14	6.787E-12	4.259E-11	2.560E-16-1.000E+00	2.960E-11	5.070E-11
BONE SUR	2.520E-14	1.323E-11	8.302E-11	4.990E-16-1.000E+00	1.640E-11	1.610E-11
THYROID	1.280E-14	7.211E-12	4.525E-11	2.720E-16-1.000E+00	6.230E-12	4.350E-13
REMAINDER	1.170E-14	6.734E-12	4.226E-11	2.540E-16-1.000E+00	1.420E-09	3.890E-09
EFFECTIVE	1.290E-14	7.396E-12	4.642E-11	2.790E-16-1.000E+00	9.160E-10	1.230E-09
SKIN(FGR)	3.960E-14	1.058E-10	6.638E-10	3.990E-15-1.000E+00	0.000E+00	0.000E+00
Ce-144						
GONADS	2.725E-15	6.328E-13	1.319E-11	6.088E-17-1.000E+00	2.390E-10	6.987E-11
BREAST	3.129E-15	6.274E-13	1.307E-11	5.922E-17-1.000E+00	3.480E-10	1.223E-11
LUNGS	2.639E-15	5.228E-13	1.089E-11	5.362E-17-1.000E+00	7.911E-07	6.551E-12
RED MARR	2.507E-15	4.755E-13	9.907E-12	5.247E-17-1.000E+00	2.880E-09	8.923E-11
BONE SUR	5.441E-15	1.646E-12	3.429E-11	1.127E-16-1.000E+00	4.720E-09	1.280E-10
THYROID	2.753E-15	5.529E-13	1.152E-11	5.418E-17-1.000E+00	2.920E-10	5.154E-12
REMAINDER	2.534E-15	5.086E-13	1.060E-11	5.283E-17-1.000E+00	1.910E-08	1.890E-08

EFFECTIVE	2.773E-15	5.909E-13	1.231E-11	5.766E-17	-1.000E+00	1.010E-07	5.711E-09
SKIN(FGR)	8.574E-14	7.648E-13	1.594E-11	1.250E-14	-1.000E+00	0.000E+00	0.000E+00
Pr-143							
GONADS	2.130E-17	2.264E-14	4.032E-13	7.930E-19	-1.000E+00	4.370E-18	8.990E-18
BREAST	2.550E-17	2.330E-14	4.149E-13	8.160E-19	-1.000E+00	2.220E-18	1.090E-18
LUNGS	1.860E-17	1.642E-14	2.923E-13	5.750E-19	-1.000E+00	1.330E-08	1.910E-19
RED MARR	1.620E-17	1.493E-14	2.659E-13	5.230E-19	-1.000E+00	1.480E-11	1.030E-12
BONE SUR	5.930E-17	5.454E-14	9.711E-13	1.910E-18	-1.000E+00	1.490E-11	1.030E-12
THYROID	2.050E-17	1.802E-14	3.208E-13	6.310E-19	-1.000E+00	1.680E-18	2.660E-20
REMAINDER	1.760E-17	1.642E-14	2.923E-13	5.750E-19	-1.000E+00	1.970E-09	4.220E-09
EFFECTIVE	2.100E-17	2.002E-14	3.564E-13	7.010E-19	-1.000E+00	2.190E-09	1.270E-09
SKIN(FGR)	1.760E-14	5.711E-11	1.017E-09	2.000E-15	-1.000E+00	0.000E+00	0.000E+00
Nd-147							
GONADS	6.130E-15	4.218E-12	7.235E-11	1.480E-16	-1.000E+00	8.410E-11	1.790E-10
BREAST	7.120E-15	4.132E-12	7.088E-11	1.450E-16	-1.000E+00	3.450E-11	1.870E-11
LUNGS	5.820E-15	3.648E-12	6.257E-11	1.280E-16	-1.000E+00	1.060E-08	2.440E-12
RED MARR	5.400E-15	3.505E-12	6.013E-11	1.230E-16	-1.000E+00	9.190E-11	5.050E-11
BONE SUR	1.320E-14	8.265E-12	1.418E-10	2.900E-16	-1.000E+00	3.260E-10	2.220E-11
THYROID	6.120E-15	3.876E-12	6.648E-11	1.360E-16	-1.000E+00	1.820E-11	2.640E-13
REMAINDER	5.530E-15	3.562E-12	6.111E-11	1.250E-16	-1.000E+00	1.760E-09	3.760E-09
EFFECTIVE	6.190E-15	3.961E-12	6.795E-11	1.390E-16	-1.000E+00	1.850E-09	1.180E-09
SKIN(FGR)	1.950E-14	3.135E-11	5.377E-10	1.100E-15	-1.000E+00	0.000E+00	0.000E+00
Np-239							
GONADS	7.530E-15	4.691E-12	4.380E-11	1.710E-16	-1.000E+00	7.450E-11	1.620E-10
BREAST	8.730E-15	4.636E-12	4.329E-11	1.690E-16	-1.000E+00	1.630E-11	1.720E-11
LUNGS	7.180E-15	4.115E-12	3.842E-11	1.500E-16	-1.000E+00	2.360E-09	2.400E-12
RED MARR	6.500E-15	4.005E-12	3.740E-11	1.460E-16	-1.000E+00	2.080E-10	4.660E-11
BONE SUR	2.000E-14	1.001E-11	9.349E-11	3.650E-16	-1.000E+00	2.030E-09	3.590E-11
THYROID	7.520E-15	4.197E-12	3.919E-11	1.530E-16	-1.000E+00	7.620E-12	2.070E-13
REMAINDER	6.760E-15	4.005E-12	3.740E-11	1.460E-16	-1.000E+00	9.590E-10	2.770E-09
EFFECTIVE	7.690E-15	4.471E-12	4.175E-11	1.630E-16	-1.000E+00	6.780E-10	8.820E-10
SKIN(FGR)	1.600E-14	7.215E-12	6.737E-11	2.630E-16	-1.000E+00	0.000E+00	0.000E+00
Pu-238							
GONADS	6.560E-18	4.291E-14	9.011E-13	1.490E-18	-1.000E+00	1.040E-05	2.330E-09
BREAST	1.270E-17	5.558E-14	1.167E-12	1.930E-18	-1.000E+00	4.400E-10	1.800E-13
LUNGS	1.060E-18	2.267E-15	4.759E-14	7.870E-20	-1.000E+00	3.200E-04	8.640E-14
RED MARR	1.680E-18	5.587E-15	1.173E-13	1.940E-19	-1.000E+00	5.800E-05	1.270E-08
BONE SUR	9.300E-18	3.514E-14	7.378E-13	1.220E-18	-1.000E+00	7.250E-04	1.580E-07
THYROID	4.010E-18	9.792E-15	2.056E-13	3.400E-19	-1.000E+00	3.860E-10	7.990E-14
REMAINDER	1.990E-18	9.216E-15	1.935E-13	3.200E-19	-1.000E+00	2.740E-05	2.180E-08
EFFECTIVE	4.880E-18	2.413E-14	5.068E-13	8.380E-19	-1.000E+00	7.790E-05	1.340E-08
SKIN(FGR)	4.090E-17	2.776E-13	5.830E-12	9.640E-18	-1.000E+00	0.000E+00	0.000E+00
Pu-239							
GONADS	4.840E-18	1.768E-14	3.713E-13	6.140E-19	-1.000E+00	1.200E-05	2.640E-09
BREAST	7.550E-18	2.238E-14	4.699E-13	7.770E-19	-1.000E+00	3.990E-10	1.210E-13
LUNGS	2.650E-18	2.267E-15	4.760E-14	7.870E-20	-1.000E+00	3.230E-04	7.890E-14
RED MARR	2.670E-18	3.456E-15	7.258E-14	1.200E-19	-1.000E+00	6.570E-05	1.410E-08
BONE SUR	9.470E-18	1.673E-14	3.514E-13	5.810E-19	-1.000E+00	8.210E-04	1.760E-07
THYROID	3.880E-18	5.126E-15	1.077E-13	1.780E-19	-1.000E+00	3.750E-10	7.500E-14
REMAINDER	2.860E-18	4.838E-15	1.016E-13	1.680E-19	-1.000E+00	3.020E-05	2.120E-08
EFFECTIVE	4.240E-18	1.057E-14	2.220E-13	3.670E-19	-1.000E+00	8.330E-05	1.400E-08
SKIN(FGR)	1.860E-17	1.057E-13	2.220E-12	3.670E-18	-1.000E+00	0.000E+00	0.000E+00
Pu-240							
GONADS	6.360E-18	4.118E-14	8.649E-13	1.430E-18	-1.000E+00	1.200E-05	2.640E-09
BREAST	1.230E-17	5.328E-14	1.119E-12	1.850E-18	-1.000E+00	4.330E-10	1.730E-13
LUNGS	1.090E-18	2.249E-15	4.723E-14	7.810E-20	-1.000E+00	3.230E-04	8.220E-14
RED MARR	1.650E-18	5.386E-15	1.131E-13	1.870E-19	-1.000E+00	6.570E-05	1.410E-08
BONE SUR	9.260E-18	3.398E-14	7.137E-13	1.180E-18	-1.000E+00	8.210E-04	1.760E-07
THYROID	3.920E-18	9.446E-15	1.984E-13	3.280E-19	-1.000E+00	3.760E-10	7.510E-14
REMAINDER	1.960E-18	8.870E-15	1.863E-13	3.080E-19	-1.000E+00	3.020E-05	2.130E-08
EFFECTIVE	4.750E-18	2.313E-14	4.857E-13	8.030E-19	-1.000E+00	8.330E-05	1.400E-08
SKIN(FGR)	3.920E-17	2.644E-13	5.552E-12	9.180E-18	-1.000E+00	0.000E+00	0.000E+00
Pu-241							
GONADS	7.190E-20	6.653E-17	1.396E-15	2.310E-21	-1.000E+00	2.760E-07	5.660E-11
BREAST	8.670E-20	7.229E-17	1.517E-15	2.510E-21	-1.000E+00	2.140E-11	2.790E-15
LUNGS	6.480E-20	4.090E-17	8.584E-16	1.420E-21	-1.000E+00	3.180E-06	4.480E-15
RED MARR	5.630E-20	4.003E-17	8.403E-16	1.390E-21	-1.000E+00	1.430E-06	2.780E-10
BONE SUR	2.190E-19	1.385E-16	2.908E-15	4.810E-21	-1.000E+00	1.780E-05	3.480E-09
THYROID	6.980E-20	4.522E-17	9.491E-16	1.570E-21	-1.000E+00	9.150E-12	1.010E-15
REMAINDER	6.090E-20	4.291E-17	9.007E-16	1.490E-21	-1.000E+00	6.020E-07	1.850E-10
EFFECTIVE	7.250E-20	5.558E-17	1.167E-15	1.930E-21	-1.000E+00	1.340E-06	2.070E-10
SKIN(FGR)	1.170E-19	2.033E-16	4.268E-15	7.060E-21	-1.000E+00	0.000E+00	0.000E+00
Am-241							
GONADS	8.580E-16	9.360E-13	1.966E-11	3.250E-17	-1.000E+00	3.250E-05	2.700E-07
BREAST	1.070E-15	1.014E-12	2.129E-11	3.520E-17	-1.000E+00	2.670E-09	2.620E-11
LUNGS	6.740E-16	5.789E-13	1.216E-11	2.010E-17	-1.000E+00	1.840E-05	3.360E-11

RED MARR	5.210E-16	4.838E-13	1.016E-11	1.680E-17	-1.000E+00	1.740E-04	1.450E-06
BONE SUR	2.870E-15	2.678E-12	5.625E-11	9.300E-17	-1.000E+00	2.170E-03	1.810E-05
THYROID	7.830E-16	6.365E-13	1.337E-11	2.210E-17	-1.000E+00	1.600E-09	1.320E-11
REMAINDER	6.340E-16	5.933E-13	1.246E-11	2.060E-17	-1.000E+00	7.820E-05	6.660E-07
EFFECTIVE	8.180E-16	7.920E-13	1.663E-11	2.750E-17	-1.000E+00	1.200E-04	9.840E-07
SKIN(FGR)	1.280E-15	2.396E-12	5.032E-11	8.320E-17	-1.000E+00	0.000E+00	0.000E+00
Cm-242							
GONADS	7.830E-18	4.893E-14	1.013E-12	1.700E-18	-1.000E+00	5.700E-07	5.200E-09
BREAST	1.480E-17	6.159E-14	1.275E-12	2.140E-18	-1.000E+00	9.440E-10	8.950E-12
LUNGS	1.130E-18	3.022E-15	6.257E-14	1.050E-19	-1.000E+00	1.550E-05	8.840E-12
RED MARR	1.890E-18	6.562E-15	1.359E-13	2.280E-19	-1.000E+00	3.900E-06	3.570E-08
BONE SUR	1.060E-17	4.231E-14	8.759E-13	1.470E-18	-1.000E+00	4.870E-05	4.460E-07
THYROID	4.910E-18	1.261E-14	2.610E-13	4.380E-19	-1.000E+00	9.410E-10	8.820E-12
REMAINDER	2.270E-18	1.079E-14	2.235E-13	3.750E-19	-1.000E+00	2.450E-06	4.020E-08
EFFECTIVE	5.690E-18	2.751E-14	5.697E-13	9.560E-19	-1.000E+00	4.670E-06	3.100E-08
SKIN(FGR)	4.290E-17	2.700E-13	5.589E-12	9.380E-18	-1.000E+00	0.000E+00	0.000E+00
Cm-244							
GONADS	6.900E-18	4.522E-14	9.492E-13	1.570E-18	-1.000E+00	1.590E-05	1.330E-07
BREAST	1.330E-17	5.702E-14	1.197E-12	1.980E-18	-1.000E+00	1.040E-09	8.820E-12
LUNGS	7.080E-19	2.592E-15	5.441E-14	9.000E-20	-1.000E+00	1.930E-05	8.810E-12
RED MARR	1.460E-18	5.875E-15	1.233E-13	2.040E-19	-1.000E+00	9.380E-05	7.820E-07
BONE SUR	8.820E-18	3.859E-14	8.101E-13	1.340E-18	-1.000E+00	1.170E-03	9.770E-06
THYROID	4.190E-18	1.146E-14	2.406E-13	3.980E-19	-1.000E+00	1.010E-09	8.440E-12
REMAINDER	1.810E-18	9.821E-15	2.062E-13	3.410E-19	-1.000E+00	4.780E-05	4.150E-07
EFFECTIVE	4.910E-18	2.529E-14	5.308E-13	8.780E-19	-1.000E+00	6.700E-05	5.450E-07
SKIN(FGR)	3.910E-17	2.506E-13	5.260E-12	8.700E-18	-1.000E+00	0.000E+00	0.000E+00

Appendix D3
RADTRAD Output Files (Excerpts)

RUN D1 – NOSPRAYS_STACKBASE.O0

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

Time (hr)	DW I-131 (Curies)	Torus I-131 (Curies)	RB I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	1.3676E+06	0.0000E+00	7.4824E+01
0.500	4.2291E+06	0.0000E+00	7.7215E+02
0.533	4.4754E+06	0.0000E+00	8.7090E+02
0.533	4.4784E+06	0.0000E+00	8.7191E+02
0.900	9.6128E+06	0.0000E+00	2.5299E+03
1.200	1.3664E+07	0.0000E+00	4.6295E+03
1.500	1.7281E+07	0.0000E+00	7.1477E+03
1.800	2.0509E+07	0.0000E+00	9.9063E+03
2.000	2.2466E+07	0.0000E+00	1.1812E+04
2.033	2.2775E+07	0.0000E+00	1.2129E+04
2.033	2.2440E+07	3.3281E+05	1.2133E+04
2.400	1.0875E+07	8.2496E+06	1.4784E+04
2.700	9.0685E+06	6.8789E+06	1.5616E+04
3.000	7.5625E+06	5.7365E+06	1.5629E+04
3.300	6.3074E+06	4.7844E+06	1.5102E+04
3.600	5.2613E+06	3.9909E+06	1.4234E+04
3.900	4.3895E+06	3.3295E+06	1.3173E+04
4.200	3.6629E+06	2.7783E+06	1.2019E+04
4.500	3.0573E+06	2.3190E+06	1.0844E+04
4.800	2.5526E+06	1.9361E+06	9.6954E+03
5.033	2.2194E+06	1.6833E+06	8.8417E+03
5.400	1.9449E+06	1.4694E+06	7.6295E+03
5.700	1.7439E+06	1.3174E+06	6.7721E+03
6.000	1.5639E+06	1.1815E+06	6.0176E+03
6.300	1.4028E+06	1.0597E+06	5.3526E+03
6.600	1.2586E+06	9.5076E+05	4.7654E+03
6.900	1.1295E+06	8.5322E+05	4.2463E+03
7.200	1.0139E+06	7.6589E+05	3.7867E+03
7.500	9.1041E+05	6.8772E+05	3.3794E+03
7.800	8.1778E+05	6.1774E+05	3.0180E+03
8.000	7.6149E+05	5.7521E+05	2.7999E+03
8.300	6.8447E+05	5.1702E+05	2.5033E+03
8.367	6.6840E+05	5.0488E+05	2.4416E+03
8.667	6.0921E+05	4.5982E+05	2.1863E+03
8.967	5.5530E+05	4.1912E+05	1.9616E+03
9.300	5.0128E+05	3.7834E+05	1.7430E+03
9.600	4.5735E+05	3.4517E+05	1.5697E+03
9.900	4.1748E+05	3.1508E+05	1.4160E+03
10.200	3.8131E+05	2.8776E+05	1.2792E+03
12.033	2.2249E+05	1.6786E+05	7.0673E+02
19.478	4.5793E+04	3.4464E+04	1.1192E+02
24.000	3.0543E+04	2.2956E+04	6.4221E+01
24.033	3.0488E+04	2.2914E+04	6.4056E+01
96.000	2.1688E+04	1.6286E+04	4.1226E+01
240.000	1.0956E+04	8.2274E+03	2.0826E+01
264.000	4.7667E+03	3.5771E+03	9.4259E+00
480.000	1.7107E+03	1.2846E+03	3.2517E+00
504.000	7.4427E+02	5.5853E+02	1.4718E+00
696.000	2.9930E+02	2.2476E+02	5.6893E-01
720.000	1.3022E+02	9.7723E+01	2.5750E-01

Time (hr)	SR I-131 (Curies)	Condenser I-131 (Curies)	TB I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	1.3937E-01	1.4886E-01	8.2642E-05
0.500	1.8338E+00	1.7383E+00	2.5651E-04

0.533	2.0822E+00	1.9848E+00	2.7153E-04
0.533	2.0847E+00	1.9873E+00	2.7170E-04
0.900	6.2159E+00	6.3260E+00	5.8387E-04
1.200	1.1562E+01	1.2371E+01	8.3139E-04
1.500	1.8041E+01	2.0548E+01	1.0536E-03
1.800	2.5182E+01	3.0747E+01	1.2531E-03
2.000	3.0133E+01	3.8620E+01	1.3748E-03
2.033	3.0958E+01	3.9999E+01	1.3941E-03
2.033	3.0966E+01	4.0013E+01	1.3826E-03
2.400	3.8180E+01	4.8855E+01	6.7741E-04
2.700	4.0591E+01	5.5391E+01	5.7128E-04
3.000	4.0819E+01	6.1494E+01	4.8303E-04
3.300	3.9596E+01	6.7233E+01	4.0970E-04
3.600	3.7456E+01	7.2668E+01	3.4879E-04
3.900	3.4783E+01	7.7846E+01	2.9823E-04
4.200	3.1850E+01	8.2809E+01	2.5630E-04
4.500	2.8846E+01	8.7590E+01	2.2156E-04
4.800	2.5899E+01	9.2217E+01	1.9282E-04
5.033	2.3703E+01	9.5721E+01	1.7398E-04
5.400	2.0566E+01	1.0113E+02	1.5928E-04
5.700	1.8345E+01	1.0548E+02	1.4863E-04
6.000	1.6391E+01	1.0976E+02	1.3923E-04
6.300	1.4668E+01	1.1399E+02	1.3093E-04
6.600	1.3146E+01	1.1817E+02	1.2364E-04
6.900	1.1801E+01	1.2231E+02	1.1723E-04
7.200	1.0609E+01	1.2639E+02	1.1162E-04
7.500	9.5533E+00	1.3044E+02	1.0672E-04
7.800	8.6160E+00	1.3446E+02	1.0246E-04
8.000	8.0501E+00	1.3711E+02	9.9941E-05
8.300	7.2804E+00	1.4107E+02	9.6597E-05
8.367	7.1205E+00	1.4195E+02	9.5917E-05
8.667	6.4571E+00	1.4587E+02	9.3628E-05
8.967	5.8732E+00	1.4976E+02	9.1648E-05
9.300	5.3050E+00	1.5405E+02	8.9790E-05
9.600	4.8548E+00	1.5789E+02	8.8391E-05
9.900	4.4551E+00	1.6171E+02	8.7228E-05
10.200	4.0993E+00	1.6551E+02	8.6279E-05
12.033	2.6091E+00	1.8830E+02	8.4075E-05
19.478	1.0413E+00	2.7527E+02	1.0137E-04
24.000	9.0195E-01	3.2452E+02	1.1623E-04
24.033	9.0141E-01	3.2487E+02	1.1634E-04
96.000	6.2967E-01	8.3539E+02	2.7876E-04
240.000	3.1809E-01	9.8295E+02	3.2276E-04
264.000	5.1126E+00	9.2802E+02	3.0271E-04
480.000	4.9667E-02	4.1873E+02	1.3643E-04
504.000	7.9828E-01	3.7714E+02	1.2259E-04
696.000	8.6898E-03	1.5191E+02	4.9381E-05
720.000	1.3967E-01	1.3485E+02	4.3784E-05

Time (hr)	Dummy I-131 (Curies)	CR I-131 (Curies)	Environment I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	2.7215E-01	5.7742E-08	9.6411E-05
0.500	1.2747E+01	1.9053E-06	5.0004E-03
0.533	1.5572E+01	2.2961E-06	6.1215E-03
0.533	1.5602E+01	2.3002E-06	6.1334E-03
0.900	7.7909E+01	9.9810E-06	3.0963E-02
1.200	1.9207E+02	2.2304E-05	7.6637E-02
1.500	3.8325E+02	4.0348E-05	1.5334E-01
1.800	6.6275E+02	6.3205E-05	2.6567E-01
2.000	9.0130E+02	8.0502E-05	3.6166E-01
2.033	9.4476E+02	8.0627E-05	3.7916E-01
2.033	9.4520E+02	8.0629E-05	3.7934E-01
2.400	1.4964E+03	8.8248E-05	6.0206E-01
2.700	2.0060E+03	9.6629E-05	8.0829E-01
3.000	2.5309E+03	1.0272E-04	1.0210E+00
3.300	3.0481E+03	1.0543E-04	1.2309E+00
3.600	3.5424E+03	1.0490E-04	1.4318E+00
3.900	4.0048E+03	1.0172E-04	1.6201E+00
4.200	4.4303E+03	9.6604E-05	1.7936E+00
4.500	4.8169E+03	9.0224E-05	1.9517E+00
4.800	5.1645E+03	8.3133E-05	2.0942E+00
5.033	5.4085E+03	7.7417E-05	2.1944E+00
5.400	5.7499E+03	6.8492E-05	2.3352E+00

5.700	5.9943E+03	6.1633E-05	2.4364E+00
6.000	6.2116E+03	5.5342E-05	2.5267E+00
6.300	6.4051E+03	4.9659E-05	2.6075E+00
6.600	6.5774E+03	4.4571E-05	2.6798E+00
6.900	6.7311E+03	4.0037E-05	2.7447E+00
7.200	6.8683E+03	3.6006E-05	2.8030E+00
7.500	6.9909E+03	3.2427E-05	2.8554E+00
7.800	7.1005E+03	2.9251E-05	2.9027E+00
8.000	7.1672E+03	2.7334E-05	2.9316E+00
8.300	7.2721E+03	1.9543E-05	2.9715E+00
8.367	7.2940E+03	1.8275E-05	2.9799E+00
8.667	7.3859E+03	1.3996E-05	3.0152E+00
8.967	7.4685E+03	1.1266E-05	3.0473E+00
9.300	7.5508E+03	9.2833E-06	3.0795E+00
9.600	7.6174E+03	8.0516E-06	3.1060E+00
9.900	7.6777E+03	7.1373E-06	3.1302E+00
10.200	7.7323E+03	6.4261E-06	3.1524E+00
12.033	7.9739E+03	3.9806E-06	3.2565E+00
19.478	8.3025E+03	1.6749E-06	3.4552E+00
24.000	8.3679E+03	1.4712E-06	3.5302E+00
24.033	8.3683E+03	1.4442E-06	3.5308E+00
96.000	8.6840E+03	7.2617E-07	4.4670E+00
240.000	7.6434E+03	2.7988E-07	5.6057E+00
264.000	1.4888E+04	4.5699E-06	8.9190E+00
480.000	7.5847E+03	4.3701E-08	9.2451E+00
504.000	8.1991E+03	7.1354E-07	9.7625E+00
696.000	4.2620E+03	7.6460E-09	9.8100E+00
720.000	4.1303E+03	1.2484E-07	9.9005E+00

##
Cumulative Dose Summary
##

	Control_Room		EAB		LPZ	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.001	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.167	7.4480E-07	2.8917E-08	1.3566E-05	6.5733E-07	6.7831E-06	3.2866E-07
0.500	7.8056E-05	2.9431E-06	7.0146E-04	3.3709E-05	3.5073E-04	1.6854E-05
0.533	1.0044E-04	3.7852E-06	8.5834E-04	4.1199E-05	4.2917E-04	2.0599E-05
0.533	1.0069E-04	3.7944E-06	8.6001E-04	4.1278E-05	4.3001E-04	2.0639E-05
0.900	7.6339E-04	2.8963E-05	4.3364E-03	2.1404E-04	2.1682E-03	1.0702E-04
1.200	2.2831E-03	8.9565E-05	1.0759E-02	5.7072E-04	5.3795E-03	2.8536E-04
1.500	5.2794E-03	2.1508E-04	2.1566E-02	1.2114E-03	1.0783E-02	6.0569E-04
1.800	1.0266E-02	4.3155E-04	3.7397E-02	2.1842E-03	1.8699E-02	1.0921E-03
2.000	1.4898E-02	6.3695E-04	5.0915E-02	3.0300E-03	2.5457E-02	1.5150E-03
2.033	1.5756E-02	6.7524E-04	5.3376E-02	3.1846E-03	2.6078E-02	1.5540E-03
2.033	1.5764E-02	6.7562E-04	5.3401E-02	3.1862E-03	2.6085E-02	1.5544E-03
2.400	2.5662E-02	1.1218E-03	8.4705E-02	5.1742E-03	3.3982E-02	2.0559E-03
2.700	3.4583E-02	1.5293E-03	1.1362E-01	7.0323E-03	4.1277E-02	2.5247E-03
3.000	4.4193E-02	1.9722E-03	1.4336E-01	8.9627E-03	4.8780E-02	3.0117E-03
3.300	5.4203E-02	2.4362E-03	1.7261E-01	1.0882E-02	5.6160E-02	3.4959E-03
3.600	6.4285E-02	2.9057E-03	2.0053E-01	1.2735E-02	6.3204E-02	3.9634E-03
3.900	7.4156E-02	3.3669E-03	2.2661E-01	1.4488E-02	6.9784E-02	4.4057E-03
4.200	8.3598E-02	3.8093E-03	2.5058E-01	1.6123E-02	7.5832E-02	4.8182E-03
4.500	9.2463E-02	4.2257E-03	2.7235E-01	1.7631E-02	8.1322E-02	5.1988E-03
4.800	1.0066E-01	4.6115E-03	2.9191E-01	1.9012E-02	8.6258E-02	5.5471E-03
5.033	1.0654E-01	4.8887E-03	3.0564E-01	1.9997E-02	8.9721E-02	5.7957E-03
5.400	1.1493E-01	5.2848E-03	3.2485E-01	2.1406E-02	9.4569E-02	6.1511E-03
5.700	1.2102E-01	5.5731E-03	3.3862E-01	2.2440E-02	9.8042E-02	6.4120E-03
6.000	1.2648E-01	5.8318E-03	3.5087E-01	2.3380E-02	1.0113E-01	6.6492E-03
6.300	1.3137E-01	6.0636E-03	3.6180E-01	2.4237E-02	1.0389E-01	6.8653E-03
6.600	1.3574E-01	6.2712E-03	3.7156E-01	2.5019E-02	1.0635E-01	7.0626E-03
6.900	1.3966E-01	6.4572E-03	3.8028E-01	2.5734E-02	1.0855E-01	7.2429E-03
7.200	1.4317E-01	6.6240E-03	3.8810E-01	2.6388E-02	1.1053E-01	7.4080E-03
7.500	1.4632E-01	6.7738E-03	3.9511E-01	2.6989E-02	1.1230E-01	7.5595E-03
7.800	1.4915E-01	6.9084E-03	4.0141E-01	2.7541E-02	1.1388E-01	7.6988E-03
8.000	1.5088E-01	6.9905E-03	4.0526E-01	2.7884E-02	1.1486E-01	7.7855E-03
8.300	1.5299E-01	7.0911E-03	4.0798E-01	2.8242E-02	1.1534E-01	7.8495E-03
8.367	1.5338E-01	7.1094E-03	4.0855E-01	2.8318E-02	1.1544E-01	7.8632E-03
8.667	1.5483E-01	7.1786E-03	4.1095E-01	2.8647E-02	1.1587E-01	7.9220E-03
8.967	1.5597E-01	7.2327E-03	4.1313E-01	2.8954E-02	1.1626E-01	7.9769E-03
9.300	1.5700E-01	7.2813E-03	4.1531E-01	2.9272E-02	1.1665E-01	8.0339E-03
9.600	1.5778E-01	7.3182E-03	4.1709E-01	2.9540E-02	1.1697E-01	8.0819E-03

9.900	1.5846E-01	7.3505E-03	4.1872E-01	2.9793E-02	1.1726E-01	8.1272E-03
10.200	1.5907E-01	7.3791E-03	4.2021E-01	3.0031E-02	1.1753E-01	8.1698E-03
12.033	1.6180E-01	7.5062E-03	4.2712E-01	3.1239E-02	1.1877E-01	8.3859E-03
19.478	1.6694E-01	7.7274E-03	4.3986E-01	3.4077E-02	1.2105E-01	8.8940E-03
24.000	1.6886E-01	7.8002E-03	4.4445E-01	3.5126E-02	1.2187E-01	9.0819E-03
24.033	1.6887E-01	7.8005E-03	4.4449E-01	3.5133E-02	1.2187E-01	9.0825E-03
96.000	1.7813E-01	8.1216E-03	5.1035E-01	4.3766E-02	1.2748E-01	9.8172E-03
240.000	1.8348E-01	8.3030E-03	5.8524E-01	5.1823E-02	1.2975E-01	1.0062E-02
264.000	1.9856E-01	8.8120E-03	8.0196E-01	7.2665E-02	1.3634E-01	1.0695E-02
480.000	2.0034E-01	8.8725E-03	8.2330E-01	7.4500E-02	1.3699E-01	1.0751E-02
504.000	2.0270E-01	8.9533E-03	8.5714E-01	7.7044E-02	1.3802E-01	1.0828E-02
696.000	2.0296E-01	8.9625E-03	8.6025E-01	7.7264E-02	1.3811E-01	1.0835E-02
720.000	2.0337E-01	8.9776E-03	8.6618E-01	7.7658E-02	1.3829E-01	1.0847E-02

```
####################################################################
                        Worst Two-Hour Doses
    Note: All of the dose locations are shown below but the
          worst two-hour dose is only meaningful for the EAB
          dose location.  Please disregard the two-hour worst
          doses for the other dose locations
####################################################################
```

Control_Room

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
2.5	6.8348E-05	6.3828E-02	2.9681E-03

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
2.2	3.1067E-03	1.8295E-01	1.2033E-02

LPZ

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
1.5	7.9503E-04	5.0073E-02	3.2018E-03

RUN D2 – NOSPRAYS_STACKTOP.O0

Environment Integral Nuclide Release:

Time (h) = 0.5000	Ci	kg	Atoms	Bq
Kr-85	1.2515E+00	3.1898E-06	2.2599E+19	4.6304E+10
Kr-85m	2.3831E+01	2.8958E-09	2.0517E+16	8.8176E+11
Kr-87	3.9788E+01	1.4047E-09	9.7230E+15	1.4721E+12
Kr-88	6.2869E+01	5.0138E-09	3.4311E+16	2.3262E+12
Rb-86	2.0367E-02	2.5031E-10	1.7528E+15	7.5358E+08
I-131	1.2371E+01	9.9786E-08	4.5872E+17	4.5772E+11
I-132	1.6416E+01	1.5904E-09	7.2556E+15	6.0739E+11
I-133	2.5324E+01	2.2355E-08	1.0122E+17	9.3699E+11
I-134	2.0361E+01	7.6323E-10	3.4301E+15	7.5334E+11
I-135	2.3300E+01	6.6345E-09	2.9596E+16	8.6208E+11
Xe-133	1.9115E+02	1.0212E-06	4.6240E+18	7.0726E+12
Xe-135	6.9924E+01	2.7381E-08	1.2214E+17	2.5872E+12
Cs-134	1.8240E+00	1.4098E-06	6.3358E+18	6.7489E+10
Cs-136	6.2023E-01	8.4626E-09	3.7473E+16	2.2949E+10
Cs-137	1.2912E+00	1.4845E-05	6.5253E+19	4.7775E+10

Environment Integral Nuclide Release:

Time (h) = 2.0000	Ci	kg	Atoms	Bq
Co-58	1.8405E-02	5.7880E-10	6.0097E+15	6.8098E+08
Co-60	1.8353E-02	1.6236E-08	1.6296E+17	6.7904E+08
Kr-85	2.5007E+02	6.3738E-04	4.5158E+21	9.2525E+12
Kr-85m	3.9561E+03	4.8073E-07	3.4059E+18	1.4638E+14
Kr-87	4.1847E+03	1.4774E-07	1.0226E+18	1.5483E+14
Kr-88	9.3877E+03	7.4867E-07	5.1234E+18	3.4734E+14
Rb-86	1.3102E+00	1.6102E-08	1.1275E+17	4.8476E+10
Sr-89	2.8678E+01	9.8711E-07	6.6792E+18	1.0611E+12
Sr-90	3.2610E+00	2.3907E-05	1.5997E+20	1.2066E+11
Sr-91	3.1796E+01	8.7713E-09	5.8046E+16	1.1764E+12
Sr-92	2.4732E+01	1.9676E-09	1.2880E+16	9.1508E+11
Y-90	6.0088E-02	1.1044E-10	7.3900E+14	2.2232E+09
Y-91	3.7405E-01	1.5252E-08	1.0094E+17	1.3840E+10
Y-92	4.0500E+00	4.2090E-10	2.7551E+15	1.4985E+11

Y-93	3.8089E-01	1.1416E-10	7.3926E+14	1.4093E+10
Zr-95	5.0243E-01	2.3387E-08	1.4825E+17	1.8590E+10
Zr-97	4.7643E-01	2.4922E-10	1.5473E+15	1.7628E+10
Nb-95	5.0455E-01	1.2903E-08	8.1794E+16	1.8668E+10
Mo-99	6.4386E+00	1.3424E-08	8.1661E+16	2.3823E+11
Tc-99m	5.7377E+00	1.0912E-09	6.6376E+15	2.1229E+11
Ru-103	5.2663E+00	1.6317E-07	9.5404E+17	1.9485E+11
Ru-105	2.6887E+00	3.9998E-10	2.2941E+15	9.9482E+10
Ru-106	1.9162E+00	5.7275E-07	3.2540E+18	7.0899E+10
Rh-105	3.2882E+00	3.8958E-09	2.2344E+16	1.2166E+11
Sb-127	7.1121E+00	2.6632E-08	1.2628E+17	2.6315E+11
Sb-129	1.6660E+01	2.9627E-09	1.3831E+16	6.1643E+11
Te-127	7.1063E+00	2.6927E-09	1.2768E+16	2.6293E+11
Te-127m	9.5862E-01	1.0163E-07	4.8191E+17	3.5469E+10
Te-129	1.8986E+01	9.0658E-10	4.2322E+15	7.0248E+11
Te-129m	4.1600E+00	1.3809E-07	6.4466E+17	1.5392E+11
Te-131m	1.2774E+01	1.6019E-08	7.3642E+16	4.7264E+11
Te-132	9.7174E+01	3.2008E-07	1.4603E+18	3.5954E+12
I-131	8.9476E+02	7.2173E-06	3.3178E+19	3.3106E+13
I-132	1.0252E+03	9.9321E-08	4.5313E+17	3.7933E+13
I-133	1.7711E+03	1.5635E-06	7.0792E+18	6.5530E+13
I-134	6.3770E+02	2.3905E-08	1.0743E+17	2.3595E+13
I-135	1.5049E+03	4.2851E-07	1.9115E+18	5.5680E+13
Xe-133	3.8093E+04	2.0351E-04	9.2147E+20	1.4094E+15
Xe-135	1.4293E+04	5.5970E-06	2.4967E+19	5.2884E+14
Cs-134	1.1753E+02	9.0842E-05	4.0825E+20	4.3487E+12
Cs-136	3.9869E+01	5.4399E-07	2.4088E+18	1.4752E+12
Cs-137	8.3203E+01	9.5656E-04	4.2048E+21	3.0785E+12
Ba-139	2.2072E+01	1.3494E-09	5.8463E+15	8.1667E+11
Ba-140	5.0388E+01	6.8827E-07	2.9606E+18	1.8643E+12
La-140	1.1823E+00	2.1272E-09	9.1501E+15	4.3747E+10
La-141	3.4517E-01	6.1035E-11	2.6068E+14	1.2771E+10
La-142	2.1482E-01	1.5007E-11	6.3643E+13	7.9484E+09
Ce-141	1.1675E+00	4.0975E-08	1.7501E+17	4.3199E+10
Ce-143	1.0556E+00	1.5896E-09	6.6942E+15	3.9058E+10
Ce-144	9.8123E-01	3.0765E-07	1.2866E+18	3.6306E+10
Pr-143	4.2483E-01	6.3088E-09	2.6568E+16	1.5719E+10
Nd-147	1.8526E-01	2.2900E-09	9.3816E+15	6.8546E+09
Np-239	1.3124E+01	5.6572E-08	1.4255E+17	4.8560E+11
Pu-238	7.2253E-03	4.2205E-07	1.0679E+18	2.6734E+08
Pu-239	3.1793E-04	5.1151E-06	1.2889E+19	1.1764E+07
Pu-240	4.4562E-04	1.9556E-06	4.9071E+18	1.6488E+07
Pu-241	1.1462E-01	1.1127E-06	2.7805E+18	4.2411E+09
Am-241	5.6167E-05	1.6365E-08	4.0893E+16	2.0782E+06
Cm-242	1.2711E-02	3.8351E-09	9.5436E+15	4.7029E+08
Cm-244	5.8698E-04	7.2554E-09	1.7907E+16	2.1718E+07

Environment Integral Nuclide Release:

Time (h) = 8.0000	Ci	kg	Atoms	Bq
Co-58	2.1336E-01	6.7100E-09	6.9670E+16	7.8945E+09
Co-60	2.1296E-01	1.8839E-07	1.8909E+18	7.8795E+09
Kr-85	6.5407E+03	1.6671E-02	1.1811E+23	2.4201E+14
Kr-85m	6.2002E+04	7.5340E-06	5.3378E+19	2.2941E+15
Kr-87	2.4684E+04	8.7145E-07	6.0322E+18	9.1332E+14
Kr-88	1.1317E+05	9.0255E-06	6.1765E+19	4.1874E+15
Rb-86	9.8874E+00	1.2152E-07	8.5091E+17	3.6584E+11
Sr-89	3.3233E+02	1.1439E-05	7.7401E+19	1.2296E+13
Sr-90	3.7841E+01	2.7741E-04	1.8563E+21	1.4001E+12
Sr-91	3.1189E+02	8.6040E-08	5.6939E+17	1.1540E+13
Sr-92	1.6812E+02	1.3375E-08	8.7552E+16	6.2204E+12
Y-90	1.5083E+00	2.7723E-09	1.8550E+16	5.5807E+10
Y-91	4.4706E+00	1.8229E-07	1.2064E+18	1.6541E+11
Y-92	8.4599E+01	8.7920E-09	5.7550E+16	3.1302E+12
Y-93	3.7724E+00	1.1307E-09	7.3217E+15	1.3958E+11
Zr-95	5.8240E+00	2.7110E-07	1.7185E+18	2.1549E+11
Zr-97	5.0221E+00	2.6271E-09	1.6310E+16	1.8582E+11
Nb-95	5.8547E+00	1.4972E-07	9.4912E+17	2.1662E+11
Mo-99	7.2869E+01	1.5193E-07	9.2420E+17	2.6962E+12
Tc-99m	6.6194E+01	1.2589E-08	7.6577E+16	2.4492E+12
Ru-103	6.1003E+01	1.8902E-06	1.1051E+19	2.2571E+12
Ru-105	2.2120E+01	3.2906E-09	1.8873E+16	8.1843E+11
Ru-106	2.2232E+01	6.6451E-06	3.7752E+19	8.2257E+11
Rh-105	3.7527E+01	4.4460E-08	2.5500E+17	1.3885E+12
Sb-127	8.1066E+01	3.0356E-07	1.4394E+18	2.9994E+12
Sb-129	1.3587E+02	2.4161E-08	1.1279E+17	5.0272E+12

Te-127	8.1757E+01	3.0979E-08	1.4690E+17	3.0250E+12
Te-127m	1.1126E+01	1.1796E-06	5.5933E+18	4.1167E+11
Te-129	1.7205E+02	8.2153E-09	3.8352E+16	6.3658E+12
Te-129m	4.8242E+01	1.6014E-06	7.4758E+18	1.7850E+12
Te-131m	1.4035E+02	1.7601E-07	8.0911E+17	5.1929E+12
Te-132	1.1041E+03	3.6366E-06	1.6591E+19	4.0850E+13
I-131	7.2528E+03	5.8502E-05	2.6894E+20	2.6835E+14
I-132	5.8664E+03	5.6834E-07	2.5929E+18	2.1706E+14
I-133	1.3380E+04	1.1812E-05	5.3482E+19	4.9507E+14
I-134	1.5046E+03	5.6402E-08	2.5348E+17	5.5671E+13
I-135	9.6989E+03	2.7618E-06	1.2320E+19	3.5886E+14
Xe-133	9.8037E+05	5.2376E-03	2.3715E+22	3.6274E+16
Xe-135	3.1354E+05	1.2278E-04	5.4768E+20	1.1601E+16
Cs-134	8.9014E+02	6.8799E-04	3.0919E+21	3.2935E+13
Cs-136	3.0042E+02	4.0990E-06	1.8150E+19	1.1115E+13
Cs-137	6.3020E+02	7.2451E-03	3.1848E+22	2.3317E+13
Ba-139	1.0125E+02	6.1902E-09	2.6819E+16	3.7464E+12
Ba-140	5.8154E+02	7.9436E-06	3.4170E+19	2.1517E+13
La-140	3.3242E+01	5.9806E-08	2.5726E+17	1.2299E+12
La-141	2.7270E+00	4.8220E-10	2.0595E+15	1.0090E+11
La-142	1.0636E+00	7.4299E-11	3.1510E+14	3.9353E+10
Ce-141	1.3528E+01	4.7477E-07	2.0278E+18	5.0053E+11
Ce-143	1.1655E+01	1.7551E-08	7.3911E+16	4.3124E+11
Ce-144	1.1384E+01	3.5691E-06	1.4926E+19	4.2119E+11
Pr-143	4.9594E+00	7.3648E-08	3.1015E+17	1.8350E+11
Nd-147	2.1363E+00	2.6407E-08	1.0818E+17	7.9044E+10
Np-239	1.4792E+02	6.3760E-07	1.6066E+18	5.4730E+12
Pu-238	8.3844E-02	4.8975E-06	1.2392E+19	3.1022E+09
Pu-239	3.6905E-03	5.9375E-05	1.4961E+20	1.3655E+08
Pu-240	5.1711E-03	2.2694E-05	5.6943E+19	1.9133E+08
Pu-241	1.3301E+00	1.2912E-05	3.2265E+19	4.9214E+10
Am-241	6.5230E-04	1.9006E-07	4.7491E+17	2.4135E+07
Cm-242	1.4743E-01	4.4484E-08	1.1070E+17	5.4551E+09
Cm-244	6.8114E-03	8.4192E-08	2.0779E+17	2.5202E+08

Environment Integral Nuclide Release:

Time (h) = 24.0000	Ci	kg	Atoms	Bq
Co-58	2.4959E-01	7.8494E-09	8.1500E+16	9.2350E+09
Co-60	2.4922E-01	2.2047E-07	2.2129E+18	9.2212E+09
Kr-85	2.6536E+04	6.7635E-02	4.7919E+23	9.8182E+14
Kr-85m	1.0426E+05	1.2669E-05	8.9758E+19	3.8576E+15
Kr-87	2.5816E+04	9.1142E-07	6.3088E+18	9.5521E+14
Kr-88	1.5140E+05	1.2074E-05	8.2625E+19	5.6017E+15
Rb-86	1.1392E+01	1.4001E-07	9.8041E+17	4.2151E+11
Sr-89	3.8869E+02	1.3379E-05	9.0529E+19	1.4382E+13
Sr-90	4.4285E+01	3.2466E-04	2.1724E+21	1.6386E+12
Sr-91	3.4410E+02	9.4924E-08	6.2818E+17	1.2732E+13
Sr-92	1.7348E+02	1.3802E-08	9.0345E+16	6.4189E+12
Y-90	2.2130E+00	4.0676E-09	2.7217E+16	8.1882E+10
Y-91	5.2872E+00	2.1559E-07	1.4267E+18	1.9563E+11
Y-92	9.6441E+01	1.0023E-08	6.5606E+16	3.5683E+12
Y-93	4.1733E+00	1.2509E-09	8.0999E+15	1.5441E+11
Zr-95	6.8126E+00	3.1712E-07	2.0102E+18	2.5207E+11
Zr-97	5.6654E+00	2.9636E-09	1.8399E+16	2.0962E+11
Nb-95	6.8517E+00	1.7522E-07	1.1107E+18	2.5351E+11
Mo-99	8.4395E+01	1.7596E-07	1.0704E+18	3.1226E+12
Tc-99m	7.7076E+01	1.4658E-08	8.9165E+16	2.8518E+12
Ru-103	7.1338E+01	2.2104E-06	1.2924E+19	2.6395E+12
Ru-105	2.3446E+01	3.4879E-09	2.0005E+16	8.6750E+11
Ru-106	2.6015E+01	7.7761E-06	4.4178E+19	9.6257E+11
Rh-105	4.3379E+01	5.1394E-08	2.9476E+17	1.6050E+12
Sb-127	9.4161E+01	3.5259E-07	1.6719E+18	3.4839E+12
Sb-129	1.4379E+02	2.5570E-08	1.1937E+17	5.3203E+12
Te-127	9.5279E+01	3.6103E-08	1.7119E+17	3.5253E+12
Te-127m	1.3022E+01	1.3805E-06	6.5463E+18	4.8181E+11
Te-129	1.8645E+02	8.9031E-09	4.1563E+16	6.8987E+12
Te-129m	5.6426E+01	1.8730E-06	8.7440E+18	2.0878E+12
Te-131m	1.6068E+02	2.0151E-07	9.2634E+17	5.9453E+12
Te-132	1.2807E+03	4.2185E-06	1.9246E+19	4.7386E+13
I-131	8.9028E+03	7.1812E-05	3.3012E+20	3.2941E+14
I-132	6.3168E+03	6.1197E-07	2.7919E+18	2.3372E+14
I-133	1.5715E+04	1.3873E-05	6.2816E+19	5.8147E+14
I-134	1.5061E+03	5.6457E-08	2.5372E+17	5.5725E+13
I-135	1.0642E+04	3.0304E-06	1.3518E+19	3.9377E+14
Xe-133	3.8014E+06	2.0309E-02	9.1957E+22	1.4065E+17

Xe-135	7.5425E+05	2.9535E-04	1.3175E+21	2.7907E+16
Cs-134	1.0271E+03	7.9384E-04	3.5676E+21	3.8002E+13
Cs-136	3.4592E+02	4.7198E-06	2.0899E+19	1.2799E+13
Cs-137	7.2718E+02	8.3601E-03	3.6749E+22	2.6906E+13
Ba-139	1.0195E+02	6.2328E-09	2.7004E+16	3.7722E+12
Ba-140	6.7901E+02	9.2749E-06	3.9896E+19	2.5123E+13
La-140	4.9286E+01	8.8671E-08	3.8142E+17	1.8236E+12
La-141	2.8706E+00	5.0760E-10	2.1680E+15	1.0621E+11
La-142	1.0738E+00	7.5010E-11	3.1811E+14	3.9730E+10
Ce-141	1.5819E+01	5.5518E-07	2.3712E+18	5.8530E+11
Ce-143	1.3369E+01	2.0131E-08	8.4777E+16	4.9464E+11
Ce-144	1.3321E+01	4.1765E-06	1.7466E+19	4.9287E+11
Pr-143	5.8183E+00	8.6404E-08	3.6387E+17	2.1528E+11
Nd-147	2.4934E+00	3.0822E-08	1.2627E+17	9.2257E+10
Np-239	1.7103E+02	7.3721E-07	1.8576E+18	6.3280E+12
Pu-238	9.8122E-02	5.7316E-06	1.4503E+19	3.6305E+09
Pu-239	4.3196E-03	6.9495E-05	1.7511E+20	1.5982E+08
Pu-240	6.0517E-03	2.6558E-05	6.6640E+19	2.2391E+08
Pu-241	1.5566E+00	1.5111E-05	3.7759E+19	5.7595E+10
Am-241	7.6368E-04	2.2251E-07	5.5600E+17	2.8256E+07
Cm-242	1.7251E-01	5.2050E-08	1.2953E+17	6.3829E+09
Cm-244	7.9713E-03	9.8530E-08	2.4318E+17	2.9494E+08

Environment Integral Nuclide Release:

Time (h) = 48.0000	Ci	kg	Atoms	Bq
Co-58	2.5093E-01	7.8912E-09	8.1935E+16	9.2842E+09
Co-60	2.5057E-01	2.2166E-07	2.2248E+18	9.2709E+09
Kr-85	5.5857E+04	1.4237E-01	1.0087E+24	2.0667E+15
Kr-85m	1.0784E+05	1.3104E-05	9.2839E+19	3.9900E+15
Kr-87	2.5817E+04	9.1142E-07	6.3089E+18	9.5522E+14
Kr-88	1.5211E+05	1.2131E-05	8.3017E+19	5.6282E+15
Rb-86	1.1446E+01	1.4067E-07	9.8502E+17	4.2349E+11
Sr-89	3.9076E+02	1.3450E-05	9.1009E+19	1.4458E+13
Sr-90	4.4524E+01	3.2641E-04	2.1841E+21	1.6474E+12
Sr-91	3.4431E+02	9.4983E-08	6.2857E+17	1.2740E+13
Sr-92	1.7348E+02	1.3802E-08	9.0346E+16	6.4189E+12
Y-90	2.2897E+00	4.2084E-09	2.8160E+16	8.4717E+10
Y-91	5.3199E+00	2.1693E-07	1.4356E+18	1.9684E+11
Y-92	9.6454E+01	1.0024E-08	6.5615E+16	3.5688E+12
Y-93	4.1762E+00	1.2518E-09	8.1056E+15	1.5452E+11
Zr-95	6.8489E+00	3.1881E-07	2.0209E+18	2.5341E+11
Zr-97	5.6743E+00	2.9682E-09	1.8428E+16	2.0995E+11
Nb-95	6.8886E+00	1.7617E-07	1.1167E+18	2.5488E+11
Mo-99	8.4724E+01	1.7665E-07	1.0746E+18	3.1348E+12
Tc-99m	7.7411E+01	1.4722E-08	8.9552E+16	2.8642E+12
Ru-103	7.1715E+01	2.2221E-06	1.2992E+19	2.6534E+12
Ru-105	2.3447E+01	3.4882E-09	2.0006E+16	8.6755E+11
Ru-106	2.6156E+01	7.8180E-06	4.4416E+19	9.6776E+11
Rh-105	4.3517E+01	5.1557E-08	2.9570E+17	1.6101E+12
Sb-127	9.4564E+01	3.5410E-07	1.6791E+18	3.4989E+12
Sb-129	1.4380E+02	2.5572E-08	1.1938E+17	5.3206E+12
Te-127	9.5726E+01	3.6272E-08	1.7200E+17	3.5419E+12
Te-127m	1.3092E+01	1.3880E-06	6.5817E+18	4.8442E+11
Te-129	1.8672E+02	8.9159E-09	4.1622E+16	6.9086E+12
Te-129m	5.6724E+01	1.8829E-06	8.7901E+18	2.0988E+12
Te-131m	1.6111E+02	2.0204E-07	9.2880E+17	5.9611E+12
Te-132	1.2860E+03	4.2358E-06	1.9325E+19	4.7580E+13
I-131	9.8088E+03	7.9119E-05	3.6371E+20	3.6292E+14
I-132	6.3526E+03	6.1544E-07	2.8078E+18	2.3505E+14
I-133	1.6367E+04	1.4448E-05	6.5420E+19	6.0558E+14
I-134	1.5061E+03	5.6457E-08	2.5372E+17	5.5725E+13
I-135	1.0700E+04	3.0467E-06	1.3591E+19	3.9589E+14
Xe-133	7.5068E+06	4.0104E-02	1.8159E+23	2.7775E+17
Xe-135	9.0406E+05	3.5402E-04	1.5792E+21	3.3450E+16
Cs-134	1.0322E+03	7.9775E-04	3.5852E+21	3.8190E+13
Cs-136	3.4751E+02	4.7415E-06	2.0996E+19	1.2858E+13
Cs-137	7.3077E+02	8.4014E-03	3.6930E+22	2.7038E+13
Ba-139	1.0195E+02	6.2328E-09	2.7004E+16	3.7722E+12
Ba-140	6.8243E+02	9.3216E-06	4.0097E+19	2.5250E+13
La-140	5.0897E+01	9.1570E-08	3.9389E+17	1.8832E+12
La-141	2.8708E+00	5.0762E-10	2.1680E+15	1.0622E+11
La-142	1.0738E+00	7.5010E-11	3.1811E+14	3.9730E+10
Ce-141	1.5902E+01	5.5810E-07	2.3836E+18	5.8838E+11
Ce-143	1.3407E+01	2.0188E-08	8.5017E+16	4.9604E+11
Ce-144	1.3393E+01	4.1990E-06	1.7560E+19	4.9553E+11

Pr-143	5.8511E+00	8.6891E-08	3.6592E+17	2.1649E+11
Nd-147	2.5058E+00	3.0975E-08	1.2690E+17	9.2716E+10
Np-239	1.7166E+02	7.3994E-07	1.8644E+18	6.3514E+12
Pu-238	9.8652E-02	5.7625E-06	1.4581E+19	3.6501E+09
Pu-239	4.3430E-03	6.9872E-05	1.7606E+20	1.6069E+08
Pu-240	6.0844E-03	2.6702E-05	6.7000E+19	2.2512E+08
Pu-241	1.5650E+00	1.5192E-05	3.7963E+19	5.7906E+10
Am-241	7.6785E-04	2.2372E-07	5.5904E+17	2.8410E+07
Cm-242	1.7344E-01	5.2330E-08	1.3022E+17	6.4172E+09
Cm-244	8.0143E-03	9.9062E-08	2.4449E+17	2.9653E+08

Environment Integral Nuclide Release:

Time (h) = 96.0000	Ci	kg	Atoms	Bq
Co-58	2.5338E-01	7.9685E-09	8.2737E+16	9.3751E+09
Co-60	2.5308E-01	2.2389E-07	2.2472E+18	9.3641E+09
Kr-85	1.1211E+05	2.8575E-01	2.0245E+24	4.1481E+15
Kr-85m	1.0793E+05	1.3114E-05	9.2914E+19	3.9932E+15
Kr-87	2.5817E+04	9.1142E-07	6.3089E+18	9.5522E+14
Kr-88	1.5212E+05	1.2131E-05	8.3018E+19	5.6283E+15
Rb-86	1.1541E+01	1.4183E-07	9.9318E+17	4.2700E+11
Sr-89	3.9454E+02	1.3580E-05	9.1891E+19	1.4598E+13
Sr-90	4.4972E+01	3.2969E-04	2.2061E+21	1.6640E+12
Sr-91	3.4435E+02	9.4994E-08	6.2864E+17	1.2741E+13
Sr-92	1.7348E+02	1.3802E-08	9.0346E+16	6.4189E+12
Y-90	2.5307E+00	4.6515E-09	3.1124E+16	9.3636E+10
Y-91	5.3811E+00	2.1942E-07	1.4521E+18	1.9910E+11
Y-92	9.6454E+01	1.0024E-08	6.5615E+16	3.5688E+12
Y-93	4.1769E+00	1.2519E-09	8.1068E+15	1.5454E+11
Zr-95	6.9157E+00	3.2192E-07	2.0407E+18	2.5588E+11
Zr-97	5.6785E+00	2.9704E-09	1.8442E+16	2.1010E+11
Nb-95	6.9578E+00	1.7794E-07	1.1279E+18	2.5744E+11
Mo-99	8.5150E+01	1.7754E-07	1.0800E+18	3.1506E+12
Tc-99m	7.7847E+01	1.4805E-08	9.0057E+16	2.8803E+12
Ru-103	7.2402E+01	2.2433E-06	1.3116E+19	2.6789E+12
Ru-105	2.3447E+01	3.4882E-09	2.0006E+16	8.6756E+11
Ru-106	2.6417E+01	7.8962E-06	4.4860E+19	9.7744E+11
Rh-105	4.3648E+01	5.1713E-08	2.9659E+17	1.6150E+12
Sb-127	9.5142E+01	3.5627E-07	1.6894E+18	3.5203E+12
Sb-129	1.4380E+02	2.5572E-08	1.1938E+17	5.3206E+12
Te-127	9.6406E+01	3.6530E-08	1.7322E+17	3.5670E+12
Te-127m	1.3224E+01	1.4020E-06	6.6479E+18	4.8929E+11
Te-129	1.8719E+02	8.9382E-09	4.1726E+16	6.9259E+12
Te-129m	5.7264E+01	1.9009E-06	8.8738E+18	2.1188E+12
Te-131m	1.6147E+02	2.0250E-07	9.3089E+17	5.9745E+12
Te-132	1.2932E+03	4.2595E-06	1.9433E+19	4.7847E+13
I-131	1.1337E+04	9.1449E-05	4.2040E+20	4.1948E+14
I-132	6.3947E+03	6.1951E-07	2.8264E+18	2.3660E+14
I-133	1.6776E+04	1.4809E-05	6.7054E+19	6.2070E+14
I-134	1.5061E+03	5.6457E-08	2.5372E+17	5.5725E+13
I-135	1.0704E+04	3.0481E-06	1.3597E+19	3.9607E+14
Xe-133	1.3357E+07	7.1356E-02	3.2310E+23	4.9420E+17
Xe-135	9.3106E+05	3.6459E-04	1.6264E+21	3.4449E+16
Cs-134	1.0416E+03	8.0507E-04	3.6181E+21	3.8540E+13
Cs-136	3.5027E+02	4.7792E-06	2.1162E+19	1.2960E+13
Cs-137	7.3749E+02	8.4786E-03	3.7270E+22	2.7287E+13
Ba-139	1.0195E+02	6.2328E-09	2.7004E+16	3.7722E+12
Ba-140	6.8833E+02	9.4022E-06	4.0444E+19	2.5468E+13
La-140	5.5327E+01	9.9540E-08	4.2817E+17	2.0471E+12
La-141	2.8708E+00	5.0762E-10	2.1680E+15	1.0622E+11
La-142	1.0738E+00	7.5010E-11	3.1811E+14	3.9730E+10
Ce-141	1.6053E+01	5.6339E-07	2.4063E+18	5.9396E+11
Ce-143	1.3441E+01	2.0240E-08	8.5235E+16	4.9731E+11
Ce-144	1.3526E+01	4.2409E-06	1.7736E+19	5.0048E+11
Pr-143	5.9115E+00	8.7787E-08	3.6970E+17	2.1872E+11
Nd-147	2.5270E+00	3.1237E-08	1.2797E+17	9.3499E+10
Np-239	1.7243E+02	7.4326E-07	1.8728E+18	6.3799E+12
Pu-238	9.9645E-02	5.8205E-06	1.4728E+19	3.6869E+09
Pu-239	4.3869E-03	7.0579E-05	1.7784E+20	1.6232E+08
Pu-240	6.1456E-03	2.6970E-05	6.7674E+19	2.2739E+08
Pu-241	1.5808E+00	1.5345E-05	3.8345E+19	5.8488E+10
Am-241	7.7577E-04	2.2603E-07	5.6480E+17	2.8703E+07
Cm-242	1.7516E-01	5.2850E-08	1.3152E+17	6.4809E+09
Cm-244	8.0949E-03	1.0006E-07	2.4695E+17	2.9951E+08

Environment Integral Nuclide Release:

Time (h) = 120.0000	Ci	kg	Atoms	Bq
Co-58	2.5454E-01	8.0050E-09	8.3116E+16	9.4181E+09
Co-60	2.5429E-01	2.2496E-07	2.2579E+18	9.4088E+09
Kr-85	1.3909E+05	3.5451E-01	2.5116E+24	5.1462E+15
Kr-85m	1.0793E+05	1.3114E-05	9.2914E+19	3.9932E+15
Kr-87	2.5817E+04	9.1142E-07	6.3089E+18	9.5522E+14
Kr-88	1.5212E+05	1.2131E-05	8.3018E+19	5.6283E+15
Rb-86	1.1584E+01	1.4236E-07	9.9689E+17	4.2859E+11
Sr-89	3.9632E+02	1.3642E-05	9.2305E+19	1.4664E+13
Sr-90	4.5187E+01	3.3127E-04	2.2166E+21	1.6719E+12
Sr-91	3.4435E+02	9.4994E-08	6.2865E+17	1.2741E+13
Sr-92	1.7348E+02	1.3802E-08	9.0346E+16	6.4189E+12
Y-90	2.6794E+00	4.9248E-09	3.2953E+16	9.9138E+10
Y-91	5.4099E+00	2.2060E-07	1.4599E+18	2.0017E+11
Y-92	9.6454E+01	1.0024E-08	6.5615E+16	3.5688E+12
Y-93	4.1769E+00	1.2519E-09	8.1069E+15	1.5454E+11
Zr-95	6.9473E+00	3.2339E-07	2.0500E+18	2.5705E+11
Zr-97	5.6789E+00	2.9706E-09	1.8443E+16	2.1012E+11
Nb-95	6.9910E+00	1.7878E-07	1.1333E+18	2.5867E+11
Mo-99	8.5289E+01	1.7783E-07	1.0817E+18	3.1557E+12
Tc-99m	7.7989E+01	1.4832E-08	9.0221E+16	2.8856E+12
Ru-103	7.2722E+01	2.2533E-06	1.3174E+19	2.6907E+12
Ru-105	2.3447E+01	3.4882E-09	2.0006E+16	8.6756E+11
Ru-106	2.6543E+01	7.9336E-06	4.5073E+19	9.8207E+11
Rh-105	4.3679E+01	5.1749E-08	2.9680E+17	1.6161E+12
Sb-127	9.5353E+01	3.5706E-07	1.6931E+18	3.5281E+12
Sb-129	1.4380E+02	2.5572E-08	1.1938E+17	5.3206E+12
Te-127	9.6670E+01	3.6630E-08	1.7369E+17	3.5768E+12
Te-127m	1.3287E+01	1.4086E-06	6.6796E+18	4.9163E+11
Te-129	1.8740E+02	8.9486E-09	4.1775E+16	6.9339E+12
Te-129m	5.7515E+01	1.9092E-06	8.9128E+18	2.1281E+12
Te-131m	1.6154E+02	2.0259E-07	9.3130E+17	5.9771E+12
Te-132	1.2956E+03	4.2677E-06	1.9470E+19	4.7939E+13
I-131	1.1981E+04	9.6639E-05	4.4425E+20	4.4329E+14
I-132	6.4093E+03	6.2093E-07	2.8328E+18	2.3714E+14
I-133	1.6830E+04	1.4857E-05	6.7271E+19	6.2271E+14
I-134	1.5061E+03	5.6457E-08	2.5372E+17	5.5725E+13
I-135	1.0705E+04	3.0481E-06	1.3597E+19	3.9607E+14
Xe-133	1.5651E+07	8.3614E-02	3.7860E+23	5.7908E+17
Xe-135	9.3162E+05	3.6481E-04	1.6274E+21	3.4470E+16
Cs-134	1.0462E+03	8.0858E-04	3.6339E+21	3.8708E+13
Cs-136	3.5149E+02	4.7958E-06	2.1236E+19	1.3005E+13
Cs-137	7.4071E+02	8.5157E-03	3.7433E+22	2.7406E+13
Ba-139	1.0195E+02	6.2328E-09	2.7004E+16	3.7722E+12
Ba-140	6.9093E+02	9.4378E-06	4.0597E+19	2.5564E+13
La-140	5.7744E+01	1.0389E-07	4.4688E+17	2.1365E+12
La-141	2.8708E+00	5.0762E-10	2.1680E+15	1.0622E+11
La-142	1.0738E+00	7.5010E-11	3.1811E+14	3.9730E+10
Ce-141	1.6123E+01	5.6585E-07	2.4168E+18	5.9655E+11
Ce-143	1.3448E+01	2.0251E-08	8.5282E+16	4.9759E+11
Ce-144	1.3590E+01	4.2610E-06	1.7820E+19	5.0284E+11
Pr-143	5.9392E+00	8.8198E-08	3.7143E+17	2.1975E+11
Nd-147	2.5362E+00	3.1351E-08	1.2843E+17	9.3840E+10
Np-239	1.7266E+02	7.4427E-07	1.8754E+18	6.3886E+12
Pu-238	1.0012E-01	5.8483E-06	1.4798E+19	3.7045E+09
Pu-239	4.4080E-03	7.0919E-05	1.7870E+20	1.6310E+08
Pu-240	6.1750E-03	2.7099E-05	6.7998E+19	2.2847E+08
Pu-241	1.5883E+00	1.5419E-05	3.8528E+19	5.8767E+10
Am-241	7.7962E-04	2.2715E-07	5.6760E+17	2.8846E+07
Cm-242	1.7598E-01	5.3098E-08	1.3213E+17	6.5114E+09
Cm-244	8.1336E-03	1.0054E-07	2.4813E+17	3.0094E+08

Environment Integral Nuclide Release:

Time (h) = 240.0000	Ci	kg	Atoms	Bq
Co-58	2.5974E-01	8.1684E-09	8.4812E+16	9.6103E+09
Co-60	2.5985E-01	2.2987E-07	2.3072E+18	9.6143E+09
Kr-85	2.6327E+05	6.7103E-01	4.7542E+24	9.7409E+15
Kr-85m	1.0793E+05	1.3114E-05	9.2914E+19	3.9932E+15
Kr-87	2.5817E+04	9.1142E-07	6.3089E+18	9.5522E+14
Kr-88	1.5212E+05	1.2131E-05	8.3018E+19	5.6283E+15
Rb-86	1.1761E+01	1.4455E-07	1.0122E+18	4.3518E+11
Sr-89	4.0418E+02	1.3912E-05	9.4136E+19	1.4955E+13
Sr-90	4.6176E+01	3.3852E-04	2.2651E+21	1.7085E+12
Sr-91	3.4435E+02	9.4994E-08	6.2865E+17	1.2741E+13

Sr-92	1.7348E+02	1.3802E-08	9.0346E+16	6.4189E+12
Y-90	3.5201E+00	6.4700E-09	4.3293E+16	1.3024E+11
Y-91	5.5384E+00	2.2584E-07	1.4945E+18	2.0492E+11
Y-92	9.6454E+01	1.0024E-08	6.5615E+16	3.5688E+12
Y-93	4.1769E+00	1.2519E-09	8.1069E+15	1.5454E+11
Zr-95	7.0880E+00	3.2994E-07	2.0915E+18	2.6226E+11
Zr-97	5.6791E+00	2.9708E-09	1.8444E+16	2.1013E+11
Nb-95	7.1429E+00	1.8267E-07	1.1580E+18	2.6429E+11
Mo-99	8.5612E+01	1.7850E-07	1.0858E+18	3.1676E+12
Tc-99m	7.8320E+01	1.4895E-08	9.0605E+16	2.8979E+12
Ru-103	7.4126E+01	2.2968E-06	1.3429E+19	2.7426E+12
Ru-105	2.3447E+01	3.4882E-09	2.0006E+16	8.6756E+11
Ru-106	2.7116E+01	8.1050E-06	4.6047E+19	1.0033E+12
Rh-105	4.3721E+01	5.1799E-08	2.9709E+17	1.6177E+12
Sb-127	9.5943E+01	3.5927E-07	1.7036E+18	3.5499E+12
Sb-129	1.4380E+02	2.5572E-08	1.1938E+17	5.3206E+12
Te-127	9.7520E+01	3.6952E-08	1.7522E+17	3.6083E+12
Te-127m	1.3574E+01	1.4391E-06	6.8240E+18	5.0225E+11
Te-129	1.8835E+02	8.9935E-09	4.1985E+16	6.9688E+12
Te-129m	5.8605E+01	1.9454E-06	9.0816E+18	2.1684E+12
Te-131m	1.6163E+02	2.0270E-07	9.3180E+17	5.9803E+12
Te-132	1.3020E+03	4.2888E-06	1.9567E+19	4.8176E+13
I-131	1.4297E+04	1.1532E-04	5.3014E+20	5.2898E+14
I-132	6.4468E+03	6.2456E-07	2.8494E+18	2.3853E+14
I-133	1.6872E+04	1.4894E-05	6.7437E+19	6.2425E+14
I-134	1.5061E+03	5.6457E-08	2.5372E+17	5.5725E+13
I-135	1.0705E+04	3.0481E-06	1.3597E+19	3.9607E+14
Xe-133	2.2937E+07	1.2254E-01	5.5484E+23	8.4866E+17
Xe-135	9.3173E+05	3.6485E-04	1.6275E+21	3.4474E+16
Cs-134	1.0670E+03	8.2468E-04	3.7062E+21	3.9479E+13
Cs-136	3.5631E+02	4.8616E-06	2.1528E+19	1.3184E+13
Cs-137	7.5555E+02	8.6863E-03	3.8183E+22	2.7955E+13
Ba-139	1.0195E+02	6.2328E-09	2.7004E+16	3.7722E+12
Ba-140	7.0119E+02	9.5780E-06	4.1200E+19	2.5944E+13
La-140	6.8679E+01	1.2356E-07	5.3150E+17	2.5411E+12
La-141	2.8708E+00	5.0762E-10	2.1680E+15	1.0622E+11
La-142	1.0738E+00	7.5010E-11	3.1811E+14	3.9730E+10
Ce-141	1.6426E+01	5.7649E-07	2.4622E+18	6.0777E+11
Ce-143	1.3458E+01	2.0266E-08	8.5345E+16	4.9795E+11
Ce-144	1.3883E+01	4.3527E-06	1.8203E+19	5.1366E+11
Pr-143	6.0514E+00	8.9864E-08	3.7844E+17	2.2390E+11
Nd-147	2.5716E+00	3.1788E-08	1.3023E+17	9.5150E+10
Np-239	1.7316E+02	7.4640E-07	1.8807E+18	6.4068E+12
Pu-238	1.0231E-01	5.9764E-06	1.5122E+19	3.7856E+09
Pu-239	4.5055E-03	7.2486E-05	1.8264E+20	1.6670E+08
Pu-240	6.3102E-03	2.7693E-05	6.9487E+19	2.3348E+08
Pu-241	1.6231E+00	1.5756E-05	3.9371E+19	6.0053E+10
Am-241	7.9779E-04	2.3244E-07	5.8083E+17	2.9518E+07
Cm-242	1.7972E-01	5.4226E-08	1.3494E+17	6.6496E+09
Cm-244	8.3116E-03	1.0274E-07	2.5356E+17	3.0753E+08

Environment Integral Nuclide Release:

Time (h) = 480.0000	Ci	kg	Atoms	Bq
Co-58	2.8043E-01	8.8192E-09	9.1569E+16	1.0376E+10
Co-60	2.8278E-01	2.5016E-07	2.5108E+18	1.0463E+10
Kr-85	9.2873E+05	2.3672E+00	1.6771E+25	3.4363E+16
Kr-85m	1.0793E+05	1.3114E-05	9.2914E+19	3.9932E+15
Kr-87	2.5817E+04	9.1142E-07	6.3089E+18	9.5522E+14
Kr-88	1.5212E+05	1.2131E-05	8.3018E+19	5.6283E+15
Rb-86	1.2400E+01	1.5240E-07	1.0672E+18	4.5882E+11
Sr-89	4.3504E+02	1.4974E-05	1.0132E+20	1.6096E+13
Sr-90	5.0265E+01	3.6849E-04	2.4657E+21	1.8598E+12
Sr-91	3.4435E+02	9.4994E-08	6.2865E+17	1.2741E+13
Sr-92	1.7348E+02	1.3802E-08	9.0346E+16	6.4189E+12
Y-90	7.3885E+00	1.3580E-08	9.0869E+16	2.7338E+11
Y-91	6.0460E+00	2.4654E-07	1.6315E+18	2.2370E+11
Y-92	9.6454E+01	1.0024E-08	6.5615E+16	3.5688E+12
Y-93	4.1769E+00	1.2519E-09	8.1069E+15	1.5454E+11
Zr-95	7.6464E+00	3.5593E-07	2.2563E+18	2.8292E+11
Zr-97	5.6791E+00	2.9708E-09	1.8444E+16	2.1013E+11
Nb-95	7.7665E+00	1.9862E-07	1.2590E+18	2.8736E+11
Mo-99	8.6138E+01	1.7960E-07	1.0925E+18	3.1871E+12
Tc-99m	7.8859E+01	1.4997E-08	9.1228E+16	2.9178E+12
Ru-103	7.9549E+01	2.4648E-06	1.4411E+19	2.9433E+12
Ru-105	2.3447E+01	3.4882E-09	2.0006E+16	8.6756E+11

Ru-106	2.9470E+01	8.8086E-06	5.0044E+19	1.0904E+12
Rh-105	4.3752E+01	5.1835E-08	2.9729E+17	1.6188E+12
Sb-127	9.7192E+01	3.6394E-07	1.7258E+18	3.5961E+12
Sb-129	1.4380E+02	2.5572E-08	1.1938E+17	5.3206E+12
Te-127	9.9893E+01	3.7851E-08	1.7948E+17	3.6960E+12
Te-127m	1.4741E+01	1.5628E-06	7.4104E+18	5.4541E+11
Te-129	1.9195E+02	9.1655E-09	4.2787E+16	7.1020E+12
Te-129m	6.2769E+01	2.0836E-06	9.7269E+18	2.3225E+12
Te-131m	1.6167E+02	2.0275E-07	9.3205E+17	5.9819E+12
Te-132	1.3141E+03	4.3285E-06	1.9748E+19	4.8622E+13
I-131	2.3353E+04	1.8837E-04	8.6593E+20	8.6405E+14
I-132	6.5389E+03	6.3348E-07	2.8901E+18	2.4194E+14
I-133	1.6882E+04	1.4903E-05	6.7477E+19	6.2462E+14
I-134	1.5061E+03	5.6457E-08	2.5372E+17	5.5725E+13
I-135	1.0705E+04	3.0481E-06	1.3597E+19	3.9607E+14
Xe-133	4.7268E+07	2.5252E-01	1.1434E+24	1.7489E+18
Xe-135	9.3173E+05	3.6485E-04	1.6275E+21	3.4474E+16
Cs-134	1.1528E+03	8.9102E-04	4.0044E+21	4.2655E+13
Cs-136	3.7265E+02	5.0845E-06	2.2515E+19	1.3788E+13
Cs-137	8.1690E+02	9.3916E-03	4.1283E+22	3.0225E+13
Ba-139	1.0195E+02	6.2328E-09	2.7004E+16	3.7722E+12
Ba-140	7.3573E+02	1.0050E-05	4.3229E+19	2.7222E+13
La-140	1.0794E+02	1.9420E-07	8.3534E+17	3.9937E+12
La-141	2.8708E+00	5.0762E-10	2.1680E+15	1.0622E+11
La-142	1.0738E+00	7.5010E-11	3.1811E+14	3.9730E+10
Ce-141	1.7582E+01	6.1707E-07	2.6355E+18	6.5055E+11
Ce-143	1.3464E+01	2.0275E-08	8.5384E+16	4.9818E+11
Ce-144	1.5081E+01	4.7282E-06	1.9774E+19	5.5798E+11
Pr-143	6.4370E+00	9.5591E-08	4.0256E+17	2.3817E+11
Nd-147	2.6870E+00	3.3215E-08	1.3607E+17	9.9419E+10
Np-239	1.7384E+02	7.4935E-07	1.8882E+18	6.4322E+12
Pu-238	1.1138E-01	6.5060E-06	1.6462E+19	4.1211E+09
Pu-239	4.9086E-03	7.8971E-05	1.9899E+20	1.8162E+08
Pu-240	6.8693E-03	3.0146E-05	7.5643E+19	2.5416E+08
Pu-241	1.7666E+00	1.7150E-05	4.2854E+19	6.5366E+10
Am-241	8.7532E-04	2.5504E-07	6.3729E+17	3.2387E+07
Cm-242	1.9492E-01	5.8813E-08	1.4636E+17	7.2122E+09
Cm-244	9.0472E-03	1.1183E-07	2.7600E+17	3.3474E+08

Environment Integral Nuclide Release:

Time (h) = 720.0000	Ci	kg	Atoms	Bq
Co-58	2.8928E-01	9.0974E-09	9.4458E+16	1.0703E+10
Co-60	2.9374E-01	2.5986E-07	2.6082E+18	1.0868E+10
Kr-85	1.2521E+06	3.1914E+00	2.2611E+25	4.6327E+16
Kr-85m	1.0793E+05	1.3114E-05	9.2914E+19	3.9932E+15
Kr-87	2.5817E+04	9.1142E-07	6.3089E+18	9.5522E+14
Kr-88	1.5212E+05	1.2131E-05	8.3018E+19	5.6283E+15
Rb-86	1.2599E+01	1.5484E-07	1.0843E+18	4.6617E+11
Sr-89	4.4763E+02	1.5408E-05	1.0426E+20	1.6562E+13
Sr-90	5.2226E+01	3.8287E-04	2.5619E+21	1.9323E+12
Sr-91	3.4435E+02	9.4994E-08	6.2865E+17	1.2741E+13
Sr-92	1.7348E+02	1.3802E-08	9.0346E+16	6.4189E+12
Y-90	9.3538E+00	1.7192E-08	1.1504E+17	3.4609E+11
Y-91	6.2579E+00	2.5518E-07	1.6887E+18	2.3154E+11
Y-92	9.6454E+01	1.0024E-08	6.5615E+16	3.5688E+12
Y-93	4.1769E+00	1.2519E-09	8.1069E+15	1.5454E+11
Zr-95	7.8822E+00	3.6690E-07	2.3258E+18	2.9164E+11
Zr-97	5.6791E+00	2.9708E-09	1.8444E+16	2.1013E+11
Nb-95	8.0551E+00	2.0600E-07	1.3058E+18	2.9804E+11
Mo-99	8.6154E+01	1.7963E-07	1.0927E+18	3.1877E+12
Tc-99m	7.8876E+01	1.5000E-08	9.1247E+16	2.9184E+12
Ru-103	8.1664E+01	2.5304E-06	1.4794E+19	3.0216E+12
Ru-105	2.3447E+01	3.4882E-09	2.0006E+16	8.6756E+11
Ru-106	3.0575E+01	9.1389E-06	5.1920E+19	1.1313E+12
Rh-105	4.3752E+01	5.1835E-08	2.9729E+17	1.6188E+12
Sb-127	9.7274E+01	3.6425E-07	1.7272E+18	3.5991E+12
Sb-129	1.4380E+02	2.5572E-08	1.1938E+17	5.3206E+12
Te-127	1.0050E+02	3.8082E-08	1.8058E+17	3.7186E+12
Te-127m	1.5263E+01	1.6182E-06	7.6730E+18	5.6475E+11
Te-129	1.9330E+02	9.2302E-09	4.3090E+16	7.1522E+12
Te-129m	6.4337E+01	2.1356E-06	9.9699E+18	2.3805E+12
Te-131m	1.6167E+02	2.0275E-07	9.3205E+17	5.9820E+12
Te-132	1.3147E+03	4.3303E-06	1.9756E+19	4.8642E+13
I-131	2.4982E+04	2.0151E-04	9.2634E+20	9.2433E+14
I-132	6.5432E+03	6.3390E-07	2.8920E+18	2.4210E+14

I-133	1.6882E+04	1.4903E-05	6.7477E+19	6.2462E+14
I-134	1.5061E+03	5.6457E-08	2.5372E+17	5.5725E+13
I-135	1.0705E+04	3.0481E-06	1.3597E+19	3.9607E+14
Xe-133	4.9914E+07	2.6666E-01	1.2074E+24	1.8468E+18
Xe-135	9.3173E+05	3.6485E-04	1.6275E+21	3.4474E+16
Cs-134	1.1936E+03	9.2252E-04	4.1459E+21	4.4163E+13
Cs-136	3.7690E+02	5.1425E-06	2.2771E+19	1.3945E+13
Cs-137	8.4633E+02	9.7300E-03	4.2770E+22	3.1314E+13
Ba-139	1.0195E+02	6.2328E-09	2.7004E+16	3.7722E+12
Ba-140	7.4456E+02	1.0170E-05	4.3748E+19	2.7549E+13
La-140	1.1818E+02	2.1262E-07	9.1461E+17	4.3727E+12
La-141	2.8708E+00	5.0762E-10	2.1680E+15	1.0622E+11
La-142	1.0738E+00	7.5010E-11	3.1811E+14	3.9730E+10
Ce-141	1.8014E+01	6.3223E-07	2.7002E+18	6.6653E+11
Ce-143	1.3464E+01	2.0275E-08	8.5384E+16	4.9818E+11
Ce-144	1.5639E+01	4.9034E-06	2.0506E+19	5.7865E+11
Pr-143	6.5394E+00	9.7112E-08	4.0896E+17	2.4196E+11
Nd-147	2.7137E+00	3.3545E-08	1.3742E+17	1.0041E+11
Np-239	1.7386E+02	7.4941E-07	1.8883E+18	6.4327E+12
Pu-238	1.1573E-01	6.7602E-06	1.7106E+19	4.2821E+09
Pu-239	5.1022E-03	8.2086E-05	2.0683E+20	1.8878E+08
Pu-240	7.1377E-03	3.1324E-05	7.8599E+19	2.6409E+08
Pu-241	1.8355E+00	1.7818E-05	4.4524E+19	6.7913E+10
Am-241	9.1613E-04	2.6693E-07	6.6700E+17	3.3897E+07
Cm-242	2.0186E-01	6.0907E-08	1.5157E+17	7.4689E+09
Cm-244	9.3998E-03	1.1619E-07	2.8676E+17	3.4779E+08

##
I-131 Summary
##

Time (hr)	DW I-131 (Curies)	Torus I-131 (Curies)	RB I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	1.3676E+06	0.0000E+00	7.4824E+01
0.500	4.2291E+06	0.0000E+00	7.7215E+02
0.533	4.4754E+06	0.0000E+00	8.7090E+02
0.533	4.4784E+06	0.0000E+00	8.7191E+02
0.900	9.6128E+06	0.0000E+00	2.5299E+03
1.200	1.3664E+07	0.0000E+00	4.6295E+03
1.500	1.7281E+07	0.0000E+00	7.1477E+03
1.800	2.0509E+07	0.0000E+00	9.9063E+03
2.000	2.2466E+07	0.0000E+00	1.1812E+04
2.033	2.2775E+07	0.0000E+00	1.2129E+04
2.033	2.2440E+07	3.3281E+05	1.2133E+04
2.400	1.0875E+07	8.2496E+06	1.4784E+04
2.700	9.0685E+06	6.8789E+06	1.5616E+04
3.000	7.5625E+06	5.7365E+06	1.5629E+04
3.300	6.3074E+06	4.7844E+06	1.5102E+04
3.500	5.5891E+06	4.2395E+06	1.4551E+04
3.800	4.6626E+06	3.5367E+06	1.3541E+04
4.000	4.1324E+06	3.1345E+06	1.2794E+04
4.300	3.4487E+06	2.6158E+06	1.1627E+04
4.600	2.8788E+06	2.1835E+06	1.0456E+04
4.900	2.4038E+06	1.8232E+06	9.3241E+03
5.033	2.2194E+06	1.6833E+06	8.8417E+03
5.400	1.9449E+06	1.4694E+06	7.6295E+03
5.700	1.7439E+06	1.3174E+06	6.7721E+03
6.000	1.5639E+06	1.1815E+06	6.0176E+03
6.300	1.4028E+06	1.0597E+06	5.3526E+03
6.600	1.2586E+06	9.5076E+05	4.7654E+03
6.900	1.1295E+06	8.5322E+05	4.2463E+03
7.200	1.0139E+06	7.6589E+05	3.7867E+03
7.500	9.1041E+05	6.8772E+05	3.3794E+03
7.800	8.1778E+05	6.1774E+05	3.0180E+03
8.000	7.6149E+05	5.7521E+05	2.7999E+03
8.300	6.8447E+05	5.1702E+05	2.5033E+03
8.367	6.6840E+05	5.0488E+05	2.4416E+03
8.667	6.0921E+05	4.5982E+05	2.1863E+03
8.967	5.5530E+05	4.1912E+05	1.9616E+03
9.300	5.0128E+05	3.7834E+05	1.7430E+03
9.600	4.5735E+05	3.4517E+05	1.5697E+03
9.900	4.1748E+05	3.1508E+05	1.4160E+03
10.200	3.8131E+05	2.8776E+05	1.2792E+03

12.033	2.2249E+05	1.6786E+05	7.0673E+02
19.478	4.5793E+04	3.4464E+04	1.1192E+02
24.000	3.0543E+04	2.2956E+04	6.4221E+01
24.033	3.0488E+04	2.2914E+04	6.4056E+01
96.000	2.1688E+04	1.6286E+04	4.1226E+01
240.000	1.0956E+04	8.2274E+03	2.0826E+01
264.000	4.7667E+03	3.5771E+03	9.4259E+00
480.000	1.7107E+03	1.2846E+03	3.2517E+00
504.000	7.4427E+02	5.5853E+02	1.4718E+00
696.000	2.9930E+02	2.2476E+02	5.6893E-01
720.000	1.3022E+02	9.7723E+01	2.5750E-01

Time (hr)	*SR* I-131 (Curies)	*Condenser* I-131 (Curies)	*TB* I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	1.3937E-01	1.4886E-01	8.2642E-05
0.500	1.8338E+00	1.7383E+00	2.5651E-04
0.533	2.0822E+00	1.9848E+00	2.7153E-04
0.533	2.0847E+00	1.9873E+00	2.7170E-04
0.900	6.2159E+00	6.3260E+00	5.8387E-04
1.200	1.1562E+01	1.2371E+01	8.3139E-04
1.500	1.8041E+01	2.0548E+01	1.0536E-03
1.800	2.5182E+01	3.0747E+01	1.2531E-03
2.000	3.0133E+01	3.8620E+01	1.3748E-03
2.033	3.0958E+01	3.9999E+01	1.3941E-03
2.033	3.0966E+01	4.0013E+01	1.3826E-03
2.400	3.8180E+01	4.8855E+01	6.7741E-04
2.700	4.0591E+01	5.5391E+01	5.7128E-04
3.000	4.0819E+01	6.1494E+01	4.8303E-04
3.300	3.9596E+01	6.7233E+01	4.0970E-04
3.500	3.8245E+01	7.0887E+01	3.6785E-04
3.800	3.5714E+01	7.6146E+01	3.1404E-04
4.000	3.3824E+01	7.9522E+01	2.8337E-04
4.300	3.0849E+01	8.4421E+01	2.4399E-04
4.600	2.7853E+01	8.9148E+01	2.1137E-04
4.900	2.4944E+01	9.3730E+01	1.8439E-04
5.033	2.3703E+01	9.5721E+01	1.7398E-04
5.400	2.0566E+01	1.0113E+02	1.5928E-04
5.700	1.8345E+01	1.0548E+02	1.4863E-04
6.000	1.6391E+01	1.0976E+02	1.3923E-04
6.300	1.4668E+01	1.1399E+02	1.3093E-04
6.600	1.3146E+01	1.1817E+02	1.2364E-04
6.900	1.1801E+01	1.2231E+02	1.1723E-04
7.200	1.0609E+01	1.2639E+02	1.1162E-04
7.500	9.5533E+00	1.3044E+02	1.0672E-04
7.800	8.6160E+00	1.3446E+02	1.0246E-04
8.000	8.0501E+00	1.3711E+02	9.9941E-05
8.300	7.2804E+00	1.4107E+02	9.6597E-05
8.367	7.1205E+00	1.4195E+02	9.5917E-05
8.667	6.4571E+00	1.4587E+02	9.3628E-05
8.967	5.8732E+00	1.4976E+02	9.1648E-05
9.300	5.3050E+00	1.5405E+02	8.9790E-05
9.600	4.8548E+00	1.5789E+02	8.8391E-05
9.900	4.4551E+00	1.6171E+02	8.7228E-05
10.200	4.0993E+00	1.6551E+02	8.6279E-05
12.033	2.6091E+00	1.8830E+02	8.4075E-05
19.478	1.0413E+00	2.7527E+02	1.0137E-04
24.000	9.0195E-01	3.2452E+02	1.1623E-04
24.033	9.0141E-01	3.2487E+02	1.1634E-04
96.000	6.2967E-01	8.3539E+02	2.7876E-04
240.000	3.1809E-01	9.8295E+02	3.2276E-04
264.000	5.1126E+00	9.2802E+02	3.0271E-04
480.000	4.9667E-02	4.1873E+02	1.3643E-04
504.000	7.9828E-01	3.7714E+02	1.2259E-04
696.000	8.6898E-03	1.5191E+02	4.9381E-05
720.000	1.3967E-01	1.3485E+02	4.3784E-05

Time (hr)	*Dummy* I-131 (Curies)	*CR* I-131 (Curies)	Environment I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	3.3735E-02	1.0071E-07	2.3852E-01
0.500	3.8434E-01	3.3232E-06	1.2371E+01

0.533	4.3769E-01	4.0048E-06	1.5145E+01
0.533	4.3824E-01	4.0120E-06	1.5174E+01
0.900	1.3851E+00	1.7408E-05	7.6603E+01
1.200	2.7064E+00	3.8902E-05	1.8960E+02
1.500	4.4793E+00	7.0373E-05	3.7936E+02
1.800	6.6650E+00	1.1024E-04	6.5728E+02
2.000	8.3333E+00	1.4041E-04	8.9476E+02
2.033	8.6239E+00	1.3619E-04	9.3805E+02
2.033	8.6268E+00	1.3615E-04	9.3849E+02
2.400	1.0523E+01	1.0938E-04	1.4895E+03
2.700	1.1838E+01	1.0237E-04	1.9997E+03
3.000	1.2984E+01	9.9632E-05	2.5260E+03
3.300	1.3981E+01	9.7483E-05	3.0453E+03
3.500	1.4573E+01	9.5614E-05	3.3798E+03
3.800	1.5362E+01	2.8853E-02	3.8567E+03
4.000	1.5829E+01	3.9393E-02	4.1554E+03
4.300	1.6454E+01	2.2160E-02	4.5721E+03
4.600	1.6998E+01	1.2477E-02	4.9502E+03
4.900	1.7473E+01	7.0356E-03	5.2901E+03
5.033	1.7664E+01	5.4611E-03	5.4291E+03
5.400	1.8148E+01	2.7230E-03	5.7773E+03
5.700	1.8507E+01	1.5496E-03	6.0276E+03
6.000	1.8836E+01	8.8843E-04	6.2511E+03
6.300	1.9140E+01	5.1518E-04	6.4509E+03
6.600	1.9420E+01	3.0387E-04	6.6299E+03
6.900	1.9681E+01	1.8373E-04	6.7904E+03
7.200	1.9924E+01	1.1496E-04	6.9346E+03
7.500	2.0152E+01	7.5184E-05	7.0644E+03
7.800	2.0366E+01	5.1829E-05	7.1813E+03
8.000	2.0502E+01	4.1738E-05	7.2528E+03
8.300	2.0697E+01	2.8575E-05	7.3652E+03
8.367	2.0739E+01	2.6460E-05	7.3888E+03
8.667	2.0922E+01	1.9430E-05	7.4883E+03
8.967	2.1099E+01	1.5082E-05	7.5787E+03
9.300	2.1287E+01	1.2044E-05	7.6697E+03
9.600	2.1451E+01	1.0236E-05	7.7441E+03
9.900	2.1611E+01	8.9467E-06	7.8124E+03
10.200	2.1766E+01	7.9779E-06	7.8750E+03
12.033	2.2658E+01	4.8338E-06	8.1667E+03
19.478	2.6279E+01	1.9473E-06	8.7067E+03
24.000	2.8862E+01	1.6933E-06	8.9028E+03
24.033	2.8882E+01	1.6191E-06	8.9042E+03
96.000	1.0432E+02	3.4202E-07	1.1337E+04
240.000	2.8014E+02	2.9109E-08	1.4297E+04
264.000	3.0346E+02	4.5428E-07	2.2505E+04
480.000	3.1993E+02	4.5451E-09	2.3353E+04
504.000	3.1187E+02	7.0931E-08	2.4634E+04
696.000	2.2012E+02	7.9523E-10	2.4758E+04
720.000	2.0844E+02	1.2410E-08	2.4982E+04

##
Cumulative Dose Summary
##

	Control_Room		EAB		LPZ	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.001	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.167	1.2991E-06	5.0436E-08	1.5244E-04	7.3863E-06	1.4476E-04	7.0139E-06
0.500	1.3614E-04	5.1333E-06	7.8822E-03	3.7877E-04	7.4848E-03	3.5968E-04
0.533	1.7519E-04	6.6019E-06	9.6451E-03	4.6294E-04	9.1588E-03	4.3960E-04
0.533	1.7562E-04	6.6180E-06	9.6639E-03	4.6383E-04	9.1766E-03	4.4045E-04
0.900	1.3315E-03	5.0517E-05	4.8728E-02	2.4051E-03	4.6271E-02	2.2838E-03
1.200	3.9820E-03	1.5622E-04	1.2090E-01	6.4129E-03	1.1480E-01	6.0896E-03
1.500	9.2082E-03	3.7514E-04	2.4234E-01	1.3612E-02	2.3012E-01	1.2925E-02
1.800	1.7905E-02	7.5270E-04	4.2023E-01	2.4542E-02	3.9904E-01	2.3305E-02
2.000	2.5985E-02	1.1110E-03	5.7212E-01	3.4045E-02	5.4327E-01	3.2329E-02
2.033	2.7457E-02	1.1766E-03	5.9978E-01	3.5783E-02	5.5664E-01	3.3169E-02
2.033	2.7471E-02	1.1773E-03	6.0006E-01	3.5801E-02	5.5677E-01	3.3177E-02
2.400	4.1686E-02	1.8154E-03	9.5182E-01	5.8138E-02	7.2674E-01	4.3970E-02
2.700	5.1837E-02	2.2766E-03	1.2767E+00	7.9016E-02	8.8373E-01	5.4058E-02
3.000	6.1535E-02	2.7214E-03	1.6109E+00	1.0071E-01	1.0452E+00	6.4539E-02
3.300	7.0990E-02	3.1584E-03	1.9396E+00	1.2227E-01	1.2040E+00	7.4957E-02
3.500	7.7151E-02	3.4445E-03	2.1508E+00	1.3626E-01	1.3061E+00	8.1717E-02

3.800	1.5940E+00	7.4691E-02	8.0832E+00	5.3328E-01	4.4869E+00	2.9459E-01
4.000	3.7825E+00	1.7755E-01	1.1789E+01	7.8418E-01	6.4740E+00	4.2911E-01
4.300	6.6380E+00	3.1178E-01	1.2051E+01	8.0208E-01	6.6002E+00	4.3776E-01
4.600	8.2401E+00	3.8705E-01	1.2287E+01	8.1855E-01	6.7143E+00	4.4572E-01
4.900	9.1400E+00	4.2931E-01	1.2499E+01	8.3359E-01	6.8167E+00	4.5299E-01
5.033	9.4003E+00	4.4153E-01	1.2585E+01	8.3980E-01	6.8584E+00	4.5599E-01
5.400	9.8539E+00	4.6283E-01	1.2801E+01	8.5563E-01	6.9627E+00	4.6364E-01
5.700	1.0050E+01	4.7201E-01	1.2955E+01	8.6725E-01	7.0374E+00	4.6925E-01
6.000	1.0161E+01	4.7723E-01	1.3093E+01	8.7781E-01	7.1040E+00	4.7436E-01
6.300	1.0225E+01	4.8024E-01	1.3216E+01	8.8744E-01	7.1633E+00	4.7901E-01
6.600	1.0262E+01	4.8199E-01	1.3326E+01	8.9622E-01	7.2163E+00	4.8325E-01
6.900	1.0284E+01	4.8303E-01	1.3424E+01	9.0425E-01	7.2637E+00	4.8713E-01
7.200	1.0298E+01	4.8367E-01	1.3511E+01	9.1160E-01	7.3061E+00	4.9068E-01
7.500	1.0306E+01	4.8407E-01	1.3590E+01	9.1835E-01	7.3442E+00	4.9394E-01
7.800	1.0312E+01	4.8435E-01	1.3661E+01	9.2455E-01	7.3784E+00	4.9694E-01
8.000	1.0315E+01	4.8448E-01	1.3704E+01	9.2841E-01	7.3993E+00	4.9881E-01
8.300	1.0318E+01	4.8463E-01	1.3739E+01	9.3280E-01	7.4113E+00	5.0032E-01
8.367	1.0319E+01	4.8466E-01	1.3747E+01	9.3374E-01	7.4138E+00	5.0064E-01
8.667	1.0321E+01	4.8476E-01	1.3777E+01	9.3776E-01	7.4244E+00	5.0203E-01
8.967	1.0322E+01	4.8483E-01	1.3805E+01	9.4151E-01	7.4340E+00	5.0332E-01
9.300	1.0324E+01	4.8490E-01	1.3833E+01	9.4540E-01	7.4437E+00	5.0466E-01
9.600	1.0325E+01	4.8494E-01	1.3856E+01	9.4868E-01	7.4516E+00	5.0579E-01
9.900	1.0326E+01	4.8499E-01	1.3877E+01	9.5175E-01	7.4588E+00	5.0685E-01
10.200	1.0326E+01	4.8502E-01	1.3896E+01	9.5465E-01	7.4653E+00	5.0785E-01
12.033	1.0330E+01	4.8518E-01	1.3984E+01	9.6927E-01	7.4957E+00	5.1288E-01
19.478	1.0336E+01	4.8545E-01	1.4142E+01	1.0031E+00	7.5500E+00	5.2453E-01
24.000	1.0338E+01	4.8554E-01	1.4196E+01	1.0154E+00	7.5688E+00	5.2879E-01
24.033	1.0338E+01	4.8554E-01	1.4197E+01	1.0155E+00	7.5689E+00	5.2880E-01
96.000	1.0342E+01	4.8569E-01	1.4975E+01	1.1171E+00	7.6977E+00	5.4562E-01
240.000	1.0343E+01	4.8571E-01	1.5859E+01	1.2122E+00	7.7488E+00	5.5112E-01
264.000	1.0345E+01	4.8576E-01	1.8298E+01	1.4467E+00	7.8898E+00	5.6467E-01
480.000	1.0345E+01	4.8577E-01	1.8549E+01	1.4685E+00	7.9043E+00	5.6593E-01
504.000	1.0345E+01	4.8578E-01	1.8930E+01	1.4971E+00	7.9263E+00	5.6759E-01
696.000	1.0345E+01	4.8578E-01	1.8967E+01	1.4998E+00	7.9285E+00	5.6774E-01
720.000	1.0345E+01	4.8578E-01	1.9034E+01	1.5042E+00	7.9323E+00	5.6800E-01

```
####################################################################
                        Worst Two-Hour Doses
    Note: All of the dose locations are shown below but the
          worst two-hour dose is only meaningful for the EAB
          dose location.  Please disregard the two-hour worst
          doses for the other dose locations
####################################################################
```

Control_Room

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
3.5	1.1598E-02	9.8419E+00	4.6244E-01

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
2.1	2.0081E-01	1.1212E+01	7.5028E-01

LPZ

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
2.1	1.0630E-01	5.9284E+00	3.9686E-01

RUN D3 – NOSPRAYS_TBROOF.O0

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

Time (hr)	DW I-131 (Curies)	Torus I-131 (Curies)	RB I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	1.3676E+06	0.0000E+00	7.4824E+01
0.500	4.2291E+06	0.0000E+00	7.7215E+02
0.533	4.4754E+06	0.0000E+00	8.7090E+02
0.533	4.4784E+06	0.0000E+00	8.7191E+02
0.900	9.6128E+06	0.0000E+00	2.5299E+03

1.200	1.3664E+07	0.0000E+00	4.6295E+03
1.500	1.7281E+07	0.0000E+00	7.1477E+03
1.800	2.0509E+07	0.0000E+00	9.9063E+03
2.000	2.2466E+07	0.0000E+00	1.1812E+04
2.033	2.2775E+07	0.0000E+00	1.2129E+04
2.033	2.2440E+07	3.3281E+05	1.2133E+04
2.400	1.0875E+07	8.2496E+06	1.4784E+04
2.700	9.0685E+06	6.8789E+06	1.5616E+04
3.000	7.5625E+06	5.7365E+06	1.5629E+04
3.300	6.3074E+06	4.7844E+06	1.5102E+04
3.600	5.2613E+06	3.9909E+06	1.4234E+04
3.900	4.3895E+06	3.3295E+06	1.3173E+04
4.200	3.6629E+06	2.7783E+06	1.2019E+04
4.500	3.0573E+06	2.3190E+06	1.0844E+04
4.800	2.5526E+06	1.9361E+06	9.6954E+03
5.033	2.2194E+06	1.6833E+06	8.8417E+03
5.400	1.9449E+06	1.4694E+06	7.6295E+03
5.700	1.7439E+06	1.3174E+06	6.7721E+03
6.000	1.5639E+06	1.1815E+06	6.0176E+03
6.300	1.4028E+06	1.0597E+06	5.3526E+03
6.600	1.2586E+06	9.5076E+05	4.7654E+03
6.900	1.1295E+06	8.5322E+05	4.2463E+03
7.200	1.0139E+06	7.6589E+05	3.7867E+03
7.500	9.1041E+05	6.8772E+05	3.3794E+03
7.800	8.1778E+05	6.1774E+05	3.0180E+03
8.000	7.6149E+05	5.7521E+05	2.7999E+03
8.300	6.8447E+05	5.1702E+05	2.5033E+03
8.367	6.6840E+05	5.0488E+05	2.4416E+03
8.667	6.0921E+05	4.5982E+05	2.1863E+03
8.967	5.5530E+05	4.1912E+05	1.9616E+03
9.300	5.0128E+05	3.7834E+05	1.7430E+03
9.600	4.5735E+05	3.4517E+05	1.5697E+03
9.900	4.1748E+05	3.1508E+05	1.4160E+03
10.200	3.8131E+05	2.8776E+05	1.2792E+03
12.033	2.2249E+05	1.6786E+05	7.0673E+02
19.478	4.5793E+04	3.4464E+04	1.1192E+02
24.000	3.0543E+04	2.2956E+04	6.4221E+01
24.033	3.0488E+04	2.2914E+04	6.4056E+01
96.000	2.1688E+04	1.6286E+04	4.1226E+01
240.000	1.0956E+04	8.2274E+03	2.0826E+01
264.000	4.7667E+03	3.5771E+03	9.4259E+00
480.000	1.7107E+03	1.2846E+03	3.2517E+00
504.000	7.4427E+02	5.5853E+02	1.4718E+00
696.000	2.9930E+02	2.2476E+02	5.6893E-01
720.000	1.3022E+02	9.7723E+01	2.5750E-01

Time (hr)	SR I-131 (Curies)	Condenser I-131 (Curies)	TB I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	1.3937E-01	1.4886E-01	8.2642E-05
0.500	1.8338E+00	1.7383E+00	2.5651E-04
0.533	2.0822E+00	1.9848E+00	2.7153E-04
0.533	2.0847E+00	1.9873E+00	2.7170E-04
0.900	6.2159E+00	6.3260E+00	5.8387E-04
1.200	1.1562E+01	1.2371E+01	8.3139E-04
1.500	1.8041E+01	2.0548E+01	1.0536E-03
1.800	2.5182E+01	3.0747E+01	1.2531E-03
2.000	3.0133E+01	3.8620E+01	1.3748E-03
2.033	3.0958E+01	3.9999E+01	1.3941E-03
2.033	3.0966E+01	4.0013E+01	1.3826E-03
2.400	3.8180E+01	4.8855E+01	6.7741E-04
2.700	4.0591E+01	5.5391E+01	5.7128E-04
3.000	4.0819E+01	6.1494E+01	4.8303E-04
3.300	3.9596E+01	6.7233E+01	4.0970E-04
3.600	3.7456E+01	7.2668E+01	3.4879E-04
3.900	3.4783E+01	7.7846E+01	2.9823E-04
4.200	3.1850E+01	8.2809E+01	2.5630E-04
4.500	2.8846E+01	8.7590E+01	2.2156E-04
4.800	2.5899E+01	9.2217E+01	1.9282E-04
5.033	2.3703E+01	9.5721E+01	1.7398E-04
5.400	2.0566E+01	1.0113E+02	1.5928E-04
5.700	1.8345E+01	1.0548E+02	1.4863E-04
6.000	1.6391E+01	1.0976E+02	1.3923E-04
6.300	1.4668E+01	1.1399E+02	1.3093E-04

6.600	1.3146E+01	1.1817E+02	1.2364E-04
6.900	1.1801E+01	1.2231E+02	1.1723E-04
7.200	1.0609E+01	1.2639E+02	1.1162E-04
7.500	9.5533E+00	1.3044E+02	1.0672E-04
7.800	8.6160E+00	1.3446E+02	1.0246E-04
8.000	8.0501E+00	1.3711E+02	9.9941E-05
8.300	7.2804E+00	1.4107E+02	9.6597E-05
8.367	7.1205E+00	1.4195E+02	9.5917E-05
8.667	6.4571E+00	1.4587E+02	9.3628E-05
8.967	5.8732E+00	1.4976E+02	9.1648E-05
9.300	5.3050E+00	1.5405E+02	8.9790E-05
9.600	4.8548E+00	1.5789E+02	8.8391E-05
9.900	4.4551E+00	1.6171E+02	8.7228E-05
10.200	4.0993E+00	1.6551E+02	8.6279E-05
12.033	2.6091E+00	1.8830E+02	8.4075E-05
19.478	1.0413E+00	2.7527E+02	1.0137E-04
24.000	9.0195E-01	3.2452E+02	1.1623E-04
24.033	9.0141E-01	3.2487E+02	1.1634E-04
96.000	6.2967E-01	8.3539E+02	2.7876E-04
240.000	3.1809E-01	9.8295E+02	3.2276E-04
264.000	5.1126E+00	9.2802E+02	3.0271E-04
480.000	4.9667E-02	4.1873E+02	1.3643E-04
504.000	7.9828E-01	3.7714E+02	1.2259E-04
696.000	8.6898E-03	1.5191E+02	4.9381E-05
720.000	1.3967E-01	1.3485E+02	4.3784E-05

Time (hr)	Dummy I-131 (Curies)	CR I-131 (Curies)	Environment I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	2.3861E-01	2.1270E-05	3.3641E-02
0.500	1.2373E+01	1.4380E-04	3.7950E-01
0.533	1.5146E+01	1.5995E-04	4.3178E-01
0.533	1.5176E+01	1.6011E-04	4.3231E-01
0.900	7.6586E+01	4.2065E-04	1.3553E+00
1.200	1.8951E+02	7.2322E-04	2.6328E+00
1.500	3.7908E+02	1.0510E-03	4.3325E+00
1.800	6.5662E+02	1.3770E-03	6.4114E+00
2.000	8.9369E+02	1.5864E-03	7.9887E+00
2.033	9.3689E+02	1.5880E-03	8.2628E+00
2.033	9.3733E+02	1.5881E-03	8.2655E+00
2.400	1.4871E+03	1.2301E-03	9.9512E+00
2.700	1.9957E+03	1.0083E-03	1.1072E+01
3.000	2.5200E+03	8.3532E-04	1.2018E+01
3.300	3.0366E+03	6.9793E-04	1.2819E+01
3.600	3.5304E+03	5.8738E-04	1.3500E+01
3.900	3.9924E+03	4.9763E-04	1.4081E+01
4.200	4.4176E+03	4.2431E-04	1.4579E+01
4.500	4.8039E+03	3.6419E-04	1.5008E+01
4.800	5.1514E+03	3.1478E-04	1.5380E+01
5.033	5.3952E+03	2.8254E-04	1.5636E+01
5.400	5.7364E+03	2.4415E-04	1.6003E+01
5.700	5.9807E+03	2.2175E-04	1.6280E+01
6.000	6.1978E+03	2.0439E-04	1.6538E+01
6.300	6.3911E+03	1.9043E-04	1.6781E+01
6.600	6.5633E+03	1.7893E-04	1.7010E+01
6.900	6.7168E+03	1.6928E-04	1.7227E+01
7.200	6.8539E+03	1.6108E-04	1.7433E+01
7.500	6.9764E+03	1.5409E-04	1.7629E+01
7.800	7.0859E+03	1.4812E-04	1.7817E+01
8.000	7.1524E+03	1.4463E-04	1.7939E+01
8.300	7.2572E+03	1.0953E-04	1.8115E+01
8.367	7.2791E+03	1.0399E-04	1.8154E+01
8.667	7.3709E+03	8.6010E-05	1.8325E+01
8.967	7.4534E+03	7.5516E-05	1.8491E+01
9.300	7.5356E+03	6.8789E-05	1.8672E+01
9.600	7.6021E+03	6.5238E-05	1.8833E+01
9.900	7.6622E+03	6.3054E-05	1.8991E+01
10.200	7.7167E+03	6.1691E-05	1.9147E+01
12.033	7.9576E+03	5.9991E-05	2.0079E+01
19.478	8.2828E+03	7.4837E-05	2.4141E+01
24.000	8.3456E+03	8.6678E-05	2.7087E+01
24.033	8.3460E+03	8.4321E-05	2.7110E+01
96.000	8.5864E+03	1.1811E-04	1.1757E+02
240.000	7.3691E+03	1.0666E-04	3.9376E+02

264.000	1.4596E+04	1.0020E-04	4.3889E+02
480.000	7.2706E+03	4.5208E-05	7.1085E+02
504.000	7.8935E+03	4.0645E-05	7.2948E+02
696.000	4.0451E+03	1.6376E-05	8.2206E+02
720.000	3.9250E+03	1.4524E-05	8.2876E+02

##
Cumulative Dose Summary
##

	Control_Room		EAB		LPZ	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.001	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.167	3.5346E-04	1.3911E-05	4.7368E-03	2.3317E-04	2.3684E-03	1.1658E-04
0.500	8.4994E-03	3.2742E-04	5.3294E-02	2.6251E-03	2.6647E-02	1.3126E-03
0.533	1.0119E-02	3.8947E-04	6.0614E-02	2.9852E-03	3.0307E-02	1.4926E-03
0.533	1.0136E-02	3.9012E-04	6.0689E-02	2.9889E-03	3.0345E-02	1.4944E-03
0.900	4.3002E-02	1.6986E-03	1.9098E-01	1.0417E-02	9.5488E-02	5.2084E-03
1.200	9.8430E-02	4.1034E-03	3.7258E-01	2.2299E-02	1.8629E-01	1.1149E-02
1.500	1.8498E-01	8.0507E-03	6.1432E-01	3.8917E-02	3.0716E-01	1.9458E-02
1.800	3.0353E-01	1.3618E-02	9.0959E-01	5.9813E-02	4.5479E-01	2.9907E-02
2.000	3.9985E-01	1.8214E-02	1.1333E+00	7.5919E-02	5.6663E-01	3.7959E-02
2.033	4.1685E-01	1.9030E-02	1.1721E+00	7.8726E-02	5.7642E-01	3.8668E-02
2.033	4.1702E-01	1.9038E-02	1.1725E+00	7.8754E-02	5.7652E-01	3.8675E-02
2.400	5.8377E-01	2.7077E-02	1.4108E+00	9.7239E-02	6.3664E-01	4.3338E-02
2.700	6.9183E-01	3.2325E-02	1.5685E+00	1.1029E-01	6.7644E-01	4.6631E-02
3.000	7.8058E-01	3.6662E-02	1.7013E+00	1.2196E-01	7.0993E-01	4.9576E-02
3.300	8.5418E-01	4.0279E-02	1.8133E+00	1.3248E-01	7.3819E-01	5.2229E-02
3.600	9.1569E-01	4.3317E-02	1.9081E+00	1.4202E-01	7.6210E-01	5.4636E-02
3.900	9.6744E-01	4.5887E-02	1.9886E+00	1.5074E-01	7.8243E-01	5.6836E-02
4.200	1.0113E+00	4.8073E-02	2.0574E+00	1.5877E-01	7.9979E-01	5.8862E-02
4.500	1.0486E+00	4.9945E-02	2.1165E+00	1.6621E-01	8.1469E-01	6.0739E-02
4.800	1.0807E+00	5.1558E-02	2.1675E+00	1.7315E-01	8.2756E-01	6.2489E-02
5.033	1.1025E+00	5.2661E-02	2.2025E+00	1.7824E-01	8.3639E-01	6.3773E-02
5.400	1.1326E+00	5.4187E-02	2.2524E+00	1.8588E-01	8.4898E-01	6.5701E-02
5.700	1.1544E+00	5.5290E-02	2.2899E+00	1.9187E-01	8.5845E-01	6.7212E-02
6.000	1.1742E+00	5.6296E-02	2.3249E+00	1.9764E-01	8.6727E-01	6.8669E-02
6.300	1.1925E+00	5.7223E-02	2.3576E+00	2.0322E-01	8.7552E-01	7.0076E-02
6.600	1.2096E+00	5.8086E-02	2.3883E+00	2.0861E-01	8.8326E-01	7.1435E-02
6.900	1.2256E+00	5.8894E-02	2.4172E+00	2.1383E-01	8.9056E-01	7.2752E-02
7.200	1.2407E+00	5.9655E-02	2.4446E+00	2.1888E-01	8.9747E-01	7.4028E-02
7.500	1.2552E+00	6.0375E-02	2.4706E+00	2.2379E-01	9.0404E-01	7.5267E-02
7.800	1.2689E+00	6.1059E-02	2.4955E+00	2.2857E-01	9.1031E-01	7.6471E-02
8.000	1.2778E+00	6.1497E-02	2.5115E+00	2.3168E-01	9.1434E-01	7.7255E-02
8.300	1.2892E+00	6.2057E-02	2.5234E+00	2.3576E-01	9.1648E-01	7.7986E-02
8.367	1.2913E+00	6.2163E-02	2.5260E+00	2.3665E-01	9.1695E-01	7.8146E-02
8.667	1.2998E+00	6.2577E-02	2.5375E+00	2.4063E-01	9.1900E-01	7.8858E-02
8.967	1.3071E+00	6.2927E-02	2.5487E+00	2.4452E-01	9.2100E-01	7.9554E-02
9.300	1.3142E+00	6.3270E-02	2.5608E+00	2.4874E-01	9.2316E-01	8.0310E-02
9.600	1.3202E+00	6.3553E-02	2.5714E+00	2.5247E-01	9.2507E-01	8.0978E-02
9.900	1.3259E+00	6.3822E-02	2.5819E+00	2.5613E-01	9.2695E-01	8.1633E-02
10.200	1.3314E+00	6.4080E-02	2.5922E+00	2.5972E-01	9.2880E-01	8.2276E-02
12.033	1.3638E+00	6.5544E-02	2.6532E+00	2.8041E-01	9.3971E-01	8.5980E-02
19.478	1.5038E+00	7.1269E-02	2.9105E+00	3.5358E-01	9.8578E-01	9.9077E-02
24.000	1.6037E+00	7.5053E-02	3.0905E+00	3.9344E-01	1.0180E+00	1.0621E-01
24.033	1.6042E+00	7.5070E-02	3.0923E+00	3.9374E-01	1.0181E+00	1.0624E-01
96.000	2.5354E+00	1.0743E-01	9.3792E+00	1.1770E+00	1.5532E+00	1.7290E-01
240.000	3.9378E+00	1.5455E-01	2.7514E+01	3.1090E+00	2.1042E+00	2.3160E-01
264.000	4.1665E+00	1.6213E-01	3.0465E+01	3.3924E+00	2.1939E+00	2.4021E-01
480.000	5.5463E+00	2.0742E-01	4.8241E+01	4.9009E+00	2.7339E+00	2.8604E-01
504.000	5.6409E+00	2.1050E-01	4.9458E+01	4.9898E+00	2.7709E+00	2.8874E-01
696.000	6.1112E+00	2.2577E-01	5.5510E+01	5.3946E+00	2.9548E+00	3.0104E-01
720.000	6.1452E+00	2.2688E-01	5.5948E+01	5.4210E+00	2.9681E+00	3.0184E-01

##
Worst Two-Hour Doses
Note: All of the dose locations are shown below but the worst two-hour dose is only meaningful for the EAB dose location. Please disregard the two-hour worst doses for the other dose locations
##

Control_Room

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
1.2	1.0884E-03	7.3122E-01	3.4970E-02

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.9	3.4943E-02	1.4660E+00	1.0766E-01

LPZ

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.7	1.3225E-02	6.1649E-01	4.3449E-02

RUN D4 – NOSPRAYS_STACKBASE_ESF.O0

##
I-131 Summary
##

Time (hr)	SP I-131 (Curies)	RB I-131 (Curies)	SR I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	2.8745E+06	2.6384E+00	3.3749E-02
0.500	1.0023E+07	2.9587E+01	4.8155E-01
0.533	1.0737E+07	3.3689E+01	5.5196E-01
0.900	2.2875E+07	1.0123E+02	1.7110E+00
1.200	3.3561E+07	1.8844E+02	3.2352E+00
1.500	4.4222E+07	2.9823E+02	5.1707E+00
1.800	5.4860E+07	4.2583E+02	7.4308E+00
2.000	6.1938E+07	5.1890E+02	9.0832E+00
2.033	6.3117E+07	5.3495E+02	9.3684E+00
2.400	6.5397E+07	6.9908E+02	1.2339E+01
2.700	6.5321E+07	8.0318E+02	1.4236E+01
3.000	6.5246E+07	8.8546E+02	1.5735E+01
3.300	6.5170E+07	9.5044E+02	1.6919E+01
3.600	6.5094E+07	1.0017E+03	1.7853E+01
3.900	6.5018E+07	1.0421E+03	1.8589E+01
4.200	6.4943E+07	1.0738E+03	1.9167E+01
4.500	6.4867E+07	1.0987E+03	1.9621E+01
4.800	6.4792E+07	1.1181E+03	1.9975E+01
5.100	6.4717E+07	1.1333E+03	2.0252E+01
5.400	6.4641E+07	1.1450E+03	2.0466E+01
5.700	6.4566E+07	1.1540E+03	2.0630E+01
6.000	6.4491E+07	1.1609E+03	2.0756E+01
6.300	6.4416E+07	1.1660E+03	2.0850E+01
6.600	6.4341E+07	1.1698E+03	2.0920E+01
6.900	6.4267E+07	1.1726E+03	2.0970E+01
7.200	6.4192E+07	1.1745E+03	2.1005E+01
7.500	6.4117E+07	1.1757E+03	2.1028E+01
7.800	6.4043E+07	1.1763E+03	2.1040E+01
8.000	6.3993E+07	1.1766E+03	2.1044E+01
8.300	6.3919E+07	1.1766E+03	2.1045E+01
8.600	6.3845E+07	1.1763E+03	2.1041E+01
8.900	6.3770E+07	1.1758E+03	2.1032E+01
9.200	6.3696E+07	1.1751E+03	2.1021E+01
9.500	6.3622E+07	1.1743E+03	2.1006E+01
9.800	6.3548E+07	1.1734E+03	2.0990E+01
10.100	6.3474E+07	1.1724E+03	2.0972E+01
10.400	6.3401E+07	1.1713E+03	2.0952E+01
24.000	6.0145E+07	1.1122E+03	1.9895E+01
96.000	4.5498E+07	8.4131E+02	1.5050E+01
720.000	4.0504E+06	7.4898E+01	1.3398E+00

Time (hr)	CR I-131 (Curies)	Environment I-131 (Curies)	Dummy I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	1.3888E-08	2.3184E-05	5.7356E-02
0.500	6.5968E-07	1.2768E-03	3.1580E+00
0.533	8.0237E-07	1.5756E-03	3.8968E+00
0.900	3.6727E-06	8.3438E-03	2.0630E+01
1.200	8.3557E-06	2.1022E-02	5.1964E+01

1.500	1.5396E-05	4.2751E-02	1.0565E+02
1.800	2.4669E-05	7.5436E-02	1.8637E+02
2.000	3.1965E-05	1.0407E-01	2.5707E+02
2.033	3.2079E-05	1.0941E-01	2.7024E+02
2.400	3.6393E-05	1.7884E-01	4.4159E+02
2.700	4.1984E-05	2.4823E-01	6.1271E+02
3.000	4.7809E-05	3.2642E-01	8.0542E+02
3.300	5.3201E-05	4.1156E-01	1.0151E+03
3.600	5.7904E-05	5.0219E-01	1.2382E+03
3.900	6.1865E-05	5.9715E-01	1.4717E+03
4.200	6.5128E-05	6.9551E-01	1.7134E+03
4.500	6.7776E-05	7.9655E-01	1.9614E+03
4.800	6.9901E-05	8.9969E-01	2.2144E+03
5.100	7.1594E-05	1.0045E+00	2.4711E+03
5.400	7.2931E-05	1.1105E+00	2.7307E+03
5.700	7.3981E-05	1.2175E+00	2.9924E+03
6.000	7.4800E-05	1.3253E+00	3.2557E+03
6.300	7.5432E-05	1.4336E+00	3.5201E+03
6.600	7.5917E-05	1.5424E+00	3.7853E+03
6.900	7.6284E-05	1.6515E+00	4.0510E+03
7.200	7.6556E-05	1.7608E+00	4.3170E+03
7.500	7.6754E-05	1.8702E+00	4.5830E+03
7.800	7.6892E-05	1.9797E+00	4.8489E+03
8.000	7.6958E-05	2.0528E+00	5.0261E+03
8.300	5.8329E-05	2.1624E+00	5.2918E+03
8.600	4.7864E-05	2.2720E+00	5.5571E+03
8.900	4.1981E-05	2.3815E+00	5.8220E+03
9.200	3.8669E-05	2.4910E+00	6.0865E+03
9.500	3.6800E-05	2.6004E+00	6.3506E+03
9.800	3.5738E-05	2.7098E+00	6.6142E+03
10.100	3.5130E-05	2.8190E+00	6.8773E+03
10.400	3.4774E-05	2.9282E+00	7.1398E+03
24.000	3.2639E-05	7.7439E+00	1.8442E+04
96.000	1.7482E-05	2.9404E+01	6.1259E+04
720.000	1.1874E-06	9.0697E+01	4.5801E+04

##

Cumulative Dose Summary

##

Time (hr)	Control_Room Thyroid (rem)	Control_Room TEDE (rem)	EAB Thyroid (rem)	EAB TEDE (rem)	LPZ Thyroid (rem)	LPZ TEDE (rem)
0.001	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.167	1.7772E-07	5.6627E-09	3.2421E-06	1.1775E-07	1.6211E-06	5.8874E-08
0.500	2.6093E-05	8.2962E-07	1.7798E-04	6.3878E-06	8.8988E-05	3.1939E-06
0.533	3.3920E-05	1.0782E-06	2.1952E-04	7.8675E-06	1.0976E-04	3.9338E-06
0.900	2.7258E-04	8.6470E-06	1.1583E-03	4.1081E-05	5.7914E-04	2.0540E-05
1.200	8.3176E-04	2.6349E-05	2.9096E-03	1.0257E-04	1.4548E-03	5.1283E-05
1.500	1.9480E-03	6.1635E-05	5.8999E-03	2.0697E-04	2.9499E-03	1.0348E-04
1.800	3.8368E-03	1.2127E-04	1.0382E-02	3.6273E-04	5.1908E-03	1.8137E-04
2.000	5.6223E-03	1.7759E-04	1.4296E-02	4.9837E-04	7.1482E-03	2.4919E-04
2.033	5.9587E-03	1.8820E-04	1.5025E-02	5.2356E-04	7.3319E-03	2.5554E-04
2.400	9.8671E-03	3.1136E-04	2.4481E-02	8.5009E-04	9.7176E-03	3.3792E-04
2.700	1.3547E-02	4.2721E-04	3.3896E-02	1.1741E-03	1.2093E-02	4.1965E-04
3.000	1.7757E-02	5.5961E-04	4.4469E-02	1.5368E-03	1.4760E-02	5.1116E-04
3.300	2.2479E-02	7.0804E-04	5.5945E-02	1.9293E-03	1.7656E-02	6.1019E-04
3.600	2.7657E-02	8.7068E-04	6.8122E-02	2.3447E-03	2.0728E-02	7.1500E-04
3.900	3.3221E-02	1.0453E-03	8.0841E-02	2.7775E-03	2.3937E-02	8.2420E-04
4.200	3.9101E-02	1.2298E-03	9.3974E-02	3.2236E-03	2.7250E-02	9.3673E-04
4.500	4.5236E-02	1.4221E-03	1.0742E-01	3.6795E-03	3.0643E-02	1.0518E-03
4.800	5.1571E-02	1.6206E-03	1.2111E-01	4.1427E-03	3.4096E-02	1.1686E-03
5.100	5.8061E-02	1.8239E-03	1.3497E-01	4.6111E-03	3.7594E-02	1.2868E-03
5.400	6.4672E-02	2.0308E-03	1.4896E-01	5.0832E-03	4.1124E-02	1.4059E-03
5.700	7.1371E-02	2.2404E-03	1.6304E-01	5.5576E-03	4.4676E-02	1.5256E-03
6.000	7.8137E-02	2.4520E-03	1.7718E-01	6.0334E-03	4.8243E-02	1.6456E-03
6.300	8.4949E-02	2.6650E-03	1.9136E-01	6.5099E-03	5.1819E-02	1.7658E-03
6.600	9.1793E-02	2.8789E-03	2.0555E-01	6.9865E-03	5.5399E-02	1.8861E-03
6.900	9.8657E-02	3.0933E-03	2.1974E-01	7.4626E-03	5.8980E-02	2.0062E-03
7.200	1.0553E-01	3.3079E-03	2.3393E-01	7.9380E-03	6.2559E-02	2.1261E-03
7.500	1.1241E-01	3.5226E-03	2.4809E-01	8.4123E-03	6.6133E-02	2.2458E-03
7.800	1.1928E-01	3.7371E-03	2.6223E-01	8.8854E-03	6.9700E-02	2.3652E-03
8.000	1.2386E-01	3.8800E-03	2.7165E-01	9.2001E-03	7.2075E-02	2.4445E-03
8.300	1.2982E-01	4.0658E-03	2.7889E-01	9.4582E-03	7.3372E-02	2.4907E-03
8.600	1.3450E-01	4.2117E-03	2.8612E-01	9.7153E-03	7.4665E-02	2.5368E-03

```
    8.900 1.3846E-01 4.3351E-03 2.9333E-01 9.9714E-03 7.5956E-02 2.5826E-03
    9.200 1.4201E-01 4.4459E-03 3.0051E-01 1.0226E-02 7.7242E-02 2.6283E-03
    9.500 1.4534E-01 4.5494E-03 3.0768E-01 1.0480E-02 7.8524E-02 2.6737E-03
    9.800 1.4852E-01 4.6487E-03 3.1482E-01 1.0733E-02 7.9803E-02 2.7190E-03
   10.100 1.5163E-01 4.7455E-03 3.2194E-01 1.0985E-02 8.1077E-02 2.7641E-03
   10.400 1.5470E-01 4.8408E-03 3.2903E-01 1.1236E-02 8.2348E-02 2.8089E-03
   24.000 2.8250E-01 8.8007E-03 6.2993E-01 2.1619E-02 1.3621E-01 4.6676E-03
   96.000 4.9827E-01 1.5410E-02 2.1511E+00 6.9657E-02 2.6569E-01 8.7563E-03
  720.000 7.8680E-01 2.4200E-02 6.1661E+00 1.9350E-01 3.8767E-01 1.2519E-02

####################################################################
                        Worst Two-Hour Doses
    Note: All of the dose locations are shown below but the
          worst two-hour dose is only meaningful for the EAB
          dose location.  Please disregard the two-hour worst
          doses for the other dose locations
####################################################################

Control_Room
   Time    Whole Body    Thyroid       TEDE
   (hr)      (rem)        (rem)        (rem)
    6.0    5.8008E-06   4.5725E-02   1.4280E-03

EAB
   Time    Whole Body    Thyroid       TEDE
   (hr)      (rem)        (rem)        (rem)
    5.4    2.3284E-04   9.4406E-02   3.1711E-03

LPZ
   Time    Whole Body    Thyroid       TEDE
   (hr)      (rem)        (rem)        (rem)
    5.4    5.8742E-05   2.3818E-02   8.0003E-04
```

RUN D5 – NOSPRAYS_STACKTOP_ESF.O0

```
Environment Integral Nuclide Release:

 Time (h) =    0.5000         Ci          kg          Atoms        Bq
 I-131                    3.1588E+00  2.5479E-08  1.1713E+17  1.1688E+11
 I-132                    4.0461E+00  3.9199E-10  1.7883E+15  1.4971E+11
 I-133                    6.4675E+00  5.7092E-09  2.5851E+16  2.3930E+11
 I-134                    5.1908E+00  1.9458E-10  8.7448E+14  1.9206E+11
 I-135                    5.9486E+00  1.6939E-09  7.5561E+15  2.2010E+11
 Xe-133                   1.5969E-01  8.5310E-10  3.8628E+15  5.9084E+09
 Xe-135                   1.7843E+00  6.9871E-10  3.1169E+15  6.6020E+10

Environment Integral Nuclide Release:

 Time (h) =    2.0000         Ci          kg          Atoms        Bq
 I-131                    2.5747E+02  2.0768E-06  9.5472E+18  9.5265E+12
 I-132                    2.3687E+02  2.2948E-08  1.0469E+17  8.7643E+12
 I-133                    5.0974E+02  4.4998E-07  2.0375E+18  1.8861E+13
 I-134                    1.8157E+02  6.8064E-09  3.0589E+16  6.7181E+12
 I-135                    4.3266E+02  1.2320E-07  5.4957E+17  1.6008E+13
 Xe-133                   1.3508E+02  7.2166E-07  3.2676E+18  4.9980E+12
 Xe-135                   1.3833E+03  5.4169E-07  2.4164E+18  5.1183E+13

Environment Integral Nuclide Release:

 Time (h) =    8.0000         Ci          kg          Atoms        Bq
 I-131                    5.0786E+03  4.0965E-05  1.8832E+20  1.8791E+14
 I-132                    1.8756E+03  1.8170E-07  8.2897E+17  6.9396E+13
 I-133                    9.0628E+03  8.0003E-06  3.6225E+19  3.3532E+14
 I-134                    5.5657E+02  2.0863E-08  9.3763E+16  2.0593E+13
 I-135                    6.0607E+03  1.7258E-06  7.6985E+18  2.2425E+14
 Xe-133                   7.2472E+03  3.8717E-05  1.7531E+20  2.6815E+14
 Xe-135                   5.6795E+04  2.2240E-05  9.9209E+19  2.1014E+15

Environment Integral Nuclide Release:

 Time (h) =   24.0000         Ci          kg          Atoms        Bq
 I-131                    1.9158E+04  1.5453E-04  7.1040E+20  7.0886E+14
 I-132                    2.2592E+03  2.1887E-07  9.9853E+17  8.3590E+13
 I-133                    2.7241E+04  2.4047E-05  1.0888E+20  1.0079E+15
 I-134                    5.6120E+02  2.1037E-08  9.4544E+16  2.0765E+13
```

I-135	1.2037E+04	3.4275E-06	1.5289E+19	4.4536E+14
Xe-133	5.1220E+04	2.7364E-04	1.2390E+21	1.8951E+15
Xe-135	2.1533E+05	8.4320E-05	3.7614E+20	7.9673E+15

Environment Integral Nuclide Release:

Time (h) = 48.0000	Ci	kg	Atoms	Bq
I-131	3.8706E+04	3.1221E-04	1.4352E+21	1.4321E+15
I-132	2.2620E+03	2.1914E-07	9.9976E+17	8.3693E+13
I-133	4.1305E+04	3.6462E-05	1.6510E+20	1.5283E+15
I-134	5.6120E+02	2.1037E-08	9.4544E+16	2.0765E+13
I-135	1.3264E+04	3.7769E-06	1.6848E+19	4.9076E+14
Xe-133	1.5088E+05	8.0606E-04	3.6498E+21	5.5825E+15
Xe-135	3.1023E+05	1.2148E-04	5.4190E+20	1.1478E+16

Environment Integral Nuclide Release:

Time (h) = 96.0000	Ci	kg	Atoms	Bq
I-131	7.2746E+04	5.8678E-04	2.6975E+21	2.6916E+15
I-132	2.2620E+03	2.1914E-07	9.9976E+17	8.3693E+13
I-133	5.0384E+04	4.4477E-05	2.0139E+20	1.8642E+15
I-134	5.6120E+02	2.1037E-08	9.4544E+16	2.0765E+13
I-135	1.3370E+04	3.8072E-06	1.6983E+19	4.9470E+14
Xe-133	3.6968E+05	1.9750E-03	8.9425E+21	1.3678E+16
Xe-135	3.3380E+05	1.3071E-04	5.8307E+20	1.2350E+16

Environment Integral Nuclide Release:

Time (h) = 120.0000	Ci	kg	Atoms	Bq
I-131	8.7533E+04	7.0606E-04	3.2458E+21	3.2387E+15
I-132	2.2620E+03	2.1914E-07	9.9976E+17	8.3693E+13
I-133	5.1635E+04	4.5581E-05	2.0639E+20	1.9105E+15
I-134	5.6120E+02	2.1037E-08	9.4544E+16	2.0765E+13
I-135	1.3371E+04	3.8073E-06	1.6984E+19	4.9472E+14
Xe-133	4.6822E+05	2.5014E-03	1.1326E+22	1.7324E+16
Xe-135	3.3440E+05	1.3094E-04	5.8412E+20	1.2373E+16

Environment Integral Nuclide Release:

Time (h) = 240.0000	Ci	kg	Atoms	Bq
I-131	1.4395E+05	1.1611E-03	5.3377E+21	5.3261E+15
I-132	2.2620E+03	2.1914E-07	9.9976E+17	8.3693E+13
I-133	5.2626E+04	4.6456E-05	2.1035E+20	1.9471E+15
I-134	5.6120E+02	2.1037E-08	9.4544E+16	2.0765E+13
I-135	1.3371E+04	3.8073E-06	1.6984E+19	4.9472E+14
Xe-133	8.1241E+05	4.3402E-03	1.9652E+22	3.0059E+16
Xe-135	3.3451E+05	1.3099E-04	5.8433E+20	1.2377E+16

Environment Integral Nuclide Release:

Time (h) = 480.0000	Ci	kg	Atoms	Bq
I-131	2.0163E+05	1.6264E-03	7.4766E+21	7.4604E+15
I-132	2.2620E+03	2.1914E-07	9.9976E+17	8.3693E+13
I-133	5.2643E+04	4.6472E-05	2.1042E+20	1.9478E+15
I-134	5.6120E+02	2.1037E-08	9.4544E+16	2.0765E+13
I-135	1.3371E+04	3.8073E-06	1.6984E+19	4.9472E+14
Xe-133	1.0729E+06	5.7320E-03	2.5954E+22	3.9699E+16
Xe-135	3.3451E+05	1.3099E-04	5.8433E+20	1.2377E+16

Environment Integral Nuclide Release:

Time (h) = 720.0000	Ci	kg	Atoms	Bq
I-131	2.2438E+05	1.8099E-03	8.3203E+21	8.3022E+15
I-132	2.2620E+03	2.1914E-07	9.9976E+17	8.3693E+13
I-133	5.2643E+04	4.6472E-05	2.1042E+20	1.9478E+15
I-134	5.6120E+02	2.1037E-08	9.4544E+16	2.0765E+13
I-135	1.3371E+04	3.8073E-06	1.6984E+19	4.9472E+14
Xe-133	1.1379E+06	6.0789E-03	2.7525E+22	4.2101E+16
Xe-135	3.3451E+05	1.3099E-04	5.8433E+20	1.2377E+16

###

I-131 Summary

###

Time (hr)	SP I-131 (Curies)	RB I-131 (Curies)	SR I-131 (Curies)

0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	2.8745E+06	2.6384E+00	3.3749E-02
0.500	1.0023E+07	2.9587E+01	4.8155E-01
0.533	1.0737E+07	3.3689E+01	5.5196E-01
0.900	2.2875E+07	1.0123E+02	1.7110E+00
1.200	3.3561E+07	1.8844E+02	3.2352E+00
1.500	4.4222E+07	2.9823E+02	5.1707E+00
1.800	5.4860E+07	4.2583E+02	7.4308E+00
2.000	6.1938E+07	5.1890E+02	9.0832E+00
2.033	6.3117E+07	5.3495E+02	9.3684E+00
2.400	6.5397E+07	6.9908E+02	1.2339E+01
2.700	6.5321E+07	8.0318E+02	1.4236E+01
3.000	6.5246E+07	8.8546E+02	1.5735E+01
3.300	6.5170E+07	9.5044E+02	1.6919E+01
3.500	6.5119E+07	9.8595E+02	1.7566E+01
3.800	6.5044E+07	1.0297E+03	1.8363E+01
4.000	6.4993E+07	1.0535E+03	1.8797E+01
4.300	6.4918E+07	1.0828E+03	1.9331E+01
4.600	6.4842E+07	1.1057E+03	1.9749E+01
4.900	6.4767E+07	1.1236E+03	2.0075E+01
5.200	6.4692E+07	1.1375E+03	2.0329E+01
5.500	6.4616E+07	1.1483E+03	2.0525E+01
5.800	6.4541E+07	1.1565E+03	2.0676E+01
6.100	6.4466E+07	1.1628E+03	2.0790E+01
6.400	6.4391E+07	1.1674E+03	2.0876E+01
6.700	6.4316E+07	1.1709E+03	2.0939E+01
7.000	6.4242E+07	1.1733E+03	2.0983E+01
7.300	6.4167E+07	1.1749E+03	2.1014E+01
7.600	6.4092E+07	1.1759E+03	2.1033E+01
7.900	6.4018E+07	1.1765E+03	2.1043E+01
8.000	6.3993E+07	1.1766E+03	2.1044E+01
8.300	6.3919E+07	1.1766E+03	2.1045E+01
8.600	6.3845E+07	1.1763E+03	2.1041E+01
8.900	6.3770E+07	1.1758E+03	2.1032E+01
9.200	6.3696E+07	1.1751E+03	2.1021E+01
9.500	6.3622E+07	1.1743E+03	2.1006E+01
9.800	6.3548E+07	1.1734E+03	2.0990E+01
10.100	6.3474E+07	1.1724E+03	2.0972E+01
10.400	6.3401E+07	1.1713E+03	2.0952E+01
24.000	6.0145E+07	1.1122E+03	1.9895E+01
96.000	4.5498E+07	8.4131E+02	1.5050E+01
720.000	4.0504E+06	7.4898E+01	1.3398E+00

Time (hr)	CR I-131 (Curies)	Environment I-131 (Curies)	Dummy I-131 (Curies)
0.001	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.167	2.4224E-08	5.7357E-02	2.3184E-05
0.500	1.1506E-06	3.1588E+00	1.2765E-03
0.533	1.3995E-06	3.8980E+00	1.5751E-03
0.900	6.4059E-06	2.0643E+01	8.3387E-03
1.200	1.4574E-05	5.2009E+01	2.1004E-02
1.500	2.6854E-05	1.0577E+02	4.2703E-02
1.800	4.3028E-05	1.8663E+02	7.5332E-02
2.000	5.5752E-05	2.5747E+02	1.0391E-01
2.033	5.4117E-05	2.7068E+02	1.0923E-01
2.400	4.4606E-05	4.4246E+02	1.7849E-01
2.700	4.3792E-05	6.1412E+02	2.4766E-01
3.000	4.5669E-05	8.0755E+02	3.2555E-01
3.300	4.8568E-05	1.0182E+03	4.1032E-01
3.500	5.0634E-05	1.1664E+03	4.6990E-01
3.800	1.9044E-02	1.3980E+03	5.6299E-01
4.000	2.7261E-02	1.5576E+03	6.2709E-01
4.300	1.5338E-02	1.8034E+03	7.2571E-01
4.600	8.6427E-03	2.0552E+03	8.2669E-01
4.900	4.8823E-03	2.3118E+03	9.2949E-01
5.200	2.7705E-03	2.5722E+03	1.0337E+00
5.500	1.5847E-03	2.8354E+03	1.1389E+00
5.800	9.1889E-04	3.1008E+03	1.2450E+00
6.100	5.4509E-04	3.3680E+03	1.3516E+00
6.400	3.3528E-04	3.6364E+03	1.4586E+00
6.700	2.1753E-04	3.9058E+03	1.5658E+00
7.000	1.5146E-04	4.1758E+03	1.6733E+00
7.300	1.1441E-04	4.4464E+03	1.7808E+00
7.600	9.3628E-05	4.7172E+03	1.8883E+00

7.900	8.1976E-05	4.9883E+03	1.9958E+00
8.000	7.9367E-05	5.0786E+03	2.0316E+00
8.300	6.1171E-05	5.3498E+03	2.1390E+00
8.600	5.0949E-05	5.6209E+03	2.2462E+00
8.900	4.5203E-05	5.8919E+03	2.3533E+00
9.200	4.1967E-05	6.1628E+03	2.4602E+00
9.500	4.0139E-05	6.4335E+03	2.5669E+00
9.800	3.9099E-05	6.7040E+03	2.6735E+00
10.100	3.8502E-05	6.9743E+03	2.7798E+00
10.400	3.8152E-05	7.2444E+03	2.8859E+00
24.000	3.5857E-05	1.9158E+04	7.4543E+00
96.000	7.8597E-06	7.2746E+04	2.4761E+01
720.000	1.1789E-07	2.2438E+05	1.8513E+01

##

Cumulative Dose Summary

##

	Control_Room		EAB		LPZ	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.001	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.167	3.0997E-07	9.8766E-09	3.6432E-05	1.3231E-06	3.4595E-05	1.2564E-06
0.500	4.5510E-05	1.4470E-06	1.9999E-03	7.1779E-05	1.8991E-03	6.8160E-05
0.533	5.9162E-05	1.8806E-06	2.4667E-03	8.8406E-05	2.3424E-03	8.3949E-05
0.900	4.7543E-04	1.5082E-05	1.3016E-02	4.6162E-04	1.2359E-02	4.3834E-04
1.200	1.4507E-03	4.5957E-05	3.2695E-02	1.1525E-03	3.1046E-02	1.0944E-03
1.500	3.3976E-03	1.0750E-04	6.6296E-02	2.3257E-03	6.2953E-02	2.2084E-03
1.800	6.6920E-03	2.1152E-04	1.1666E-01	4.0760E-03	1.1077E-01	3.8705E-03
2.000	9.8062E-03	3.0975E-04	1.6065E-01	5.6001E-03	1.5255E-01	5.3178E-03
2.033	1.0383E-02	3.2795E-04	1.6883E-01	5.8831E-03	1.5650E-01	5.4545E-03
2.400	1.5959E-02	5.0366E-04	2.7509E-01	9.5523E-03	2.0784E-01	7.2274E-03
2.700	2.0089E-02	6.3364E-04	3.8088E-01	1.3193E-02	2.5896E-01	8.9864E-03
3.000	2.4270E-02	7.6515E-04	4.9969E-01	1.7268E-02	3.1637E-01	1.0956E-02
3.300	2.8668E-02	9.0339E-04	6.2865E-01	2.1679E-02	3.7868E-01	1.3087E-02
3.500	3.1749E-02	1.0002E-03	7.1912E-01	2.4766E-02	4.2240E-01	1.4579E-02
3.800	9.8596E-01	3.0958E-02	3.5047E+00	1.1964E-01	1.9160E+00	6.5449E-02
4.000	2.4271E+00	7.6181E-02	5.4194E+00	1.8474E-01	2.9425E+00	1.0035E-01
4.300	4.3495E+00	1.3648E-01	5.5682E+00	1.8979E-01	3.0145E+00	1.0279E-01
4.600	5.4285E+00	1.7030E-01	5.7204E+00	1.9494E-01	3.0880E+00	1.0528E-01
4.900	6.0353E+00	1.8931E-01	5.8749E+00	2.0017E-01	3.1626E+00	1.0781E-01
5.200	6.3777E+00	2.0003E-01	6.0312E+00	2.0545E-01	3.2382E+00	1.1036E-01
5.500	6.5720E+00	2.0611E-01	6.1888E+00	2.1076E-01	3.3143E+00	1.1292E-01
5.800	6.6835E+00	2.0960E-01	6.3473E+00	2.1610E-01	3.3909E+00	1.1550E-01
6.100	6.7485E+00	2.1163E-01	6.5063E+00	2.2145E-01	3.4677E+00	1.1809E-01
6.400	6.7876E+00	2.1285E-01	6.6656E+00	2.2680E-01	3.5447E+00	1.2068E-01
6.700	6.8121E+00	2.1362E-01	6.8251E+00	2.3216E-01	3.6218E+00	1.2326E-01
7.000	6.8285E+00	2.1413E-01	6.9846E+00	2.3751E-01	3.6988E+00	1.2585E-01
7.300	6.8403E+00	2.1450E-01	7.1439E+00	2.4284E-01	3.7758E+00	1.2843E-01
7.600	6.8496E+00	2.1479E-01	7.3030E+00	2.4817E-01	3.8527E+00	1.3100E-01
7.900	6.8574E+00	2.1503E-01	7.4618E+00	2.5348E-01	3.9294E+00	1.3357E-01
8.000	6.8598E+00	2.1510E-01	7.5147E+00	2.5525E-01	3.9550E+00	1.3442E-01
8.300	6.8660E+00	2.1530E-01	7.5961E+00	2.5815E-01	3.9830E+00	1.3542E-01
8.600	6.8709E+00	2.1545E-01	7.6773E+00	2.6104E-01	4.0110E+00	1.3641E-01
8.900	6.8751E+00	2.1558E-01	7.7583E+00	2.6391E-01	4.0389E+00	1.3741E-01
9.200	6.8790E+00	2.1570E-01	7.8390E+00	2.6678E-01	4.0667E+00	1.3839E-01
9.500	6.8826E+00	2.1582E-01	7.9196E+00	2.6963E-01	4.0945E+00	1.3938E-01
9.800	6.8861E+00	2.1592E-01	7.9998E+00	2.7248E-01	4.1221E+00	1.4036E-01
10.100	6.8895E+00	2.1603E-01	8.0798E+00	2.7530E-01	4.1497E+00	1.4133E-01
10.400	6.8928E+00	2.1613E-01	8.1596E+00	2.7812E-01	4.1772E+00	1.4230E-01
24.000	7.0332E+00	2.2049E-01	1.1541E+01	3.9479E-01	5.3421E+00	1.8250E-01
96.000	7.1325E+00	2.2353E-01	2.8634E+01	9.3459E-01	8.1718E+00	2.7186E-01
720.000	7.1616E+00	2.2441E-01	7.3750E+01	2.3262E+00	1.0780E+01	3.5232E-01

##

Worst Two-Hour Doses

Note: All of the dose locations are shown below but the worst two-hour dose is only meaningful for the EAB dose location. Please disregard the two-hour worst doses for the other dose locations

##

Control_Room

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)

3.5	9.3203E-04	6.5403E+00	2.0511E-01

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
3.5	1.5148E-02	5.4697E+00	1.8599E-01

LPZ

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
3.5	8.0144E-03	2.8919E+00	9.8346E-02

Appendix D4
Fumigation Spreadsheet

Time	NoSpray (run D2') Stacktop Release CR TEDE	Delta CR TEDE	NoSpray (run D4') Stacktop ESF Release CR TEDE	Delta CR TEDE	Total Delta CR TEDE
0.1	9.45E-07	9.45E-07	1.83E-07	1.83E-07	1.13E-06
0.2	2.60E-05	2.50E-05	5.41E-06	5.23E-06	3.02E-05
0.3	1.52E-04	1.26E-04	3.88E-05	3.34E-05	1.60E-04
0.4	5.01E-04	3.49E-04	1.37E-04	9.78E-05	4.47E-04
0.5	1.24E-03	7.36E-04	3.49E-04	2.12E-04	9.49E-04
0.6	2.54E-03	1.30E-03	7.31E-04	3.82E-04	1.68E-03
0.7	4.62E-03	2.08E-03	1.36E-03	6.25E-04	2.71E-03
0.8	7.73E-03	3.11E-03	2.30E-03	9.39E-04	4.05E-03
0.9	1.22E-02	4.45E-03	3.64E-03	1.34E-03	5.80E-03
1	1.84E-02	6.19E-03	5.48E-03	1.84E-03	8.03E-03
1.1	2.67E-02	8.35E-03	7.92E-03	2.45E-03	1.08E-02
1.2	3.77E-02	1.09E-02	1.11E-02	3.16E-03	1.41E-02
1.3	5.17E-02	1.40E-02	1.51E-02	3.98E-03	1.80E-02
1.4	6.91E-02	1.75E-02	2.00E-02	4.91E-03	2.24E-02
1.5	9.05E-02	2.13E-02	2.59E-02	5.95E-03	2.73E-02
1.6	1.16E-01	2.56E-02	3.30E-02	7.09E-03	3.27E-02
1.7	1.46E-01	3.02E-02	4.13E-02	8.33E-03	3.86E-02
1.8	1.82E-01	3.52E-02	5.10E-02	9.66E-03	4.49E-02
1.9	2.22E-01	4.04E-02	6.21E-02	1.11E-02	5.15E-02
2	2.68E-01	4.60E-02	7.47E-02	1.26E-02	5.85E-02
2.1	3.20E-01	5.17E-02	8.89E-02	1.42E-02	6.58E-02
2.2	3.77E-01	5.76E-02	1.05E-01	1.59E-02	7.34E-02
2.3	4.41E-01	6.35E-02	1.22E-01	1.76E-02	8.11E-02
2.4	5.10E-01	6.93E-02	1.42E-01	1.93E-02	8.86E-02
2.5	5.85E-01	7.48E-02	1.63E-01	2.11E-02	9.58E-02
2.6	6.65E-01	7.98E-02	1.85E-01	2.28E-02	1.03E-01
2.7	7.49E-01	8.44E-02	2.10E-01	2.44E-02	1.09E-01
2.8	8.37E-01	8.84E-02	2.36E-01	2.60E-02	1.14E-01
2.9	9.29E-01	9.18E-02	2.63E-01	2.76E-02	1.19E-01
3	1.02E+00	9.47E-02	2.92E-01	2.90E-02	1.24E-01
3.1	1.12E+00	9.70E-02	3.23E-01	3.04E-02	1.27E-01
3.2	1.22E+00	9.88E-02	3.55E-01	3.17E-02	1.31E-01
3.3	1.32E+00	1.00E-01	3.87E-01	3.30E-02	1.33E-01
3.4	1.42E+00	1.01E-01	4.22E-01	3.41E-02	1.35E-01
3.5	1.52E+00	1.01E-01	4.57E-01	3.52E-02	1.36E-01
3.6	1.62E+00	1.01E-01	4.93E-01	3.62E-02	1.38E-01
3.7	1.72E+00	1.01E-01	5.30E-01	3.71E-02	1.38E-01
3.8	1.82E+00	1.00E-01	5.68E-01	3.80E-02	1.38E-01
3.9	1.92E+00	9.92E-02	6.07E-01	3.88E-02	1.38E-01
4	2.02E+00	9.79E-02	6.47E-01	3.96E-02	1.37E-01
4.1	2.12E+00	9.64E-02	6.87E-01	4.03E-02	1.37E-01

4.2	2.21E+00	9.48E-02	7.28E-01	4.09E-02	1.36E-01
4.3	2.31E+00	9.29E-02	7.69E-01	4.15E-02	1.34E-01
4.4	2.40E+00	9.10E-02	8.11E-01	4.21E-02	1.33E-01
4.5	2.49E+00	8.88E-02	8.54E-01	4.26E-02	1.31E-01
4.6	2.57E+00	8.67E-02	8.97E-01	4.30E-02	1.30E-01
4.7	2.66E+00	8.44E-02	9.40E-01	4.35E-02	1.28E-01
4.8	2.74E+00	8.20E-02	9.84E-01	4.38E-02	1.26E-01
4.9	2.82E+00	7.97E-02	1.03E+00	4.42E-02	1.24E-01
5	2.90E+00	7.73E-02	1.07E+00	4.45E-02	1.22E-01
5.1	2.97E+00	7.48E-02	1.12E+00	4.48E-02	1.20E-01
5.2	3.04E+00	7.24E-02	1.16E+00	4.51E-02	1.18E-01
5.3	3.11E+00	7.01E-02	1.21E+00	4.53E-02	1.15E-01
5.4	3.18E+00	6.77E-02	1.25E+00	4.56E-02	1.13E-01
5.5	3.25E+00	6.54E-02	1.30E+00	4.57E-02	1.11E-01
5.6	3.31E+00	6.31E-02	1.35E+00	4.59E-02	1.09E-01
5.7	3.37E+00	6.08E-02	1.39E+00	4.61E-02	1.07E-01
5.8	3.43E+00	5.88E-02	1.44E+00	4.62E-02	1.05E-01
5.9	3.49E+00	5.66E-02	1.48E+00	4.64E-02	1.03E-01
6	3.54E+00	5.46E-02	1.53E+00	4.64E-02	1.01E-01
6.1	3.59E+00	5.26E-02	1.58E+00	4.66E-02	9.92E-02
6.2	3.64E+00	5.08E-02	1.62E+00	4.67E-02	9.75E-02
6.3	3.69E+00	4.89E-02	1.67E+00	4.67E-02	9.56E-02
6.4	3.74E+00	4.72E-02	1.72E+00	4.68E-02	9.40E-02
6.5	3.78E+00	4.54E-02	1.76E+00	4.68E-02	9.22E-02
6.6	3.83E+00	4.38E-02	1.81E+00	4.69E-02	9.07E-02
6.7	3.87E+00	4.23E-02	1.86E+00	4.70E-02	8.93E-02
6.8	3.91E+00	4.07E-02	1.90E+00	4.69E-02	8.76E-02
6.9	3.95E+00	3.93E-02	1.95E+00	4.70E-02	8.63E-02
7	3.99E+00	3.78E-02	2.00E+00	4.70E-02	8.48E-02
7.1	4.03E+00	3.66E-02	2.05E+00	4.71E-02	8.37E-02
7.2	4.06E+00	3.52E-02	2.09E+00	4.70E-02	8.22E-02
7.3	4.09E+00	3.40E-02	2.14E+00	4.70E-02	8.10E-02
7.4	4.13E+00	3.27E-02	2.19E+00	4.70E-02	7.97E-02
7.5	4.16E+00	3.17E-02	2.23E+00	4.71E-02	7.88E-02
7.6	4.19E+00	3.05E-02	2.28E+00	4.70E-02	7.75E-02
7.7	4.22E+00	2.95E-02	2.33E+00	4.70E-02	7.65E-02
7.8	4.25E+00	2.84E-02	2.37E+00	4.69E-02	7.53E-02
7.9	4.27E+00	2.75E-02	2.42E+00	4.70E-02	7.45E-02
8	4.30E+00	2.65E-02	2.47E+00	4.69E-02	7.34E-02

Appendix D5
Max 2-hour EAB TEDE Spreadsheet

Time hour	NoSrays Stackbase Release (run D1)	NoSprays Stacktop Release (run D2)	NoSprays Tbroof Release (run D3)	NoSprays Stackbase ESF Release (run D4)	NoSprays Stacktop ESF Release (run D5)	Total EAB TEDE rem	2-hour EAB rem	
0.1	5.92E-08	6.65E-07	5.89E-05	1.05E-08	1.18E-07	5.97E-05	1.33E-01	EAB(2.1)-EAB(0.1)
0.2	1.36E-06	1.53E-05	3.59E-04	2.46E-07	2.76E-06	3.79E-04	1.45E-01	EAB(2.2)-EAB(0.2)
0.3	6.15E-06	6.91E-05	8.99E-04	1.13E-06	1.27E-05	9.88E-04	1.57E-01	...
0.4	1.64E-05	1.84E-04	1.66E-03	3.05E-06	3.43E-05	1.90E-03	1.69E-01	
0.5	3.37E-05	3.79E-04	2.63E-03	6.39E-06	7.18E-05	3.12E-03	1.81E-01	
0.6	5.94E-05	6.68E-04	3.79E-03	1.15E-05	1.29E-04	4.65E-03	1.93E-01	
0.7	9.53E-05	1.07E-03	5.38E-03	1.86E-05	2.09E-04	6.77E-03	2.04E-01	
0.8	1.45E-04	1.63E-03	7.60E-03	2.83E-05	3.18E-04	9.72E-03	2.14E-01	
0.9	2.14E-04	2.41E-03	1.04E-02	4.11E-05	4.62E-04	1.35E-02	2.24E-01	
1	3.06E-04	3.43E-03	1.38E-02	5.74E-05	6.45E-04	1.83E-02	2.32E-01	
1.1	4.24E-04	4.76E-03	1.78E-02	7.78E-05	8.74E-04	2.39E-02	2.40E-01	
1.2	5.71E-04	6.41E-03	2.23E-02	1.03E-04	1.15E-03	3.05E-02	2.46E-01	
1.3	7.50E-04	8.42E-03	2.73E-02	1.32E-04	1.48E-03	3.81E-02	2.51E-01	
1.4	9.63E-04	1.08E-02	3.29E-02	1.67E-04	1.87E-03	4.67E-02	2.55E-01	
1.5	1.21E-03	1.36E-02	3.89E-02	2.07E-04	2.33E-03	5.63E-02	2.58E-01	
1.6	1.50E-03	1.68E-02	4.54E-02	2.53E-04	2.84E-03	6.68E-02	4.17E-01	
1.7	1.82E-03	2.05E-02	5.24E-02	3.05E-04	3.42E-03	7.84E-02	5.74E-01	
1.8	2.18E-03	2.45E-02	5.98E-02	3.63E-04	4.08E-03	9.10E-02	7.26E-01	
1.9	2.59E-03	2.91E-02	6.77E-02	4.27E-04	4.80E-03	1.05E-01	8.76E-01	
2	3.03E-03	3.40E-02	7.59E-02	4.98E-04	5.60E-03	1.19E-01	1.02E+00	
2.1	3.51E-03	3.95E-02	8.25E-02	5.76E-04	6.48E-03	1.33E-01	1.02E+00	
2.2	4.03E-03	4.53E-02	8.76E-02	6.61E-04	7.43E-03	1.45E-01	1.02E+00	
2.3	4.59E-03	5.16E-02	9.25E-02	7.53E-04	8.46E-03	1.58E-01	1.02E+00	
2.4	5.17E-03	5.81E-02	9.72E-02	8.50E-04	9.55E-03	1.71E-01	1.01E+00	
2.5	5.78E-03	6.49E-02	1.02E-01	9.53E-04	1.07E-02	1.84E-01	1.01E+00	
2.6	6.40E-03	7.19E-02	1.06E-01	1.06E-03	1.19E-02	1.97E-01	1.01E+00	
2.7	7.03E-03	7.90E-02	1.10E-01	1.17E-03	1.32E-02	2.11E-01	1.00E+00	
2.8	7.67E-03	8.62E-02	1.14E-01	1.29E-03	1.45E-02	2.24E-01	9.99E-01	
2.9	8.32E-03	9.35E-02	1.18E-01	1.41E-03	1.59E-02	2.37E-01	9.96E-01	
3	8.96E-03	1.01E-01	1.22E-01	1.54E-03	1.73E-02	2.50E-01	9.92E-01	
3.1	9.61E-03	1.08E-01	1.26E-01	1.66E-03	1.87E-02	2.64E-01	9.88E-01	
3.2	1.02E-02	1.15E-01	1.29E-01	1.80E-03	2.02E-02	2.76E-01	9.83E-01	
3.3	1.09E-02	1.22E-01	1.32E-01	1.93E-03	2.17E-02	2.89E-01	9.79E-01	
3.4	1.15E-02	1.29E-01	1.36E-01	2.07E-03	2.32E-02	3.02E-01	9.75E-01	
3.5	1.21E-02	1.36E-01	1.39E-01	2.20E-03	2.48E-02	3.14E-01	9.71E-01	
3.6	1.27E-02	2.71E-01	1.42E-01	2.34E-03	5.60E-02	4.84E-01	8.09E-01	
3.7	1.33E-02	4.04E-01	1.45E-01	2.49E-03	8.76E-02	6.52E-01	6.49E-01	
3.8	1.39E-02	5.33E-01	1.48E-01	2.63E-03	1.20E-01	8.17E-01	4.92E-01	
3.9	1.45E-02	6.60E-01	1.51E-01	2.78E-03	1.52E-01	9.80E-01	3.37E-01	
4	1.50E-02	7.84E-01	1.53E-01	2.92E-03	1.85E-01	1.14E+00	1.84E-01	
4.1	1.56E-02	7.90E-01	1.56E-01	3.07E-03	1.86E-01	1.15E+00	1.80E-01	

4.2	1.61E-02	7.96E-01	1.59E-01	3.22E-03	1.88E-01	1.16E+00	1.77E-01
4.3	1.66E-02	8.02E-01	1.61E-01	3.37E-03	1.90E-01	1.17E+00	1.73E-01
4.4	1.71E-02	8.08E-01	1.64E-01	3.53E-03	1.92E-01	1.18E+00	1.70E-01
4.5	1.76E-02	8.13E-01	1.66E-01	3.68E-03	1.93E-01	1.19E+00	1.66E-01
4.6	1.81E-02	8.19E-01	1.69E-01	3.83E-03	1.95E-01	1.20E+00	1.63E-01
4.7	1.86E-02	8.24E-01	1.71E-01	3.99E-03	1.97E-01	1.21E+00	1.60E-01
4.8	1.90E-02	8.29E-01	1.73E-01	4.14E-03	1.98E-01	1.22E+00	1.57E-01
4.9	1.94E-02	8.34E-01	1.75E-01	4.30E-03	2.00E-01	1.23E+00	1.54E-01
5	1.99E-02	8.38E-01	1.78E-01	4.45E-03	2.02E-01	1.24E+00	1.51E-01
5.1	2.03E-02	8.43E-01	1.80E-01	4.61E-03	2.04E-01	1.25E+00	1.49E-01
5.2	2.07E-02	8.47E-01	1.82E-01	4.77E-03	2.05E-01	1.26E+00	1.46E-01
5.3	2.10E-02	8.52E-01	1.84E-01	4.93E-03	2.07E-01	1.27E+00	1.43E-01
5.4	2.14E-02	8.56E-01	1.86E-01	5.08E-03	2.09E-01	1.28E+00	1.41E-01
5.5	2.18E-02	8.60E-01	1.88E-01	5.24E-03	2.11E-01	1.29E+00	1.39E-01
5.6	2.21E-02	8.64E-01	1.90E-01	5.40E-03	2.13E-01	1.29E+00	1.36E-01
5.7	2.24E-02	8.67E-01	1.92E-01	5.56E-03	2.14E-01	1.30E+00	1.34E-01
5.8	2.28E-02	8.71E-01	1.94E-01	5.72E-03	2.16E-01	1.31E+00	1.32E-01
5.9	2.31E-02	8.74E-01	1.96E-01	5.87E-03	2.18E-01	1.32E+00	1.30E-01
6	2.34E-02	8.78E-01	1.98E-01	6.03E-03	2.20E-01	1.32E+00	1.28E-01

Appendix D6
Spreadsheet for AST Calculation Design Output Table

Run D2 – No Sprays Top of Stack Release - Curies in the Environment

	0.5	2	8	24	48	96	120	240	480	720
Co-58	0.00E+00	1.84E-02	2.13E-01	2.50E-01	2.51E-01	2.53E-01	2.55E-01	2.60E-01	2.80E-01	2.89E-01
Co-60	0.00E+00	1.84E-02	2.13E-01	2.49E-01	2.51E-01	2.53E-01	2.54E-01	2.60E-01	2.83E-01	2.94E-01
Kr-85	1.25E+00	2.50E+02	6.54E+03	2.65E+04	5.59E+04	1.12E+05	1.39E+05	2.63E+05	9.29E+05	1.25E+06
Kr-85m	2.38E+01	3.96E+03	6.20E+04	1.04E+05	1.08E+05	1.08E+05	1.08E+05	1.08E+05	1.08E+05	1.08E+05
Kr-87	3.98E+01	4.18E+03	2.47E+04	2.58E+04	2.58E+04	2.58E+04	2.58E+04	2.58E+04	2.58E+04	2.58E+04
Kr-88	6.29E+01	9.39E+03	1.13E+05	1.51E+05	1.52E+05	1.52E+05	1.52E+05	1.52E+05	1.52E+05	1.52E+05
Rb-86	2.04E-02	1.31E+00	9.89E+00	1.14E+01	1.14E+01	1.15E+01	1.16E+01	1.18E+01	1.24E+01	1.26E+01
Sr-89	0.00E+00	2.87E+01	3.32E+02	3.89E+02	3.91E+02	3.95E+02	3.96E+02	4.04E+02	4.35E+02	4.48E+02
Sr-90	0.00E+00	3.26E+00	3.78E+01	4.43E+01	4.45E+01	4.50E+01	4.52E+01	4.62E+01	5.03E+01	5.22E+01
Sr-91	0.00E+00	3.18E+01	3.12E+02	3.44E+02	3.44E+02	3.44E+02	3.44E+02	3.44E+02	3.44E+02	3.44E+02
Sr-92	0.00E+00	2.47E+01	1.68E+02	1.73E+02	1.73E+02	1.73E+02	1.73E+02	1.73E+02	1.73E+02	1.73E+02
Y-90	0.00E+00	6.01E-02	1.51E+00	2.21E+00	2.29E+00	2.53E+00	2.68E+00	3.52E+00	7.39E+00	9.35E+00
Y-91	0.00E+00	3.74E-01	4.47E+00	5.29E+00	5.32E+00	5.38E+00	5.41E+00	5.54E+00	6.05E+00	6.26E+00
Y-92	0.00E+00	4.05E+00	8.46E+01	9.64E+01	9.65E+01	9.65E+01	9.65E+01	9.65E+01	9.65E+01	9.65E+01
Y-93	0.00E+00	3.81E-01	3.77E+00	4.17E+00	4.18E+00	4.18E+00	4.18E+00	4.18E+00	4.18E+00	4.18E+00
Zr-95	0.00E+00	5.02E-01	5.82E+00	6.81E+00	6.85E+00	6.92E+00	6.95E+00	7.09E+00	7.65E+00	7.88E+00
Zr-97	0.00E+00	4.76E-01	5.02E+00	5.67E+00	5.67E+00	5.68E+00	5.68E+00	5.68E+00	5.68E+00	5.68E+00
Nb-95	0.00E+00	5.05E-01	5.85E+00	6.85E+00	6.89E+00	6.96E+00	6.99E+00	7.14E+00	7.77E+00	8.06E+00
Mo-99	0.00E+00	6.44E+00	7.29E+01	8.44E+01	8.47E+01	8.52E+01	8.53E+01	8.56E+01	8.61E+01	8.62E+01
Tc-99m	0.00E+00	5.74E+00	6.62E+01	7.71E+01	7.74E+01	7.78E+01	7.80E+01	7.83E+01	7.89E+01	7.89E+01
Ru-103	0.00E+00	5.27E+00	6.10E+01	7.13E+01	7.17E+01	7.24E+01	7.27E+01	7.41E+01	7.95E+01	8.17E+01
Ru-105	0.00E+00	2.69E+00	2.21E+01	2.34E+01	2.34E+01	2.34E+01	2.34E+01	2.34E+01	2.34E+01	2.34E+01
Ru-106	0.00E+00	1.92E+00	2.22E+01	2.60E+01	2.62E+01	2.64E+01	2.65E+01	2.71E+01	2.95E+01	3.06E+01
Rh-105	0.00E+00	3.29E+00	3.75E+01	4.34E+01	4.35E+01	4.36E+01	4.37E+01	4.37E+01	4.38E+01	4.38E+01
Sb-127	0.00E+00	7.11E+00	8.11E+01	9.42E+01	9.46E+01	9.51E+01	9.54E+01	9.59E+01	9.72E+01	9.73E+01
Sb-129	0.00E+00	1.67E+01	1.36E+02	1.44E+02	1.44E+02	1.44E+02	1.44E+02	1.44E+02	1.44E+02	1.44E+02
Te-127	0.00E+00	7.11E+00	8.18E+01	9.53E+01	9.57E+01	9.64E+01	9.67E+01	9.75E+01	9.99E+01	1.01E+02
Te-127m	0.00E+00	9.59E-01	1.11E+01	1.30E+01	1.31E+01	1.32E+01	1.33E+01	1.36E+01	1.47E+01	1.53E+01
Te-129	0.00E+00	1.90E+01	1.72E+02	1.86E+02	1.87E+02	1.87E+02	1.87E+02	1.88E+02	1.92E+02	1.93E+02
Te-129m	0.00E+00	4.16E+00	4.82E+01	5.64E+01	5.67E+01	5.73E+01	5.75E+01	5.86E+01	6.28E+01	6.43E+01
Te-131m	0.00E+00	1.28E+01	1.40E+02	1.61E+02	1.61E+02	1.61E+02	1.62E+02	1.62E+02	1.62E+02	1.62E+02
Te-132	0.00E+00	9.72E+01	1.10E+03	1.28E+03	1.29E+03	1.29E+03	1.30E+03	1.30E+03	1.31E+03	1.31E+03
I-131	1.24E+01	8.95E+02	7.25E+03	8.90E+03	9.81E+03	1.13E+04	1.20E+04	1.43E+04	2.34E+04	2.50E+04
I-132	1.64E+01	1.03E+03	5.87E+03	6.32E+03	6.35E+03	6.39E+03	6.41E+03	6.45E+03	6.54E+03	6.54E+03
I-133	2.53E+01	1.77E+03	1.34E+04	1.57E+04	1.64E+04	1.68E+04	1.68E+04	1.69E+04	1.69E+04	1.69E+04
I-134	2.04E+01	6.38E+02	1.50E+03	1.51E+03	1.51E+03	1.51E+03	1.51E+03	1.51E+03	1.51E+03	1.51E+03
I-135	2.33E+01	1.50E+03	9.70E+03	1.06E+04	1.07E+04	1.07E+04	1.07E+04	1.07E+04	1.07E+04	1.07E+04
Xe-133	1.91E+02	3.81E+04	9.80E+05	3.80E+06	7.51E+06	1.34E+07	1.57E+07	2.29E+07	4.73E+07	4.99E+07
Xe-135	6.99E+01	1.43E+04	3.14E+05	7.54E+05	9.04E+05	9.31E+05	9.32E+05	9.32E+05	9.32E+05	9.32E+05
Cs-134	1.82E+00	1.18E+02	8.90E+02	1.03E+03	1.03E+03	1.04E+03	1.05E+03	1.07E+03	1.15E+03	1.19E+03
Cs-136	6.20E-01	3.99E+01	3.00E+02	3.46E+02	3.48E+02	3.50E+02	3.51E+02	3.56E+02	3.73E+02	3.77E+02
Cs-137	1.29E+00	8.32E+01	6.30E+02	7.27E+02	7.31E+02	7.37E+02	7.41E+02	7.56E+02	8.17E+02	8.46E+02
Ba-139	0.00E+00	2.21E+01	1.01E+02	1.02E+02	1.02E+02	1.02E+02	1.02E+02	1.02E+02	1.02E+02	1.02E+02
Ba-140	0.00E+00	5.04E+01	5.82E+02	6.79E+02	6.82E+02	6.88E+02	6.91E+02	7.01E+02	7.36E+02	7.45E+02
La-140	0.00E+00	1.18E+00	3.32E+01	4.93E+01	5.09E+01	5.53E+01	5.77E+01	6.87E+01	1.08E+02	1.18E+02
La-141	0.00E+00	3.45E-01	2.73E+00	2.87E+00	2.87E+00	2.87E+00	2.87E+00	2.87E+00	2.87E+00	2.87E+00
La-142	0.00E+00	2.15E-01	1.06E+00	1.07E+00	1.07E+00	1.07E+00	1.07E+00	1.07E+00	1.07E+00	1.07E+00

Ce-141	0.00E+00	1.17E+00	1.35E+01	1.58E+01	1.59E+01	1.61E+01	1.61E+01	1.64E+01	1.76E+01	1.80E+01
Ce-143	0.00E+00	1.06E+00	1.17E+01	1.34E+01	1.34E+01	1.34E+01	1.34E+01	1.35E+01	1.35E+01	1.35E+01
Ce-144	0.00E+00	9.81E-01	1.14E+01	1.33E+01	1.34E+01	1.35E+01	1.36E+01	1.39E+01	1.51E+01	1.56E+01
Pr-143	0.00E+00	4.25E-01	4.96E+00	5.82E+00	5.85E+00	5.91E+00	5.94E+00	6.05E+00	6.44E+00	6.54E+00
Nd-147	0.00E+00	1.85E-01	2.14E+00	2.49E+00	2.51E+00	2.53E+00	2.54E+00	2.57E+00	2.69E+00	2.71E+00
Np-239	0.00E+00	1.31E+01	1.48E+02	1.71E+02	1.72E+02	1.72E+02	1.73E+02	1.73E+02	1.74E+02	1.74E+02
Pu-238	0.00E+00	7.23E-03	8.38E-02	9.81E-02	9.87E-02	9.96E-02	1.00E-01	1.02E-01	1.11E-01	1.16E-01
Pu-239	0.00E+00	3.18E-04	3.69E-03	4.32E-03	4.34E-03	4.39E-03	4.41E-03	4.51E-03	4.91E-03	5.10E-03
Pu-240	0.00E+00	4.46E-04	5.17E-03	6.05E-03	6.08E-03	6.15E-03	6.18E-03	6.31E-03	6.87E-03	7.14E-03
Pu-241	0.00E+00	1.15E-01	1.33E+00	1.56E+00	1.57E+00	1.58E+00	1.59E+00	1.62E+00	1.77E+00	1.84E+00
Am-241	0.00E+00	5.62E-05	6.52E-04	7.64E-04	7.68E-04	7.76E-04	7.80E-04	7.98E-04	8.75E-04	9.16E-04
Cm-242	0.00E+00	1.27E-02	1.47E-01	1.73E-01	1.73E-01	1.75E-01	1.76E-01	1.80E-01	1.95E-01	2.02E-01
Cm-244	0.00E+00	5.87E-04	6.81E-03	7.97E-03	8.01E-03	8.09E-03	8.13E-03	8.31E-03	9.05E-03	9.40E-03

Run D5 – No Sprays ESF Top of Stack Release - Curies in the Environment

	0.5	2	8	24	48	96	120	240	480	720
I-131	3.16E+00	2.57E+02	5.08E+03	1.92E+04	3.87E+04	7.27E+04	8.75E+04	1.44E+05	2.02E+05	2.24E+05
I-132	4.05E+00	2.37E+02	1.88E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03
I-133	6.47E+00	5.10E+02	9.06E+03	2.72E+04	4.13E+04	5.04E+04	5.16E+04	5.26E+04	5.26E+04	5.26E+04
I-134	5.19E+00	1.82E+02	5.57E+02	5.61E+02	5.61E+02	5.61E+02	5.61E+02	5.61E+02	5.61E+02	5.61E+02
I-135	5.95E+00	4.33E+02	6.06E+03	1.20E+04	1.33E+04	1.34E+04	1.34E+04	1.34E+04	1.34E+04	1.34E+04
Xe-133	1.60E-01	1.35E+02	7.25E+03	5.12E+04	1.51E+05	3.70E+05	4.68E+05	8.12E+05	1.07E+06	1.14E+06
Xe-135	1.78E+00	1.38E+03	5.68E+04	2.15E+05	3.10E+05	3.34E+05	3.34E+05	3.35E+05	3.35E+05	3.35E+05

TVAN CALCULATION DESIGN OUTPUT

Calculation Identifier: ND-Q0031-920075 Revision 15	Engineering Change Document EDC-51014

Calculation Title:
Control Room and Offsite Doses Due to a LOCA

F. Hennion	6/19/02	J. Metcalf	6/19/02
Preparer	Date	Verifier	Date
J. Metcalf	6/19/02		
Checker	Date	Approval	Date

This Calculation Design Output is a compilation of the design output requirements of the referenced calculation. Review of the referenced calculation for additional design output information is not required nor allowed. Any new design output or changes to design output portions of calculations shall be processed under the authority of the engineering change process.

Appendix D Design Output

The following table is the AST update of the design output of the main body of the calculation. It was obtained by requesting in RADTRAD's runs D2 and D5 the detailed output for the environment control volume. The spreadsheet used to come up with this table is shown in Appendix D6.

Runs D2 +D5 – No Sprays Top of Stack Releases - Curies Release Rates (uCi/sec)

Time Interval	0-0.5 hr	0.5-2 hr	2-8 hr	8-24 hr	24-48 hr
Seconds	1800	5400	21600	57600	86400
Total I	6.810E+04	1.357E+06	2.448E+06	7.639E+05	4.224E+05
Total NG	2.171E+05	1.320E+07	6.910E+07	6.191E+07	4.726E+07
Total I+NG	2.852E+05	1.456E+07	7.155E+07	6.267E+07	4.768E+07

Time Interval	48-96 hr	96-120 hr	120-240 hr	240-480 hr	480-720 hr
Seconds	172800	86400	432000	864000	864000
Total I	2.616E+05	1.939E+05	1.384E+05	7.738E+04	2.822E+04
Total NG	3.574E+07	2.802E+07	1.795E+07	2.923E+07	3.512E+06
Total I+NG	3.600E+07	2.821E+07	1.809E+07	2.931E+07	3.540E+06

Appendix E
Independent Review of the Alternative Source Term (AST) Application to TVA/BFN LOCA
(No Drywell Spray Credit Case)

This appendix presents check calculation results using the Polestar STARDOSE (Reference E-1) computer code to check the RADTRAD results presented in Appendix D.

STARDOSE Analysis

The Design Input Data and the Assumptions are the same as those used in Appendix D.

The STARDOSE LIBFILE1.TXT file is included as Appendix D1. This file has the following format (by column):

1. Radionuclide ID
2. Radionuclide group (Reference D-1)
3. Parent
4. Daughter
5. Ci/MW (Reference D-2, Item 1.1)
6. Decay constant, per sec (Reference E-2)
7. Thyroid DCF (rem/Ci) (Reference E-3)
8. WB DCF (rem-sec/Ci-m3) (Reference E-2 except where Reference E-3 provides updates)
9. Not used
10. Not used
11. Skin DCF (rem-sec/Ci-m3 (Reference E-2)
12. CEDE DCF (rem/Ci) (Reference E-3)
13. Ave beta energy
14. Not used
15. Not used
16. Not used
17. Not used
18. Not used

The 66 radionuclide inventories are taken from Reference D-2, Item 1.1. These 66 radionuclides include the 60 RADTRAD radionuclides minus two insignificant Cobalt nuclides plus eight additional radionuclides (mostly noble gases): Kr83m, Kr89, Xe131m, Xe133m, Xe135m, Xe137, Xe138, Ba137m.

The INPUT.DAT file is provided as Appendix E2. As previously noted, the model is the same as the corresponding RADTRAD case documented in Appendix D except for the turbine building which is completely removed from the model (Junction 11 and 12 of Figure D-1 go directly to the environment, Junction 13 is removed). Note that one STARDOSE run covers the five RADTRAD runs.

The maximum two-hour EAB dose was obtained using the 2 to 4 hour period identified in Appendix D.

Note also that the control room X/Qs used in STARDOSE do not reflect a 50% reduction allowed by SRP Section 6.4. Therefore, STARDOSE control room dose results, as shown in the output files, needs to be reduced by 50% prior to being compared with the RADTRAD control room dose results.

Results Summary and Comparison to RADTRAD Results

	RADTRAD (Appendix D)	STARDOSE (Appendix E)
CR	4.85E-1	4.76E-1
EAB	1.02E+0	9.72E-1
LPZ	1.25E+0	1.26E+0

These results show good agreement between the two computer codes. Consequently, the RADTRAD results of Appendix D are considered acceptable.

Checker's Note

As shown in Appendix C, CR and offsite dose due to activity released from the coolant is essentially negligible. Therefore, this case is not repeated.

References for Appendix E (in addition to several Appendix D references)

E-1 STARDOSE Executable file dated 3/21/97, PSAT CI09.03, Rev. 0, "STARDOSE Model Report", January 31, 1997
E-2 NUREG/CR-5106, "Manual for TACT5", Version SAIC 9/23/1987
E-3 Federal Guide 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion", 1988
E-4 TVA Calculation ND-Q0999-980016, "Parameters Used in Dose Analysis", Revision 6
E-5 BFN Unit 2 and Unit 3 Technical Specification 3.4.6

Appendix E1
STARDOSE Library File

n_isotopes		76	n_isotope_groups	11													
Kr83m	N_Gas	NONE	NONE	3.43E+03	1.04E-04	0	4.2E-06	0	0	0	0	0	0	0	0	0	0
Kr85m	N_Gas	NONE	NONE	7.33E+03	4.39E-05	0	0.03069	0	0	0.05	0	0.22	0	0	0	0	0
Kr85	N_Gas	NONE	NONE	3.60E+02	2.04E-09	0	0.00048	0	0	0.05	0	0.22	0	0	0	0	0
Kr87	N_Gas	NONE	NONE	1.45E+04	1.52E-04	0	0.14626	0	0	0.34	0	1.48	0	0	0	0	0
Kr88	N_Gas	NONE	NONE	2.01E+04	6.88E-05	0	0.3708	0	0	0.08	0	0.35	0	0	0	0	0
Kr89	N_Gas	NONE	NONE	2.52E+04	3.63E-03	0	0.303	0	0	0.35	0	1.52	0	0	0	0	0
Xe131m	N_Gas	NONE	NONE	3.54E+02	6.68E-07	0	0.00152	0	0	0.02	0	0.04	0	0	0	0	0
Xe133m	N_Gas	NONE	NONE	1.73E+03	3.49E-06	0	0.00554	0	0	0.03	0	0.13	0	0	0	0	0
Xe133	N_Gas	I133Part	NONE	5.50E+04	1.52E-06	0	0.00625	0	0	0.01	0	0.04	0	0	0	0	0
Xe135m	N_Gas	NONE	NONE	1.14E+04	7.40E-04	0	0.07756	0	0	0.02	0	0.09	0	0	0	0	0
Xe135	N_Gas	I135Part	NONE	1.97E+04	2.09E-05	0	0.0482	0	0	0.06	0	0.26	0	0	0	0	0
Xe137	N_Gas	NONE	NONE	5.02E+04	2.96E-03	0	0.0283	0	0	0.46	0	2	0	0	0	0	0
Xe138	N_Gas	NONE	NONE	4.76E+04	6.80E-04	0	0.19776	0	0	0.15	0	0.65	0	0	0	0	0
I131Org	Org_I	NONE	NONE	2.67E+04	9.96E-07	1080400	0.0559	0	0	0.03	32893	0.13	0	0	0	0	0
I132Org	Org_I	NONE	NONE	3.89E+04	8.27E-05	6438	0.355	0	0	0.11	381.1	0.48	0	0	0	0	0
I133Org	Org_I	NONE	NONE	5.53E+04	9.22E-06	179820	0.0911	0	0	0.09	5846	0.39	0	0	0	0	0
I134Org	Org_I	NONE	NONE	6.14E+04	2.23E-04	1065.6	0.411	0	0	0.14	131.35	0.61	0	0	0	0	0
I135Org	Org_I	NONE	NONE	5.25E+04	2.86E-05	31302	0.249	0	0	0.08	1228.4	0.35	0	0	0	0	0
I131Elem	Elm_I	NONE	NONE	2.67E+04	9.96E-07	1080400	0.0559	0	0	0.03	32893	0.13	0	0	0	0	0
I132Elem	Elm_I	NONE	NONE	3.89E+04	8.27E-05	6438	0.355	0	0	0.11	381.1	0.48	0	0	0	0	0
I133Elem	Elm_I	NONE	NONE	5.53E+04	9.22E-06	179820	0.0911	0	0	0.09	5846	0.39	0	0	0	0	0
I134Elem	Elm_I	NONE	NONE	6.14E+04	2.23E-04	1065.6	0.411	0	0	0.14	131.35	0.61	0	0	0	0	0
I135Elem	Elm_I	NONE	NONE	5.25E+04	2.86E-05	31302	0.249	0	0	0.08	1228.4	0.35	0	0	0	0	0
I131Part	Prt_I	Te131m	NONE	2.67E+04	9.96E-07	1080400	0.0559	0	0	0.03	32893	0.13	0	0	0	0	0
I132Part	Prt_I	Te132	NONE	3.89E+04	8.27E-05	6438	0.355	0	0	0.11	381.1	0.48	0	0	0	0	0
I133Part	Prt_I	NONE	Xe133	5.53E+04	9.22E-06	179820	0.0911	0	0	0.09	5846	0.39	0	0	0	0	0
I134Part	Prt_I	NONE	NONE	6.14E+04	2.23E-04	1065.6	0.411	0	0	0.14	131.35	0.61	0	0	0	0	0
I135Part	Prt_I	NONE	Xe135	5.25E+04	2.86E-05	31302	0.249	0	0	0.08	1228.4	0.35	0	0	0	0	0
Rb86	CsGrp	NONE	NONE	6.37E+01	4.29E-07	4921	0	0	0	0	6623	0	0	0	0	0	0
Cs134	CsGrp	NONE	NONE	5.70E+03	9.55E-09	41070	0	0	0	0	46250	0	0	0	0	0	0
Cs136	CsGrp	NONE	NONE	1.94E+03	6.16E-07	6401	0	0	0	0	7326	0	0	0	0	0	0
Cs137	CsGrp	NONE	Ba137m	4.04E+03	7.30E-10	29341	0	0	0	0	31931	0	0	0	0	0	0
Sb127	TeGrp	NONE	Te127	2.80E+03	2.07E-06	227.55	0	0	0	0	6031	0	0	0	0	0	0
Sb129	TeGrp	NONE	Te129	8.46E+03	4.42E-05	35.964	0	0	0	0	643.8	0	0	0	0	0	0

Te127m	TeGrp	NONE	NONE	3.72E+02	7.64E-08	357.42	0	0	0	0	21497	0	0	0	0	0	0
Te127	TeGrp	Sb127	NONE	2.77E+03	2.06E-05	6.808	0	0	0	0	318.2	0	0	0	0	0	0
Te129m	TeGrp	NONE	NONE	1.62E+03	2.36E-07	577.2	0	0	0	0	23939	0	0	0	0	0	0
Te129	TeGrp	Sb129	NONE	8.33E+03	1.57E-04	1.8833	0	0	0	0	77.33	0	0	0	0	0	0
Te131m	TeGrp	NONE	I131Part	5.16E+03	6.42E-06	133570	0	0	0	0	6401	0	0	0	0	0	0
Te132	TeGrp	NONE	I132Part	3.83E+04	2.51E-06	232360	0	0	0	0	9435	0	0	0	0	0	0
Ba137m	BaGrp	Cs137	NONE	3.83E+03	4.53E-03	0	0	0	0	0	0	0	0	0	0	0	0
Ba139	BaGrp	NONE	NONE	4.93E+04	1.39E-04	8.88	0	0	0	0	171.68	0	0	0	0	0	0
Ba140	BaGrp	NONE	La140	4.91E+04	6.27E-07	947.2	0	0	0	0	3737	0	0	0	0	0	0
Mo99	NMtls	NONE	Tc99m	5.09E+04	2.87E-06	56.24	0	0	0	0	3959	0	0	0	0	0	0
Tc99m	NMtls	Mo99	NONE	4.45E+04	3.18E-05	185.37	0	0	0	0	32.56	0	0	0	0	0	0
Ru103	NMtls	NONE	NONE	4.09E+04	2.03E-07	950.9	0	0	0	0	8954	0	0	0	0	0	0
Ru105	NMtls	NONE	Rh105	2.71E+04	4.22E-05	15.355	0	0	0	0	455.1	0	0	0	0	0	0
Ru106	NMtls	NONE	NONE	1.49E+04	2.20E-08	6364	0	0	0	0	477300	0	0	0	0	0	0
Rh105	NMtls	Ru105	NONE	2.56E+04	5.40E-06	10.656	0	0	0	0	954.6	0	0	0	0	0	0
Y90	LaGrp	Sr90	NONE	3.28E+03	2.99E-06	1.9129	0	0	0	0	8436	0	0	0	0	0	0
Y91	LaGrp	Sr91	NONE	3.58E+04	1.38E-07	31.45	0	0	0	0	48840	0	0	0	0	0	0
Y92	LaGrp	Sr92	NONE	3.70E+04	5.35E-05	3.885	0	0	0	0	780.7	0	0	0	0	0	0
Y93	LaGrp	NONE	NONE	4.15E+04	1.91E-05	3.4262	0	0	0	0	2153.4	0	0	0	0	0	0
Zr95	LaGrp	NONE	Nb95	4.88E+04	1.27E-07	4292	0	0	0	0	23347	0	0	0	0	0	0
Zr97	LaGrp	NONE	NONE	4.95E+04	1.13E-05	85.47	0	0	0	0	4329	0	0	0	0	0	0
Nb95	LaGrp	Zr95	NONE	4.90E+04	2.29E-07	1324.6	0	0	0	0	5809	0	0	0	0	0	0
La140	LaGrp	Ba140	NONE	5.23E+04	4.77E-06	254.19	0	0	0	0	4847	0	0	0	0	0	0
La141	LaGrp	NONE	Ce141	4.50E+04	4.94E-05	9.065	0	0	0	0	562.4	0	0	0	0	0	0
La142	LaGrp	NONE	NONE	4.40E+04	1.26E-04	18.167	0	0	0	0	203.5	0	0	0	0	0	0
Pr143	LaGrp	Ce143	NONE	4.11E+04	5.85E-07	6.2E-06	0	0	0	0	8103	0	0	0	0	0	0
Nd147	LaGrp	NONE	NONE	1.81E+04	7.10E-07	67.34	0	0	0	0	6845	0	0	0	0	0	0
Am241	LaGrp	NONE	NONE	5.45E+00	4.80E-11	5920	0	0	0	0	4.4E+08	0	0	0	0	0	0
Cm242	LaGrp	NONE	NONE	1.23E+03	4.94E-08	3481.7	0	0	0	0	1.7E+07	0	0	0	0	0	0
Cm244	LaGrp	NONE	NONE	5.70E+01	1.25E-09	3737	0	0	0	0	2.5E+08	0	0	0	0	0	0
Ce141	CeGrp	La141	NONE	4.54E+04	2.51E-07	94.35	0	0	0	0	8954	0	0	0	0	0	0
Ce143	CeGrp	NONE	Pr143	4.25E+04	6.03E-06	23.051	0	0	0	0	3389.2	0	0	0	0	0	0
Ce144	CeGrp	NONE	NONE	3.81E+04	2.77E-08	1080.4	0	0	0	0	373700	0	0	0	0	0	0
Np239	CeGrp	NONE	NONE	5.20E+05	3.44E-06	28.194	0	0	0	0	2508.6	0	0	0	0	0	0
Pu238	CeGrp	NONE	NONE	2.81E+02	2.40E-10	3559.4	0	0	0	0	3.9E+08	0	0	0	0	0	0
Pu239	CeGrp	NONE	NONE	1.23E+01	9.00E-13	3341.1	0	0	0	0	4.3E+08	0	0	0	0	0	0
Pu240	CeGrp	NONE	NONE	1.73E+01	3.30E-12	3348.5	0	0	0	0	4.3E+08	0	0	0	0	0	0
Pu241	CeGrp	NONE	NONE	4.45E+03	1.67E-09	45.88	0	0	0	0	82510000	0	0	0	0	0	0
Sr89	SrGrp	NONE	NONE	2.79E+04	1.59E-07	1539.2	0	0	0	0	6512	0	0	0	0	0	0

Sr90	SrGrp	NONE	Y90	3.17E+03	8.00E-10	9768	0	0	0	0	239390	0	0	0	0	0	0
Sr91	SrGrp	NONE	Y91	3.49E+04	2.01E-05	150.96	0	0	0	0	932.4	0	0	0	0	0	0
Sr92	SrGrp	NONE	Y92	3.68E+04	7.29E-05	81.03	0	0	0	0	629	0	0	0	0	0	0

Appendix E2
STARDOSE Main Input File

```
edit_time
0     2.0333      2     4     8     24    96    720
end_edit_time

participating_isotopes
Kr83m   Kr85m   Kr85    Kr87    Kr88    Kr89
Xe131m  Xe133m  Xe133   Xe135m  Xe135   Xe137   Xe138
I131Org I131Elem        I131Part
I132Org I132Elem        I132Part
I133Org I133Elem        I133Part
I134Org I134Elem        I134Part
I135Org I135Elem        I135Part
Rb86    Cs134   Cs136   Cs137
Sb127   Sb129   Te127m  Te127   Te129m  Te129   Te131m  Te132
Ba137m  Ba139   Ba140
Mo99    Tc99m   Ru103   Ru105   Ru106   Rh105
Y90     Y91     Y92     Y93     Zr95    Zr97    Nb95
La140   La141   La142   Pr143   Nd147   Am241   Cm242   Cm244
Ce141   Ce143   Ce144   Np239   Pu238   Pu239   Pu240   Pu241
Sr89    Sr90    Sr91    Sr92
end_participating_isotopes

core
thermal_power                 4031
elemental_iodine_frac         0.0485
organic_iodine_frac           0.0015
particulate_iodine_frac       0.95
release_frac
to_control_volume DW
Time   N_Gas  I_Grp  CsGrp  TeGrp  BaGrp  NMtls  CeGrp  LaGrp  SrGrp
0.0333      0      0      0      0      0      0      0      0      0
0.5333      0.1    0.1    0.1    0      0      0      0      0      0
2.0333      0.63   0.166  0.133  0.033  0.013  0.0017        0.00033      0.00013      0.013
720    0     0      0      0      0      0      0      0      0
end_to_control_volume
to_control_volume SP
Time   N_Gas  I_Grp  CsGrp  TeGrp  BaGrp  NMtls  CeGrp  LaGrp  SrGrp
0.0333      0      0      0      0      0      0      0      0      0
0.5333      0      0.2    0      0      0      0      0      0      0
2.0333      0      0.332  0      0      0      0      0      0      0
720    0     0      0      0      0      0      0      0      0
end_to_control_volume
end_release_frac
end_core

control_volume
obj_type                      OBJ_CV
name                          DW
air_volume                    1.59e+005
water_volume                  0
surface_area                  1
has_recirc_filter             false
removal_rate_to_surface
Time   NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
0.033       0      0      0      0      0      0
0.533       0      0.75   0      0.75   0.75   0.75
2.033       0      0.37   0      0.37   0.37   0.37
```

```
5.033         0     1.06  0     1.06  1.06  1.06
8.367         0     0.64  0     0.64  0.64  0.64
12.033        0     0.56  0     0.56  0.56  0.56
19.478        0     0.53  0     0.53  0.53  0.53
24.033        0     0.51  0     0.51  0.51  0.51
720           0     0     0     0     0     0
end_removal_rate_to_surface
frac_4_daughter_resusp_from_surface
Time  NobleGas    ElemIodine  OrgIodine    PartIodine  Solubles    Insolubles
720   0     0     0     0     0     0
end_frac_4_daughter_resusp_from_surface
end_control_volume

control_volume
obj_type                      OBJ_CV
name                          WW
air_volume                    1.194e+005
water_volume                  1.215e+005
surface_area                  0
has_recirc_filter             false
end_control_volume

control_volume
obj_type                      OBJ_CV
name                          RB
air_volume                    1.932e+006
water_volume                  0
surface_area                  0
has_recirc_filter             false
end_control_volume

control_volume
obj_type                      OBJ_CV
name                          SR
air_volume                    3.456e+004
water_volume                  0
surface_area                  0
has_recirc_filter             false
end_control_volume

control_volume
obj_type                      OBJ_CV
name                          MC
air_volume                    1.224e+005
water_volume                  0
surface_area                  0
has_recirc_filter             false
end_control_volume

control_volume
obj_type                      OBJ_CV
name                          SP
air_volume                    1.215e+005
water_volume                  0
surface_area                  0
has_recirc_filter             false
end_control_volume

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
```

```
upstream                      CORE
downstream                    DW
has_filter                    false
flow_rate
Time  (hr)  Value (cfm)
720         1
end_flow_rate
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      CORE
downstream                    SP
has_filter                    false
flow_rate
Time  (hr)  Value (cfm)
720         1
end_flow_rate
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      DW
downstream                    WW
has_filter                    false
flow_rate
Time  (hr)  Value (cfm)
2.034       0
720         119400
end_flow_rate
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      DW
downstream                    MC
has_filter                    true
flow_rate
Time  (hr)  Value (cfm)
720         1.3
end_flow_rate
filter_efficiency
Time  NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720   0     0.9901      0     0.9987      0.9987      0.9987
end_filter_efficiency
frac_4_daughter_resusp
Time  NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720   0     0     0     0     0     0
end_frac_4_daughter_resusp
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      RB
downstream                    SR
has_filter                    true
flow_rate
```

```
Time   (hr)  Value (cfm)
720          10
end_flow_rate
filter_efficiency
Time  NobleGas     ElemIodine  OrgIodine    PartIodine  Solubles    Insolubles
720   0      0     0     0.9   0.9    0.9
end_filter_efficiency
frac_4_daughter_resusp
Time  NobleGas     ElemIodine  OrgIodine    PartIodine  Solubles    Insolubles
720   1      1     0     0     0      0
end_frac_4_daughter_resusp
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      MC
downstream                    environment
has_filter                    false
flow_rate
Time   (hr)  Value (cfm)
720          3.97
end_flow_rate
X_over_Q_4_ctrl_room
Time   (hr)  Value (s/m*3)
2      0.000217
8      0.000164
24     0.0000789
96     0.0000433
720    0.0000335
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time   (hr)  Value (s/m*3)
2      0
4      0.000262
24     0
96     0
720    0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time   (hr)  Value (s/m*3)
2      0.000131
8      0.0000661
24     0.0000469
96     0.0000223
720    0.00000796
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      DW
downstream                    environment
has_filter                    true
flow_rate
Time   (hr)  Value (cfm)
720          0.0065
end_flow_rate
filter_efficiency
Time  NobleGas     ElemIodine  OrgIodine    PartIodine  Solubles    Insolubles
```

```
720   0      0.1637      0      0.8933      0.8933      0.8933
end_filter_efficiency
frac_4_daughter_resusp
Time  NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720   0     0     0     0     0     0
end_frac_4_daughter_resusp
X_over_Q_4_ctrl_room
Time  (hr)  Value (s/m*3)
2     0.000217
8     0.000164
24    0.0000789
96    0.0000433
720   0.0000335
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time  (hr)  Value (s/m*3)
2     0
4     0.000262
24    0
96    0
720   0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time  (hr)  Value (s/m*3)
2     0.000131
8     0.0000661
24    0.0000469
96    0.0000223
720   0.00000796
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      WW
downstream                    SR
has_filter                    true
flow_rate
Time  (hr)  Value (cfm)
240         0
264         0.0562
480         0
504         0.0562
696         0
720         0.0562
end_flow_rate
filter_efficiency
Time  NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720   0     0     0     0.9   0.9   0.9
end_filter_efficiency
frac_4_daughter_resusp
Time  NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720   0     0     0     0     0     0
end_frac_4_daughter_resusp
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      WW
```

```
downstream                     RB
has_filter                     false
flow_rate
Time  (hr)  Value (cfm)
720         1.66
end_flow_rate
end_junction

junction
junction_type                  AIR_JUNCTION
downstream_location            AIR_SPACE
upstream                       DW
downstream                     RB
has_filter                     false
flow_rate
Time  (hr)  Value (cfm)
720         2.21
end_flow_rate
end_junction

junction
junction_type                  AIR_JUNCTION
downstream_location            AIR_SPACE
upstream                       SP
downstream                     RB
has_filter                     true
flow_rate
Time  (hr)  Value (cfm)
720         0.668
end_flow_rate
filter_efficiency
Time  NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720   0.5   0     0     0.999 0     0
end_filter_efficiency
frac_4_daughter_resusp
Time  NobleGas    ElemIodine  OrgIodine   PartIodine  Solubles    Insolubles
720   0     0     0     0     0     0
end_frac_4_daughter_resusp
end_junction

junction
junction_type                  AIR_JUNCTION
downstream_location            AIR_SPACE
upstream                       WW
downstream                     environment
has_filter                     false
flow_rate
Time  (hr)  Value (cfm)
8           0
720         0.167
end_flow_rate
X_over_Q_4_ctrl_room
Time  (hr)  Value (s/m*3)
2     1.41e-007
3.5   4.50e-008
4     3.40e-005
8     4.50e-008
24    2.54e-008
96    7.36e-009
720   1.24e-009
end_X_over_Q_4_ctrl_room
```

```
X_over_Q_4_site_boundary
Time   (hr)   Value (s/m*3)
2      0
3.5    1.19e-006
4      2.35e-005
24     0
96     0
720    0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time   (hr)   Value (s/m*3)
2      1.13e-006
3.5    5.75e-007
4      1.26e-005
8      5.75e-007
24     4.10e-007
96     1.97e-007
720    6.88e-008
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      WW
downstream                    environment
has_filter                    true
flow_rate
Time   (hr)   Value (cfm)
240           0
264           139
480           0
504           139
696           0
720           139
end_flow_rate
filter_efficiency
Time   NobleGas     ElemIodine   OrgIodine    PartIodine   Solubles    Insolubles
720    0      0      0      0.9    0.9    0.9
end_filter_efficiency
frac_4_daughter_resusp
Time   NobleGas     ElemIodine   OrgIodine    PartIodine   Solubles    Insolubles
720    0      0      0      0      0      0
end_frac_4_daughter_resusp
X_over_Q_4_ctrl_room
Time   (hr)   Value (s/m*3)
2      1.41e-007
3.5    4.50e-008
4      3.40e-005
8      4.50e-008
24     2.54e-008
96     7.36e-009
720    1.24e-009
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time   (hr)   Value (s/m*3)
2      0
3.5    1.19e-006
4      2.35e-005
24     0
96     0
```

```
720     0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time    (hr)   Value (s/m*3)
2       1.13e-006
3.5     5.75e-007
4       1.26e-005
8       5.75e-007
24      4.10e-007
96      1.97e-007
720     6.88e-008
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      SR
downstream                    environment
has_filter                    false
flow_rate
Time    (hr)   Value (cfm)
720            10
end_flow_rate
X_over_Q_4_ctrl_room
Time    (hr)   Value (s/m*3)
2       0.0002
8       0.000128
24      0.0000572
96      0.0000405
720     0.0000309
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time    (hr)   Value (s/m*3)
2       0
4       0.000262
8       0
24      0
96      0
720     0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time    (hr)   Value (s/m*3)
2       0.000131
8       0.0000661
24      0.0000469
96      0.0000223
720     0.00000796
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      RB
downstream                    environment
has_filter                    true
flow_rate
Time    (hr)   Value (cfm)
720            2.474e+004
end_flow_rate
```

```
filter_efficiency
Time  NobleGas    ElemIodine   OrgIodine    PartIodine  Solubles    Insolubles
720   0     0     0     0.9    0.9    0.9
end_filter_efficiency
frac_4_daughter_resusp
Time  NobleGas    ElemIodine   OrgIodine    PartIodine  Solubles    Insolubles
720   0     0     0     0      0      0
end_frac_4_daughter_resusp
X_over_Q_4_ctrl_room
Time  (hr)  Value (s/m*3)
2     1.41e-007
3.5   4.50e-008
4     3.40e-005
8     4.50e-008
24    2.54e-008
96    7.36e-009
720   1.24e-009
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time  (hr)  Value (s/m*3)
2     0
3.5   1.19e-006
4     2.35e-005
24    0
96    0
720   0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time  (hr)  Value (s/m*3)
2     1.13e-006
3.5   5.75e-007
4     1.26e-005
8     5.75e-007
24    4.10e-007
96    1.97e-007
720   6.88e-008
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type                 AIR_JUNCTION
downstream_location           AIR_SPACE
upstream                      WW
downstream                    DW
has_filter                    false
flow_rate
Time   (hr)  Value (cfm)
2.035        0
720          119400
end_flow_rate
end_junction

environment
breathing_rate_sb
Time   (hr)  Value (cfm)
8      0.00035
24     0.00018
720    0.00023
end_breathing_rate_sb
breathing_rate_lpz
Time   (hr)  Value (frac)
```

```
8      0.00035
24     0.00018
720    0.00023
end_breathing_rate_lpz
end_environment

control_volume
obj_type                       OBJ_CR
name                           Control_Room
air_volume                     2.1e+005
water_volume                   0
surface_area                   0
has_recirc_filter              false
breathing_rate
Time  (hr)  Value (cfm)
720         0.00035
end_breathing_rate
occupancy_factor
Time  (hr)  Value (frac)
24          1
96          0.6
720         0.4
end_occupancy_factor
end_control_volume

junction
junction_type                  AIR_JUNCTION
downstream_location            AIR_SPACE
upstream                       Control_Room
downstream                     environment
has_filter                     false
flow_rate
Time  (hr)  Value (cfm)
720         6717
end_flow_rate
end_junction

junction
junction_type                  AIR_JUNCTION
downstream_location            AIR_SPACE
upstream                       environment
downstream                     Control_Room
has_filter                     true
flow_rate
Time  (hr)  Value (cfm)
720         3000
end_flow_rate
filter_efficiency
Time  NobleGas     ElemIodine  OrgIodine    PartIodine  Solubles    Insolubles
0.167 0      0      0      0      0      0
720   0      0      0      0.9    0.9    0.9
end_filter_efficiency
frac_4_daughter_resusp
Time  NobleGas     ElemIodine  OrgIodine    PartIodine  Solubles    Insolubles
720   0      0      0      0      0      0
end_frac_4_daughter_resusp
end_junction

junction
junction_type                  AIR_JUNCTION
downstream_location            AIR_SPACE
```

```
upstream          environment
downstream        Control_Room
has_filter        false
flow_rate
Time  (hr)  Value (cfm)
720         3717
end_flow_rate
end_junction
```

Appendix E3
STARDOSE Result File (Excerpts)

```
edit time 720.000000

Control_Room

               thyroid    wbody      skin       CEDE
Total dose:    2.52E+001  2.99E-002  6.79E-001  9.22E-001
Noble gas      0.00E+000  2.84E-002  6.65E-001  0.00E+000
Org iodine     5.40E+000  9.79E-005  9.89E-004  1.65E-001
Elem iodine    1.35E+001  9.92E-004  9.06E-003  4.21E-001
Part iodine    5.96E+000  4.70E-004  4.24E-003  1.86E-001
Cesium         5.01E-002  0.00E+000  0.00E+000  5.59E-002
Tellurium      2.55E-001  0.00E+000  0.00E+000  1.24E-002
Barium         5.08E-004  0.00E+000  0.00E+000  2.01E-003
Noble metal    2.06E-004  0.00E+000  0.00E+000  1.12E-002
Lanthanides    3.66E-005  0.00E+000  0.00E+000  8.21E-003
Cerium         1.74E-005  0.00E+000  0.00E+000  4.93E-002
Strontinum     8.71E-004  0.00E+000  0.00E+000  1.08E-002

environment

              thyroid    wbody      skin       CEDE
EAB dose:     1.81E+001  2.34E-001  1.56E-001  7.38E-001
LPZ dose:     2.35E+001  4.11E-001  5.22E-001  8.50E-001

STARDOSE 1.0 (c) 1996 Polestar Applied Technology, Inc.
11:55:46 AM June 06, 2002
Total elapsed hours: 00, mins: 06, secs: 39
```

Appendix F

Regulatory Guide 1.3 LOCA Control Room Doses Due to Alternate CREVS Flows

Purpose/Introduction

On December 12, 2002, BFN entered T/S LCO 3.7.3 7 day LCO due to low CREVS flow. This has been documented in BFN PER 02-15729. This appendix performs the same calculations for the control room as performed in the main body of this calculation except with flow rates that are reflective of the flows seen on 12/2/2002.

Design Input

CREVS Makeup flow: 1500 cfm or 2500 cfm (assumed)
CREVS unfiltered inflow: 2000 cfm (ref. MD-Q0031-920154 R1 gives 1489 cfm, 2000 cfm is round up for conservatism)

all other parameters same as in main body of text.

Calculations

The COROD runs from the main body of the text are modified by changing the CREVS makeup flow (either 1500 or 2500 cfm) and unfiltered inflow (2000 cfm). The COROD code has been enhanced since the original runs, so that the thyroid ICRP-30 doses are now calculated directly (i.e. no modification to change ICRP-2 to ICRP-30 conversion factors needed). The results (in rem) are presented below. The control room results are divided by 2 to account for the dual intakes (see assumption #4 in main text). Note that fumigation is included in the top of stack contribution for the control room. The control room doses due to MSIV leakage as determined by GE were based on 3000 cfm. To scale the GE results for 1500 cfm and 2500 cfm CREVS flow, the following scaling factor is applied: (GE MSIV dose)*(x cfmbase dose+ x cfmtop dose)/(3000 cfmbase dose+3000 cfmtop dose) where "x' variable is either 1500 or 2500 cfm. The total gamma dose includes 0.667 rem (ref.16) due to shine from secondary containment (this 0.667 rem is not divided by two).

Results

case=2500 cfm makeup flow, 2000 unfiltered

CR U1	base	top	MSIV	Total	Total/2
Gamma	9.74E-04	6.67E-03	2.02E-02	6.95E-01	6.81E-01
Beta	7.81E-03	6.97E-02	2.02E-01	2.80E-01	1.40E-01
Thyroid (ICRP-30)	5.11E-01	1.59E+00	4.00E+01	4.21E+01	2.11E+01

CR U3	base	top	MSIV	Total	Total/2
Gamma	4.82E-04	8.80E-03	2.04E-02	6.97E-01	6.82E-01
Beta	3.86E-03	8.63E-02	2.05E-01	2.95E-01	1.48E-01
Thyroid (ICRP-30)	2.53E-01	2.74E+00	4.06E+01	4.36E+01	2.18E+01

case=1500 cfm makeup flow, 2000 unfiltered

CR U1	base	top	MSIV	Total	Total/2
Gamma	9.74E-04	6.45E-03	1.96E-02	6.94E-01	6.81E-01
Beta	7.81E-03	6.63E-02	1.94E-01	2.68E-01	1.34E-01
Thyroid (ICRP-30)	6.27E-01	1.94E+00	4.90E+01	5.16E+01	2.58E+01

CR U3	base	top	MSIV	Total	Total/2
Gamma	4.82E-04	8.58E-03	1.99E-02	6.96E-01	6.81E-01
Beta	3.86E-03	8.31E-02	1.98E-01	2.85E-01	1.42E-01
Thyroid (ICRP-30)	3.10E-01	3.36E+00	4.97E+01	5.33E+01	2.67E+01

Discussion/Conclusion

This calculation determined that for reduced CREVS flow (1500 cfm or 2500 cfm) and reduced unfiltered inleakage (2000 cfm) the control room dose limits (5 rem gamma, 30 rem beta, 30 rem thyroid) are not exceeded. Based on the main text, the control room doses will be acceptable for reduced inflow only if the unfiltered inleakage is also reduced.

Appendix G
Sensitivity Study for Control Room Filtered Make-Up Using the AST

This appendix presents a sensitivity study to evaluate the variation of control room AST TEDE dose with variations in the filtered make-up rate to the control room. This is done simply by slightly modifying the RADTRAD .psf files (Appendix D1, Cases D1, D2, D3, D4, and D5) as described below. For each case's .psf file in Appendix D1, the entries which are changed are shown in **bold** (added by Revision 17). Cases D2' and D5' (the fumigation cases) are included in the AST analysis only to determine the worst fumigation period (activity release from stack). This fumigation period determination is not affected by the control room filtered make-up assumptions since it is a question only of the time-varying magnitude of the release.

There are four entries per .psf file that are affected. These are:
- t = 0.0, 6717 cfm make-up + unfiltered inleakage
- t = 0.167 hours, 6717 cfm make-up + unfiltered inleakage
- t = 0.167 hours, 40.2% effective particulate filtration efficiency
- t = 0.0 hours, 6717 cfm control room total outleakage

The values being substituted for these four values are as follows:
- Sensitivity Cases D1a, D2a, D3a, D4a, and D5a: 7017 cfm, 7017 cfm, 42.3%, 7017 cfm
- Sensitivity Cases D1b, D2b, D3b, D4b, and D5b: 6417 cfm, 6417 cfm, 37.9%, 6417 cfm
- Sensitivity Cases D1c, D2c, D3c, D4c, and D5c: 5217 cfm, 5217 cfm, 25.9%, 5217 cfm

The effective particulate filtration efficiency is determined by multiplying the filtered make-up by the quantity [1-(filter efficiency for particulate)]; i.e., 0.1, and then adding the unfiltered inleakage (3717 cfm). This value is then divided by the sum of the filtered make-up flow and the unfiltered inleakage flow; i.e., 6717 cfm for the base case. Finally, the resultant value is subtracted from 1.0 to obtain the effective filter efficiency.

For the base case example, the effective filter efficiency is 1-[(0.1x3000)+3717]/6717 = 40.2%.

With the input changes as described above, the doses from the RADTRAD runs are as follows:

Case	Make-Up Flow Rate (cfm)	Control Room TEDE (RADTRAD)
D1	3000	0.01
D1a	3300	0.01
D1b	2700	0.01
D1c	1500	0.01
D2	3000	0.49
D2a	3300	0.47
D2b	2700	0.50

D2c	1500	0.56
D3	3000	0.23
D3a	3300	0.23
D3b	2700	0.23
D3c	1500	0.24
D4	3000	0.02
D4a	3300	0.02
D4b	2700	0.02
D4c	1500	0.02
D5	3000	0.22
D5a	3300	0.22
D5b	2700	0.22
D5c	1500	0.22
Base total	3000	0.97
Case a total	3300	0.95
Case b total	2700	0.98
Case c total	1500	1.05

As can be seen, the RADTRAD dose increases with decreasing filtered make-up, but the dose increase is considered insignificant. This is particularly the case because the above control room TEDE doses (taken directly from the RADTRAD runs) do not include the permissible factor of two reduction for the control room (refer to Appendix D), nor do they reflect the 0.76 rem control room dose contribution from shine. When these corrections are applied, the results are as follows:

Case	Make-Up Flow Rate (cfm)	Control Room TEDE (total)
Base total	3000	1.25
Case a total	3300	1.24
Case b total	2700	1.25
Case c total	1500	1.29

These case-to-case differences are considered even less significant. For all of these cases, the unfiltered inleakage remains constant at 3717 cfm. The increase in dose with decreasing filtered make-up is the result of a decreasing ratio of filtered flow to total flow into the control room.

Appendix H
Applicability of AST Offsite and Control Room Doses to Unit 1

This appendix addresses two areas of difference that have been identified between this DBA-LOCA analysis as it applies to Units 2 and 3 (see Appendix D) and how it would apply to Unit 1. These are as follows:

- A reduced free volume of the Secondary Containment for Unit 1 and
- Increased Turbine Building Exhaust X/Q for Unit 1.

Approach

The first of these differences has two potential impacts. First, it will reduce the residence time in the secondary containment which will tend to increase the releases to the environment and, therefore, both the offsite and control room doses. However, for the control room, there is a second impact, and that will be a substantial decrease in the shine source for external radiation from the reactor building (secondary containment). The shine dose, calculated in Reference H-1 (strictly applicable only to Units 2 and 3), can be adjusted for Unit 1 to account for this effect. That is done in the first section below.

For Unit 1, the more rapid release of activity from the reactor building via the plant stack (even accounting for a one-half hour of fumigation conditions) actually reduces the control room dose relative to that for Units 2 and 3. It will be shown in this appendix that there is sufficient reduction in the Unit 1 control room shine dose (arising from activity trapped within the reactor building) to more than offset the control room dose increase resulting from both decreased residence time in the reactor building and the potential increase associated with possible increases in the Turbine Building X/Qs. It will also be shown that the increases in offsite dose for Unit 1 are nearly negligible given the margin to the 25 rem TEDE limit for DBA-LOCA offsite doses.

Assessment of the Impact of Reduced Reactor Building/Secondary Containment Residence Time

The following is the Design Input to this part of the assessment:

- Reactor Building Volume Units 2/3 – 1.932E6 ft^3 (Item 3.4 of Reference H-2)
- Shine Dose for Units 2/3 – 0.762 rem (Reference H-1)
- Reactor Building Volume Unit 1 – 1.311E6 ft^3 (Item 3.4 of Reference H-2)
- SGTS Exhaust Rate – 24750 cfm (Item 12.13 of Reference H-2)

Reactor Building Shine Impact on Control Room Dose

The fractional exhaust rate of the Unit 2/3 secondary containment volume is 24750 cfm/1.932E6 ft^3 = 0.013 per minute or 0.77 per hour. The "time constant" for equilibration of a system to changes in inputs and/or outputs is usually taken to be three inverse fractional exchange rates or, in this case, 3/0.77 per hour = 3.9 hours. Since the 3.9 hours is short relative to the duration of the dose analysis, and the 0.77 per hour exhaust rate is comparable to the rates of change of activity in the primary containment (the source of leakage into the secondary containment for which activity in particulate form is added and/or removed at fractional rates of between 0.37 and 1.06 per hour – see Appendix D), one can treat the secondary containment as if equilibrium is reached.

For a system involving a source rate, S, and a fractional removal rate, λ, the equilibrium value of that system is S/λ. Since the exhaust rate is the same for both the Unit 1 secondary containment and the Unit 2/3 secondary containments, and since the Unit 1 secondary containment volume is only 68% that of Unit 2/3 secondary containment volume, the Unit 1 secondary containment lambda is 1.47 times greater; and the S/λ equilibrium value is, once again, 68% that of Units 2/3. This means that the source for the control room shine and the control room shine dose are also reduced by 32% for Unit 1; i.e., to 68% of their Unit 2/3 values. Note that since the parts of the Unit 1 and Unit 2 reactor buildings adjacent to the control rooms and the control rooms, themselves, are essentially symmetrical about column line T6, one would expect not expect geometrical differences in the shine dose calculation. Note also, that the activity concentration would be the same in both volumes when equilibrium is reached, but gamma radiation (because of its range) is better characterized by total source strength than by source concentration.

From Reference H-1, it is known that the shine dose contribution from activity within the reactor building is approximately 75% of the total shine dose; i.e., 75% of 0.762 rem or approximately 0.57 rem. Reducing this value by 32% gives a total shine dose of 0.68 x 0.57 rem + 0.25 x 0.762 rem = 0.58 rem. By using the 0.762 rem value for Unit 1, one would then be introducing approximately 0.18 rem of conservatism in the Unit 1 control room dose calculation compared to that for Units 2/3.

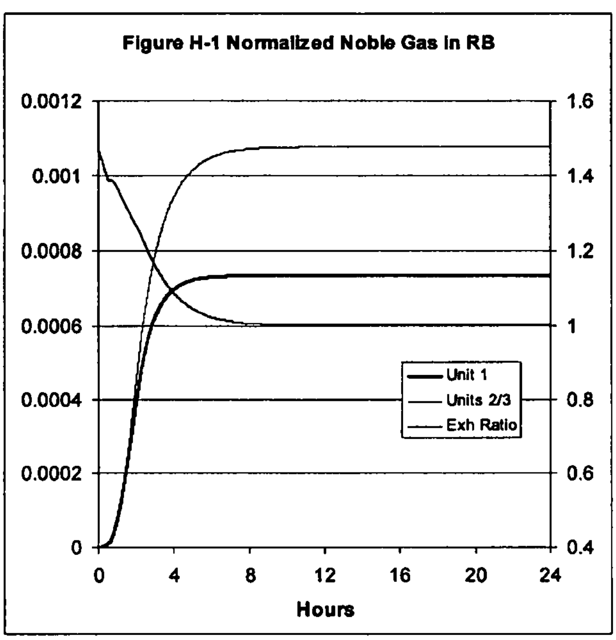
Impact on Control Room and Offsite Doses from Reduced RB Residence Time

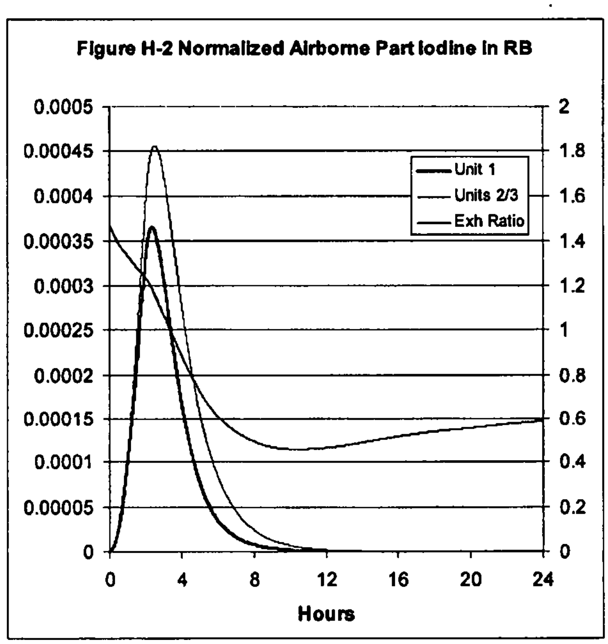
In order to determine the degree to which the doses are *increased* by the change in the reactor building volume for Unit 1, one must slightly modify the RADTRAD .psf files involving release via the reactor building (Appendix D1, Cases D1, D2, D4, and D5) to address the change in reactor building volume from 1.932E6 ft^3 to 1.311E6 ft^3. Normally, it would also be necessary to rerun D2' and D5' to identify the worst fumigation period, but that can more readily be done by creating a spreadsheet to investigate the airborne activity in the reactor building since such a spreadsheet is useful for other reasons.

Two such spreadsheets were created: one for noble gas (no removal inside the primary containment) and one for particulate iodine (also applicable to elemental iodine with removal inside the primary containment). Organic iodine inside the primary containment would behave like noble gas and other particulates would behave like particulate iodine.

The spreadsheets consist first of a term to introduce activity into the primary containment. Each spreadsheet is normalized to unity where unity is the total release of either noble gas or particulate/elemental iodine. Therefore, the noble gas release rate is 0.1 per hour for the first ½ hour and 0.63 per hour for the next 1.5 hours. The particulate iodine release rate is 0.33 per hour for the first ½ hour and 0.56 per hour for the next 1.5 hours. (These rates give total releases of 1.0 and 0.3, respectively; the appropriate fractional release for each of the two groups). Then, the normalized amount airborne in the primary containment is tracked, using zero removal for noble gas and the "no-spray" removal rates from Appendix D for particulate/elemental iodine.

A fractional release of the normalized primary containment airborne activity is then added to the secondary containment at a rate of 0.02 per day (8.3E-4 per hour). From the secondary containment, it is removed at a rate of 0.77 per hour for Units 2/3 and 1.13 per hour for Unit 1. The results (in terms of normalized airborne activity in the reactor building) are as follows:





The "Exh Ratio" (read on the right hand axis) is the ratio of the normalized activity release from the RB for Unit 1 divided by that for Units 2/3. The other two curves are the Unit 1 normalized airborne activity (bold) and Unit 2/3 normalized airborne activity (fine).

In all cases, the normalized activity reaches a level of about 0.00045 by two hours. Beyond that point, all four cases diverge. For the noble gas (without removal in the primary containment) equilibration occurs about four hours after the end of release (as expected, given the equilibration "time constant" discussed above), with the Unit 1 normalized value about 68% of that of Units 2/3. At this point, the exhaust ratio becomes essentially one; i.e., the activity being released per unit time from both secondary containments is the same and equal to the source rate.

From 0 – 0.5 hours, the noble gas release rate for Unit 1 is, on average, about 1.4 times that of Units 2/3. From 0.5 – 2 hours, it is about 1.3 times that of Units 2/3. From 2 – 8 hours, it is about 1.1 times that of Units 2/3. Beyond 8 hours, it is essentially the same. These ratios would also apply to the organic iodine release rates, as well.

For the particulate iodine, the normalized activity reaches a peak at about 2.7 hours for Units 2/3 and at about 2.5 hours for Unit 1. From 0 – 0.5 hours, the particulate iodine release rate for Unit 1 is, on average, about 1.4 times that of Units 2/3 (same as for noble gasses and organic iodine). From 0.5 – 2 hours, it is about 1.3 times that of Units 2/3 (once again, the same as for noble gasses and organic iodine). From 2 – 8 hours, it is about 0.8 times that of Units 2/3. Beyond 8 hours, the ratio of the two rates becomes no longer important because the normalized airborne particulate iodine in the RB becomes essentially zero.

Note that for Units 2/3, the maximum EAB dose is found to occur between 2 and 4 hours, an interval which brackets the peak normalized particulate iodine activity in the RB. The maximum impact of fumigation is seen between 3.5 and 4 hours; later than the moment of peak normalized particulate iodine activity in the RB, but just before the maximum normalized activity for the noble gasses (and organic iodine) is reached. (Note also, that the iodine released by ESF leakage would be expected to reach its maximum at roughly the same time as the noble gasses, since it is essentially a constant source like the noble gasses leaking from the primary containment). Because the particulate release peaks at about 2.7 hours and the noble gas, organic iodine, and iodine from ESF leakage reach an equilibrium in the reactor building about three hours later, it makes sense that the peak EAB dose occurs between 2 and 4 hours for Units 2/3 and that the largest impact of the fumigation effect is seen between 3.5 and 4 hours.

Because the peak normalized particulate iodine activity occurs for Unit 1 about 0.2 hours before Units 2/3, the 2-hour time frame for maximum EAB dose and the ½-hour time frame for fumigation have both been moved forward by 0.2 hours in the RADTRAD analyses supporting Unit 1.

In order to run the four RADTRAD cases necessary to assess the dose impact of these changes on Unit 1, the following changes were made to the .psf files Cases D1, D2, D4, and D5 (Appendix D1). First, the size of the RB (Compartment 2 in the RADTRAD input) is changed from:

```
Compartment 2:
 RB
   3
   1.9320E+06
   0
   0
   0
   0
   0
```

To:

```
Compartment 2:
 RB
   3
   1.3110E+06
   0
   0
```

```
0
0
0
```

Then, for Cases D1 and D4 (ground-level releases from the RB via the Stack Room) the EAB X/Qs are changed from:

```
Location 2:
 EAB
   9
   1
   2
   0.0000E+00   2.6200E-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
```

To:

```
Location 2:
 EAB
   9
   1
   4
   0.0000E+00   0.0000E+00
   1.8000E+00   2.6200E-04
   3.8000E+00   0.0000E+00
   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
```

And, for Cases D2 and D5 (stack releases from the RB) the X/Qs are changed from:

```
Location 2:
 EAB
   9
   1
   4
   0.0000E+00   1.1900E-06
   3.5000E+00   2.3500E-05
   4.0000E+00   1.1900E-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:
 LPZ
   9
   1
   8
   0.0000E+00   1.1300E-06
   2.0000E+00   5.7500E-07
   3.5000E+00   1.2600E-05
   4.0000E+00   5.7500E-07
   8.0000E+00   4.1000E-07
```

```
  2.4000E+01   1.9700E-07
  9.6000E+01   6.8800E-08
  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
 Effective Volume Location:
  1
  8
  0.0000E+00   1.4100E-07
  2.0000E+00   4.5000E-08
  3.5000E+00   3.4000E-05
  4.0000E+00   4.5000E-08
  8.0000E+00   2.5400E-08
  2.4000E+01   7.3600E-09
  9.6000E+01   1.2400E-09
  7.2000E+02   0.0000E+00
```

To:

```
Location 2:
 EAB
  9
  1
  5
  0.0000E+00   0.0000E+00
  1.8000E+00   1.1900E-06
  3.3000E+00   2.3500E-05
  3.8000E+00   0.0000E+00
  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:
 LPZ
  9
  1
  8
  0.0000E+00   1.1300E-06
  2.0000E+00   5.7500E-07
  3.3000E+00   1.2600E-05
  3.8000E+00   5.7500E-07
  8.0000E+00   4.1000E-07
  2.4000E+01   1.9700E-07
  9.6000E+01   6.8800E-08
  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
 Effective Volume Location:
  1
  8
  0.0000E+00   1.4100E-07
  2.0000E+00   4.5000E-08
  3.3000E+00   3.4000E-05
  3.8000E+00   4.5000E-08
  8.0000E+00   2.5400E-08
  2.4000E+01   7.3600E-09
```

```
9.6000E+01   1.2400E-09
7.2000E+02   0.0000E+00
```

When these cases are run, it is found that the EAB dose for Unit 1 increases over that for Units 2/3 by just under ten percent, while the LPZ dose for Unit 1 increases over that for Units 2/3 by just under five percent. A comparison of the Unit 1 and Unit 2/3 doses for these changes is as follows:

Run #	Release Pathway	Max 2-h U2/3 EAB TEDE (rem)	30-d U2/3 LPZ TEDE (rem)	Max 2-h U1 EAB TEDE (rem)	30-d U1 LPZ TEDE (rem)
D1	Base of Stack	(1)	1.08E-2	(1)	1.14E-02
D2	Top of Stack	(1)	5.68E-1	(1)	6.14E-01
D3	TB Roof	(1)	3.02E-1	(1)	Same as U2/3
D4	ESF (ECCS) - Base of Stack	(1)	1.25E-2	(1)	1.27E-02
D5	ESF (ECCS) – Top of Stack	(1)	3.52E-1	(1)	3.64E-01
Total	All Pathways	1.02E+0	1.25E+0	1.11E+0	1.30E+0

(1) Not Applicable – individual maximums not relevant (occur at different times)

The Unit 1 control room dose due to activity brought into the control room increased by about six percent, from 0.485 rem TEDE for Units 2 and 3 (Appendix D) to 0.514 rem TEDE, still far less than the benefit of the reduced RB shine dose for Unit 1. However, consideration must also be given to the increased X/Qs for turbine building releases for Unit 1. This is covered in the next section.

Assessment of the Impact of Turbine Building X/Qs

The assessment presented in the previous section covers releases via the reactor building. This assessment covers releases via the turbine building.

Two sets of control room X/Qs for turbine building releases appear in the main body of Reference H-2. One is for "Turbine Building Roof Ventilators" (applicable to all units), while the second is for "Turbine Building Exhaust Release" which is calculated for each unit uniquely. For Units 2/3, the roof ventilator set bounds the exhaust release set, but that is not true for Unit 1. Therefore, the impact of increasing the turbine building release X/Qs for Unit 1 is assessed in this section. The increase is as follows:

	Turbine Building Roof Ventilators (sec/m^3)	Turbine Building Exhaust Release (sec/m^3)
0 - 2 hr:	2.17E-4	3.22E-4
2 hr - 8 hr:	1.64E-4	2.77E-4
8 hr - 1 day:	7.89E-5	1.31E-4
1 day - 4 day:	4.33E-5	7.91E-5
4 day - 30 day:	3.35E-5	6.10E-5

To assess the impact, Case D3 of Appendix D1 has been rerun with the following changes in the .psf file:

From:

```
Effective Volume Location:
   1
   6
   0.0000E+00   2.1700E-04
   2.0000E+00   1.6400E-04
```

```
8.0000E+00   7.8900E-05
2.4000E+01   4.3300E-05
9.6000E+01   3.3500E-05
7.2000E+02   0.0000E+00
```

To:

```
Effective Volume Location:
   1
   6
0.0000E+00   3.2200E-04
2.0000E+00   2.7700E-04
8.0000E+00   1.3100E-04
2.4000E+01   7.9100E-05
9.6000E+01   6.1000E-05
7.2000E+02   0.0000E+00
```

This change increases the Unit 1 control room dose due to activity brought into the control room from 0.514 rem TEDE to 0.602 rem TEDE, an increase of ~0.09 rem TEDE over the ~0.03 rem TEDE increase due to the smaller Unit 1 reactor building. When combined with the expected decrease of ~0.18 rem TEDE for the reduced activity held up in the reactor building (and the associated reduction in the RB shine dose contribution to the control room dose), the Unit 2/3 results for the control room are still bounding.

Summary

The impacts of including Unit 1 in the Browns Ferry AST application are as follows:

Area	Impact	New Value	Limit
EAB dose	Unit 1 ~10% greater than Units 2/3	1.11E+0 rem TEDE for Unit 1	25 rem TEDE
LPZ dose	Unit 1 ~5% greater than Units 2/3	1.30E+0 rem TEDE for Unit 1	25 rem TEDE
Control Room dose	Unit 1 < Units 2/3	1.18E+0 rem TEDE for Unit 1	5 rem TEDE
Release rates from RB	Unit 1 values increased for 0-2 hours. For 2-8 hours, Unit 1 noble gas release rate greater, iodine release rate less. Beyond 8 hours, no change.	For noble gas and iodine, Unit 1 1.4 times greater than Units 2/3 for 0-0.5 hours and 1.3 times greater for 0.5 to 2 hours. For noble gas, Unit 1 1.1 times greater than Units 2/3 for 2-8 hours. For iodine, Unit 1 reduced by 20% compared to Units 2/3, 2-8 hours.	No limit – see Design Output evaluation for this appendix below.

The release rates from the Unit 1 RB via the top of the stack would then become as follows:

Design Output Evaluation for Unit 1, Top of Stack Releases - Activity Release Rates (uCi/sec)
(based on Runs D2 + D5 of Appendix D1 and Appendix D6 with Unit 1 correction factors, first three intervals)

Time Interval	0-0.5 hr	0.5-2 hr	2-8 hr	8-24 hr	24-48 hr
Seconds	1800	5400	21600	57600	86400
Total I	9.534E+04	1.764E+06	1.958E+06	7.639E+05	4.224E+05
Total NG	3.039E+05	1.716E+07	7.601E+07	6.191E+07	4.726E+07
Total I+NG	3.993E+05	1.892E+07	7.797E+07	6.267E+07	4.768E+07

Time Interval	48-96 hr	96-120 hr	120-240 hr	240-480 hr	480-720 hr
Seconds	172800	86400	432000	864000	2592000
Total I	2.616E+05	1.939E+05	1.384E+05	7.738E+04	2.822E+04
Total NG	3.574E+07	2.802E+07	1.795E+07	2.923E+07	3.512E+06
Total I+NG	3.600E+07	2.821E+07	1.809E+07	2.931E+07	3.540E+06

These rates are equal to or greater than the Design Output for Appendix D (Units 2/3) with the exception of the 2-8 hr interval (only a 0.6% decrease). The Unit 2/3 Design Output for emergency procedures (to identify levels of core damage) is acceptable for Unit 1.

Overall, the impact of including Unit 1 in the AST DBA-LOCA analysis for Browns Ferry is to increase slightly the offsite doses (EAB and LPZ) because of reduced holdup in the smaller Unit 1 reactor building volume. This reduced holdup (and the use of more limiting X/Qs for the turbine building releases) would tend to also increase the control room dose for Unit 1 if activity brought into the control room were the only consideration. However, the reduced holdup (faster removal of the reactor building volume) also reduces the control room shine dose from the reactor building, and the net effect is actually a small decrease in the control room dose for Unit 1. This illustrates the importance of the stack at Browns Ferry; releases that are able to be diverted to the stack have relatively little impact on control room dose even considering a one-half hour period of fumigation conditions. Because of this behavior, the reduced reactor building holdup on Unit 1 is actually a benefit to control room dose.

References

H-1 TVA Calculation ND-Q0000-890013, "Post-LOCA Control Room Gamma Dose form Secondary Containment and Core Spray Piping", Revision 5

H-2 TVA Calculation ND-Q0999-980016, "Parameters Used in Dose Analyses", Revision 6

Appendix – I

(Please note, since the entire Appendix is a revision, revision bars will NOT be utilized to indicate Revision 22 in this Appendix)

Appendix I
Application of the AST to TVA/BFN LOCA Analysis using RADTRAD
without Credit for Drywell Sprays, with reduced MSIV Leak Rate and
Increased Main Condenser Bypass Flow

Purpose:
This appendix calculates updated doses associated with reduced MSIV leak rate and increased Main Condenser bypass flow and assumes that only the alternate leak treatment secondary flow path is available. These changes also affect the aerosol and elemental iodine removal coefficients and the curie releases to the environment through the main steam line and condenser leak paths, thus affecting the dose.

Design Input Data:
Design input data is taken from Reference I1. All Design input from Appendix B is the same except for the following:
1. Volumetric Flowrate, Drywell to Main condenser (MSIV leakage) - 0.363 cfm
2. Volumetric Flowrate, Drywell to Environment (MSIV leakage Main Condenser bypass) - 0.3788 cfm
3. Volumetric Flowrate, Main Condenser to Environment - 1.107 cfm
4. Removal Efficiencies in the Steam lines and Main Condenser

	Removal Efficiency for Aerosol Particles	Removal Efficiency for Elemental Iodine
Steam Line Leakage (Item 3.7)* (Drywell to Main Condenser)	99.97%	99.70%
MC Bypass (Item 3.14) (Drywell to Environment)	92.9%	25.3%

*These removal efficiencies applied to a leakage entering the main condenser volume include removal in the condenser downstream.

Assumptions:
The Design Input and Methods used for this calculation are identical to those of Appendix B, EXCEPT for the following:
1. The combined MSIV Tested leak rates are 85 scfh total. The maximum per Line MSIV tested leak rate is 60 scfh.

Justification: These values are consistent with the proposed Technical Specification change being requested.

RADTRAD Analysis:
Matrix of RADTRAD Runs

The table below summarizes the characteristics of each of the five RADTRAD runs performed for this analysis.

Appendix I – Table 1
RADTRAD Cases

Run #	Release Pathways to the Environment	PSF File	NIF File	DCF File	RFT File
I1	Base of Stack Release (activity in DW)	StackBase.psf	Bfn.nif	Fgr11&12.inp	Bfn.rft
I2	Top of Stack Release (activity in DW)	StackTop.psf	Bfn.nif	Fgr11&12.inp	Bfn.rft
I3	TB Roof Release (activity in DW)	TBRoof.psf	Bfn.nif	Fgr11&12.inp	Bfn.rft
I4	Stack Base (iodine ESF activity in SP)	StackBase_ESF.psf	Bfnesf.nif	Fgr11&12.inp	Bfn.rft
I5	Stack Top (iodine ESF activity in SP)	StackTop_ESF.psf	Bfnesf.nif	Fgr11&12.inp	Bfn.rft

The RADTRAD input (.psf) files are provided in Appendix I1. In comparison with the .psf files in Appendix B there are changes in flow rates and removal efficiencies in StackBase.psf, StackTop.psf and TBRoof.psf as a result of the new steam line leak rates (i.e., 85 scfh total/60 scfh max per line) and the new flow split between the main condenser and bypass line (i.e., 48.9% and 51.1%). StackBase ESF.psf and StackTop_ESF.psf, on the other hand, are not affected by the new flow rates and removal efficiencies. These two input files were rerun to account for the different 2 hour EAB maximum interval.

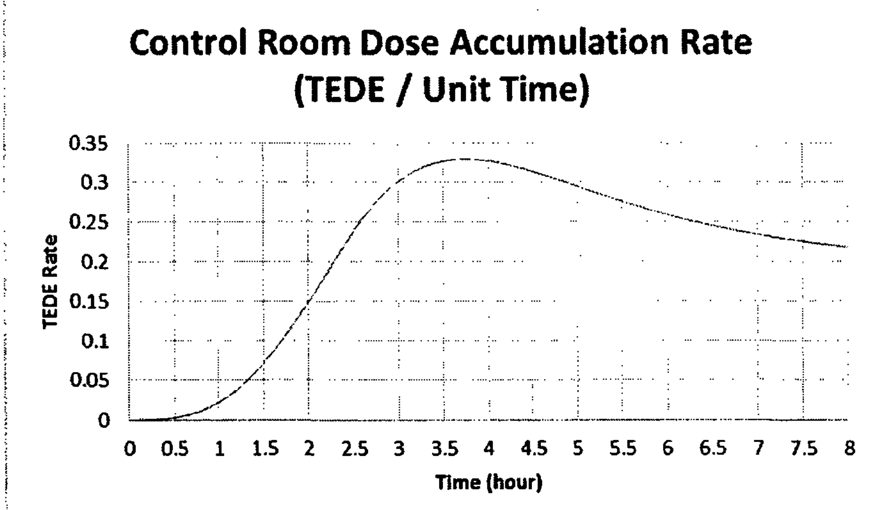
There are seven RADTRAD input files in Appendix I1, the first five corresponding to the five runs in the above table with the fumigation X/Q in the 3.5 to 4 hour interval. Two additional RADTRAD input files are also included, which repeat Runs I2 and I5 but with the fumigation X/Q for EAB shifted to the 2.5 to 3.0 hour interval. The NIF and RFT files as well as FGR11 and 12.inp are included in Appendix I2. Excerpts of the RADTRAD output corresponding to the seven RADTRAD input files are provided in Appendix I3.

Fumigation Time Interval

As discussed in Appendix B, in order to retrieve the most conservative result for the limiting dose location (the Control Room), the half-hour period when fumigation is occurring must correspond to the time interval when the control room dose accumulation rate is maximum. In order to determine this time interval, two additional RADTRAD runs with the Top of Stack release activity (Runs I2 and I5) were rerun with the fumigation X/Q applied from start to finish for the control room location (these new runs are labeled I2' and I5' as was done in Appendix I4). The control room dose accumulation rates were retrieved as a function of time, added to one another at each time step so that the peak control room dose accumulation rate could be obtained. These two additional RADTRAD runs (I2' and I5') are included in Appendix I4 along with the Fumigation Spreadsheet.

The Fumigation Spreadsheet shows a peak at about 3.75 hours (also shown in the figure below). Thus, the fumigation X/Q was used in Runs I2 and I5 from t = 3.5 to t = 4.0 hours accident time. Note that this time period is the same as the period in Appendix B, as expected.

Appendix I – Figure 1



Maximum Two-Hour EAB TEDE

Unlike Appendix B, the five cases, Runs I1 through I5, were run with the maximum two-hour EAB dose period NOT specified. Instead, the EAB X/Q was extended to cover the entire 30 days of the accident duration. Thus, the maximum two-hour EAB dose could be calculated using a spreadsheet, as shown in Appedix I8. The maximum 2 hour dose is deteremined from subtracting the dose for time T_0 from the dose for time T_1, where T_1 minus T_0 equals 2 hours, and selecting the maximum difference. The 0.5 hour fumigation interval was also adjusted for EAB dose to be inside the maximum two-hour interval as discussed below.

Documentation of Runs

Appendix I1 - RADTRAD Main Input Files
Appendix I2 - RADTRAD Secondary Input Files
Appendix I3 - RADTRAD Output Excerpts
Appendix I4 - Fumigation Spreadsheet (including RADTRAD output excerpts for Runs I2' and I5')
Appendix I5 - STARDOSE LIBFILE1
Appendix I6 - STARDOSE Input Files
Appendix I7 - STARDOSE Output File Excerpts
Appendix I8 - Max 2-hour EAB TEDE Spreadsheet.

Secondary Containment Shine Dose

The external shine dose of 0.762 rem used to obtain the CR TEDE was taken from Appendix B.

Results

In the table below, the CR TEDE reflects a 50% reduction allowed per SRP 6.4. Therefore, these CR doses are half of those documented in Appendix I3.

The Appendix I8 spreadsheet row with yellow highlight indicates that the total EAB dose from the combination of all five pathways reaches a maximum for the interval between 1.0 and 3.0 hours. Note that the fumigation X/Q interval, which was chosen to maximize control room dose, is outside this 1 to 3 hour time range.

In order to address Regulatory Guide 1.183 guidance on fumigation for the EAB (see Regulatory Guide 1.183, Section 5.3), the fumigation 0.5 hour interval has been moved to be inside the 1.0 to 3.0 hour interval for maximum EAB dose. Specifically, the 0.5 hour fumigation interval was selected based on the above figure on dose accumulation rate which indicates that, within the 1 to 3 hour interval, the highest dose rate occurs from 2.5 to 3 hours.

The maximum 2 hour EAB dose then becomes 5.92 rem TEDE, over the 1.0 to 3.0 time interval, with the fumigation X/Q applied from 2.5 to 3.0 hours, as shown in the fourth column in the table below.

RADTRAD Results for Updated Dose (Appendix B results in parentheses are shown for reference only):

Appendix I – Table 2

Run #	Release Pathway	30-d CR* TEDE (rem)	Max-2h EAB** TEDE (1-3 hr) (rem)	30-d LPZ* TEDE (rem)
I1	Base of Stack	0.0128 (0.0127)	0.0212 (0.0272)	0.023 (0.0228)
I2	Top of Stack	0.358 (0.358)	0.90 (0.791)	0.593 (0.592)
I3	TB Roof	3.004 (0.224)	4.318 (0.0776)	3.319 (0.302)
I4	ESF (ECCS) - Base of Stack	0.089 (0.089)	0.0145 (0.022)	0.094 (0.094)
I5	ESF (ECCS) - Top of Stack	0.491 (0.491)	0.664 (0.795)	1.370 (1.370)
Appendix B	External Shine	0.762 (0.762)	0 (0)	0 (0)
Total	All Pathways	4.72 (1.94)	5.92 (1.71)	5.40 (2.38)

* Fumigation X/Q interval from 3.5 to 4 hours.
** Fumigation X/Q interval from 2.5 to 3 hours.

Based on the dose results provided in the Table above, the 30-day CR TEDE, the maximum 2-hour EAB TEDE, and the 30-day LPZ TEDE are greater than what was previously calculated in Appendix B. Per 10 CFR 50.67 and U.S. NRC Regulatory Guide 1.183, the regulatory required doses are 5 rem TEDE for the CR, and 25 rem TEDE for the EAB and LPZ. Consequently, although the CR and offsite doses increase, they are still below the regulatory requirements.

Independent Review of AST Application to TVA/BFN LOCA:
Calculations were performed using the STARDOSE computer code to check the RADTRAD results for StackBase, StackTop and TBRoof presented in Appendix I3 since significant changes have been made in these pathways as a result of the lower steam line leak rates (i.e., 85 scfh total/60 scfh max per line) and the new flow split between condenser and bypass line (i.e., 48.9% and 51.1%). The changes in StackBase_ESF and StackTop_ESF are so minor (only the duration of X/Q and change of fumigation X/Q interval to 2.5 to 3 hours for EAB dose) that their RADTRAD results can be verified by simpler methods, i.e., by checking the RADTRAD input and repeating the RADTRAD calculations. These results were also compared against the RADTRAD results from Appendix B.

STARDOSE Analysis
The Design Input Data and the Assumptions are the same as provided previously utilized in Appendix C with the exception of the changes noted above in "Assumptions" and "Design Inputs."

The STARDOSE LIBFILE1.TXT file is included as Appendix I5. This file has the same format as in Appendix C.

The INPUT.DAT files are provided in Appendix I6. As previously noted, the models are the same as the corresponding RADTRAD cases documented in this report.

The fumigation X/Q interval was set to 3.5 to 4 hours for CR and LPZ. The maximum 2-hour EAB dose was obtained using the 1.0 to 3.0 hour period identified previously by RADTRAD calculation as shown in the spreadsheet in Appendix I8 with the fumigation X/Q hour interval at 2.5 to 3.0 hours.

Note also that the control room X/Qs used in STARDOSE does not reflect a 50% reduction allowed by SRP Section 6.4. Therefore, STARDOSE control room dose results, as shown in the output files provided in Appendix I7, need to be reduced by 50% prior to being compared with the RADTRAD control room dose results.

Results Summary and Comparison to RADTRAD Results (only for the releases from the stack base, stack top and the turbine building roof that are affected by the change of the MSIV leak rates and the flow split between the main condenser and the bypass).

Appendix I – Table 3

	RADTRAD	STARDOSE	Difference
Control Room	3.374	3.193	5%
EAB	5.239	5.065	3%
LPZ	3.935	3,827	3%

These results show good agreement between the two computer codes. This confirms the acceptability of the RADTRAD results.

References:

I1. TVA Calculation NDQ0999980016 R8, "Parameters Used in Dose Analyses."

I2. TVA Calculation NDQ099920010019 R3, "Ex-Containment Removal Coefficients for Alternative Source Term Analyses."

Appendix I1 – RADTRAD Main Input Files

StackBase.psf

Radtrad 3.03 4/15/2001
RUN StackBase
Nuclide Inventory File:
c:\users\jun\documents\tva browns ferry nuclear\radtrad\bfn.nif
Plant Power Level:
4.0310E+03
Compartments:
9
Compartment 1:
DW
3
1.5900E+05
0
0
0
1
0
Compartment 2:
Torus
3
1.1940E+05
0
0
0
0
0
Compartment 3:
RB
3
1.3110E+06
0
0
0
0
0
Compartment 4:
SR
3
3.4560E+04
0
0
0
0
0
Compartment 5:
Condenser
3
1.2240E+05
0

0
0
0
0
Compartment 6:
TB
3
1.0000E+00
0
0
0
0
0
Compartment 7:
Dummy
3
1.0000E+06
0
0
0
0
0
Compartment 8:
CR
1
2.1000E+05
0
0
0
0
0
Compartment 9:
Environment
2
0.0000E+00
0
0
0
0
0
Pathways:
15
Pathway 1:
DW to Torus
1
2
2
Pathway 2:
Torus to DW
2
1
2
Pathway 3:

DW to RB
1
3
2
Pathway 4:
Torus to RB
2
3
2
Pathway 5:
RB to SR
3
4
2
Pathway 6:
Torus to SR
2
4
2
Pathway 7:
Torus to Dummy
2
7
2
Pathway 8:
SR to Environment
4
9
2
Pathway 9:
SR to Dummy
4
7
2
Pathway 10:
DW to Condenser
1
5
2
Pathway 11:
DW to TB
1
6
2
Pathway 12:
Condenser to TB
5
6
2
Pathway 13:
TB to Dummy
6
7

2
Pathway 14:
Environment to CR
9
8
2
Pathway 15:
CR to Environment
8
9
2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
1
1 1.0000E+00
c:\program files (x86)\radtrad3.03\defaults\fgr11&12.inp
c:\users\jun\documents\tva browns ferry nuclear\radtrad\bfn.rft
0.0000E+00
1
9.5000E-01 4.8500E-02 1.5000E-03 1.0000E+00
Overlying Pool:
0
0.0000E+00
0
0
0
0
Compartments:
9
Compartment 1:
0
1
0
0
0
0
0
1
10
0.0000E+00 0.0000E+00
3.3000E-02 7.5000E-01
5.3300E-01 3.7000E-01
2.0330E+00 1.0600E+00
5.0330E+00 6.4000E-01
8.3670E+00 5.6000E-01
1.2033E+01 5.3000E-01
1.9478E+01 5.1000E-01
2.4033E+01 0.0000E+00
7.2000E+02 0.0000E+00

1
10
0.0000E+00 0.0000E+00
3.3000E-02 7.5000E-01
5.3300E-01 3.7000E-01
2.0330E+00 1.0600E+00
5.0330E+00 6.4000E-01
8.3670E+00 5.6000E-01
1.2033E+01 5.3000E-01
1.9478E+01 5.1000E-01
2.4033E+01 0.0000E+00
7.2000E+02 0.0000E+00
Compartment 2:
0
1
0
0
0
0
0
0
0
Compartment 3:
0
1
0
0
0
0
0
0
0
Compartment 4:
0
1
0
0
0
0
0
0
0
Compartment 5:
0
1
0
0
0
0
0
0
0
Compartment 6:

0
1
0
0
0
0
0
0
0
Compartment 7:
0
1
0
0
0
0
0
0
0
Compartment 8:
0
1
0
0
0
0
0
0
0
Compartment 9:
0
1
0
0
0
0
0
0
0
Pathways:
15
Pathway 1:
0
0
0
0
0
1
3
0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
2.0330E+00 1.1940E+05 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 2:
0
0
0
0
0
1
3
0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
2.0330E+00 1.1940E+05 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 3:
0
0
0
0
0
1
2
0.0000E+00 2.2080E+00 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 1.6580E+00 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	2.4750E+04	9.0000E+01	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 6:
0
0
0
0
0
1
7

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
2.4000E+02	1.3900E+02	9.0000E+01	0.0000E+00	0.0000E+00
2.6400E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
4.8000E+02	1.3900E+02	9.0000E+01	0.0000E+00	0.0000E+00
5.0400E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
6.9600E+02	1.3900E+02	9.0000E+01	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 7:
0
0
0
0
0
1
3

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
8.0000E+00	1.6700E-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
Pathway 8:
0
0
0
0
0
1
2
0.0000E+00 2.0000E+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
Pathway 9:
0
0
0
0
0
1
2
0.0000E+00 2.4740E+04 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 10:
0
0
0
0
0
1
2
0.0000E+00 3.6250E-01 9.9970E+01 9.9700E+01 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 11:
0
0

0
0
0
1
2
0.0000E+00 3.7880E-01 9.2900E+01 2.5300E+01 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 12:
0
0
0
0
0
1
2
0.0000E+00 1.1100E+00 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 13:
0
0
0
0
0
1
2
0.0000E+00 1.0000E+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 14:
0
0
0
0
0
1
2

```
 0.0000E+00  6.7170E+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 15:
 0
 0
 0
 0
 0
 1
 2
 0.0000E+00  6.7170E+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
Dose Locations:
 3
Location 1:
Control Room
 8
 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
Location 2:
EAB
 9
 1
 4
 0.0000E+00  2.6200E-04
 2.0000E+00  2.6200E-04
 4.0000E+00  2.6200E-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 3:
LPZ
9
1
6
0.0000E+00 1.3100E-04
2.0000E+00 6.6100E-05
8.0000E+00 4.6900E-05
2.4000E+01 2.2300E-05
9.6000E+01 7.9600E-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
Effective Volume Location:
1
6
0.0000E+00 2.0000E-04
2.0000E+00 1.2800E-04
8.0000E+00 5.7200E-05
2.4000E+01 4.0500E-05
9.6000E+01 3.0900E-05
7.2000E+02 0.0000E+00
Simulation Parameters:
4
0.0000E+00 1.0000E-01
8.0000E+00 1.0000E+00
2.4000E+01 2.4000E+01
7.2000E+02 0.0000E+00
Output Filename:
C:\Users\jun\Documents\TVA Browns Ferry Nuclear\RADTRAD\QA Calc\StackBaseFinal.o1
1
1
1
1
1
End of Scenario File

StackTop.psf (Fumigation X/Q between 3.5 and 4 hours)

Radtrad 3.03 4/15/2001
Run StackTop
Nuclide Inventory File:
c:\users\jun\documents\tva browns ferry nuclear\radtrad\bfn.nif
Plant Power Level:
4.0310E+03
Compartments:
9
Compartment 1:
DW
3
1.5900E+05
0
0
0
1
0
Compartment 2:
Torus
3
1.1940E+05
0
0
0
0
0
Compartment 3:
RB
3
1.3110E+06
0
0
0
0
0
Compartment 4:
SR
3
3.4560E+04
0
0
0
0
0
Compartment 5:
Condenser
3
1.2240E+05
0
0

0
0
0
Compartment 6:
TB
3
1.0000E+00
0
0
0
0
0
Compartment 7:
Dummy
3
1.0000E+06
0
0
0
0
0
Compartment 8:
CR
1
2.1000E+05
0
0
0
0
0
Compartment 9:
Environment
2
0.0000E+00
0
0
0
0
0
Pathways:
15
Pathway 1:
DW to Torus
1
2
2
Pathway 2:
Torus to DW
2
1
2
Pathway 3:
DW to RB

1
3
2
Pathway 4:
Torus to RB
2
3
2
Pathway 5:
RB to SR
3
4
2
Pathway 6:
Torus to SR
2
4
2
Pathway 7:
Torus to Environment
2
9
2
Pathway 8:
SR to Dummy
4
7
2
Pathway 9:
SR to Environment
4
9
2
Pathway 10:
DW to Condenser
1
5
2
Pathway 11:
DW to TB
1
6
2
Pathway 12:
Condenser to TB
5
6
2
Pathway 13:
TB to Dummy
6
7
2

Pathway 14:
Environment to CR
9
8
2
Pathway 15:
CR to Environment
8
9
2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
1
1 1.0000E+00
c:\program files (x86)\radtrad3.03\defaults\fgr11&12.inp
c:\users\jun\documents\tva browns ferry nuclear\radtrad\bfn.rft
0.0000E+00
1
9.5000E-01 4.8500E-02 1.5000E-03 1.0000E+00
Overlying Pool:
0
0.0000E+00
0
0
0
0
Compartments:
9
Compartment 1:
0
1
0
0
0
0
0
1
10
0.0000E+00 0.0000E+00
3.3000E-02 7.5000E-01
5.3300E-01 3.7000E-01
2.0330E+00 1.0600E+00
5.0330E+00 6.4000E-01
8.3670E+00 5.6000E-01
1.2033E+01 5.3000E-01
1.9478E+01 5.1000E-01
2.4033E+01 0.0000E+00
7.2000E+02 0.0000E+00
1

10
0.0000E+00 0.0000E+00
3.3000E-02 7.5000E-01
5.3300E-01 3.7000E-01
2.0330E+00 1.0600E+00
5.0330E+00 6.4000E-01
8.3670E+00 5.6000E-01
1.2033E+01 5.3000E-01
1.9478E+01 5.1000E-01
2.4033E+01 0.0000E+00
7.2000E+02 0.0000E+00
Compartment 2:
0
1
0
0
0
0
0
0
0
Compartment 3:
0
1
0
0
0
0
0
0
0
Compartment 4:
0
1
0
0
0
0
0
0
0
Compartment 5:
0
1
0
0
0
0
0
0
0
Compartment 6:
0

1
0
0
0
0
0
0
0
Compartment 7:
0
1
0
0
0
0
0
0
0
Compartment 8:
0
1
0
0
0
0
0
0
0
Compartment 9:
0
1
0
0
0
0
0
0
0
Pathways:
15
Pathway 1:
0
0
0
0
0
1
3
0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
2.0330E+00 1.1940E+05 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 2:
0
0
0
0
0
1
3
0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
2.0330E+00 1.1940E+05 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 3:
0
0
0
0
0
1
2
0.0000E+00 2.2080E+00 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 1.6580E+00 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 2.4750E+04 9.0000E+01 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 6:
0
0
0
0
0
1
7
0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
2.4000E+02 1.3900E+02 9.0000E+01 0.0000E+00 0.0000E+00
2.6400E+02 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
4.8000E+02 1.3900E+02 9.0000E+01 0.0000E+00 0.0000E+00
5.0400E+02 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
6.9600E+02 1.3900E+02 9.0000E+01 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 7:
0
0
0
0
0
1
3
0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
8.0000E+00 1.6700E-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
Pathway 8:
0
0
0
0
0
1
2
0.0000E+00 2.0000E+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
Pathway 9:
0
0
0
0
0
1
2
0.0000E+00 2.4740E+04 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 10:
0
0
0
0
0
1
2
0.0000E+00 3.6250E-01 9.9970E+01 9.9700E+01 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 11:
0
0
0

0
0
1
2
0.0000E+00 3.7880E-01 9.2900E+01 2.5300E+01 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 12:
0
0
0
0
0
1
2
0.0000E+00 1.1100E+00 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 13:
0
0
0
0
0
1
2
0.0000E+00 1.0000E+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 14:
0
0
0
0
0
1
2
0.0000E+00 6.7170E+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 15:
0
0
0
0
0
1
2
0.0000E+00 6.7170E+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
Dose Locations:
3
Location 1:
Control Room
8
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
Location 2:
EAB
9
1
5
0.0000E+00 1.1900E-06
2.0000E+00 1.1900E-06
3.5000E+00 2.3500E-05
4.0000E+00 1.1900E-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:
LPZ
9
1
8
0.0000E+00 1.1300E-06
2.0000E+00 5.7500E-07
3.5000E+00 1.2600E-05
4.0000E+00 5.7500E-07
8.0000E+00 4.1000E-07
2.4000E+01 1.9700E-07
9.6000E+01 6.8800E-08
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
Effective Volume Location:
1
8
0.0000E+00 1.4100E-07
2.0000E+00 4.5000E-08
3.5000E+00 3.4000E-05
4.0000E+00 4.5000E-08
8.0000E+00 2.5400E-08
2.4000E+01 7.3600E-09
9.6000E+01 1.2400E-09
7.2000E+02 0.0000E+00
Simulation Parameters:
4
0.0000E+00 1.0000E-01
8.0000E+00 1.0000E+00
2.4000E+01 2.4000E+01
7.2000E+02 0.0000E+00
Output Filename:
C:\Users\jun\Documents\TVA Browns Ferry Nuclear\RADTRAD\QA Calc\StackTopFinal.o1
1
1
1
1
1
End of Scenario File

TBRoof.psf

Radtrad 3.03 4/15/2001
Run-TBRoof
Nuclide Inventory File:
c:\users\jun\documents\tva browns ferry nuclear\radtrad\bfn.nif
Plant Power Level:
4.0310E+03
Compartments:
9
Compartment 1:
DW
3
1.5900E+05
0
0
0
1
0
Compartment 2:
Torus
3
1.1940E+05
0
0
0
0
0
Compartment 3:
RB
3
1.3110E+06
0
0
0
0
0
Compartment 4:
SR
3
3.4560E+04
0
0
0
0
0
Compartment 5:
Condenser
3
1.2240E+05
0
0

0
0
0
Compartment 6:
TB
3
1.0000E+00
0
0
0
0
0
Compartment 7:
Dummy
3
1.0000E+06
0
0
0
0
0
Compartment 8:
CR
1
2.1000E+05
0
0
0
0
0
Compartment 9:
Environment
2
0.0000E+00
0
0
0
0
0
Pathways:
15
Pathway 1:
DW to Torus
1
2
2
Pathway 2:
Torus to DW
2
1
2
Pathway 3:
DW to RB

1
3
2
Pathway 4:
Torus to RB
2
3
2
Pathway 5:
RB to SR
3
4
2
Pathway 6:
Torus to SR
2
4
2
Pathway 7:
Torus to Dummy
2
7
2
Pathway 8:
SR to Dummy
4
7
2
Pathway 9:
SR to Dummy
4
7
2
Pathway 10:
DW to Condenser
1
5
2
Pathway 11:
DW to TB
1
6
2
Pathway 12:
Condenser to TB
5
6
2
Pathway 13:
TB to Environment
6
9
2

Pathway 14:
Environment to CR
9
8
2
Pathway 15:
CR to Environment
8
9
2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
1
1 1.0000E+00
c:\program files (x86)\radtrad3.03\defaults\fgr11&12.inp
c:\users\jun\documents\tva browns ferry nuclear\radtrad\bfn.rft
0.0000E+00
1
9.5000E-01 4.8500E-02 1.5000E-03 1.0000E+00
Overlying Pool:
0
0.0000E+00
0
0
0
0
Compartments:
9
Compartment 1:
0
1
0
0
0
0
0
1
10
0.0000E+00 0.0000E+00
3.3000E-02 7.5000E-01
5.3300E-01 3.7000E-01
2.0330E+00 1.0600E+00
5.0330E+00 6.4000E-01
8.3670E+00 5.6000E-01
1.2033E+01 5.3000E-01
1.9478E+01 5.1000E-01
2.4033E+01 0.0000E+00
7.2000E+02 0.0000E+00
1

10
0.0000E+00 0.0000E+00
3.3000E-02 7.5000E-01
5.3300E-01 3.7000E-01
2.0330E+00 1.0600E+00
5.0330E+00 6.4000E-01
8.3670E+00 5.6000E-01
1.2033E+01 5.3000E-01
1.9478E+01 5.1000E-01
2.4033E+01 0.0000E+00
7.2000E+02 0.0000E+00
Compartment 2:
0
1
0
0
0
0
0
0
0
Compartment 3:
0
1
0
0
0
0
0
0
0
Compartment 4:
0
1
0
0
0
0
0
0
0
Compartment 5:
0
1
0
0
0
0
0
0
0
Compartment 6:
0

1
0
0
0
0
0
0
0
Compartment 7:
0
1
0
0
0
0
0
0
0
Compartment 8:
0
1
0
0
0
0
0
0
0
Compartment 9:
0
1
0
0
0
0
0
0
0
Pathways:
15
Pathway 1:
0
0
0
0
0
1
3
0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
2.0330E+00 1.1940E+05 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 2:
0
0
0
0
0
1
3
0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
2.0330E+00 1.1940E+05 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 3:
0
0
0
0
0
1
2
0.0000E+00 2.2080E+00 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 1.6580E+00 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 2.4750E+04 9.0000E+01 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 6:
0
0
0
0
0
1
7
0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
2.4000E+02 1.3900E+02 9.0000E+01 0.0000E+00 0.0000E+00
2.6400E+02 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
4.8000E+02 1.3900E+02 9.0000E+01 0.0000E+00 0.0000E+00
5.0400E+02 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
6.9600E+02 1.3900E+02 9.0000E+01 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 7:
0
0
0
0
0
1
3
0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
8.0000E+00 1.6700E-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
Pathway 8:
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
Pathway 9:
0
0
0
0
0
1
2
0.0000E+00 2.4740E+04 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 10:
0
0
0
0
0
1
2
0.0000E+00 3.6250E-01 9.9970E+01 9.9700E+01 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 11:
0
0
0

0
0
1
2
0.0000E+00 3.7880E-01 9.2900E+01 2.5300E+01 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 12:
0
0
0
0
0
1
2
0.0000E+00 1.1100E+00 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 13:
0
0
0
0
0
1
2
0.0000E+00 1.0000E+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 14:
0
0
0
0
0
1
2
0.0000E+00 6.7170E+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 15:
0
0
0
0
0
1
2
0.0000E+00 6.7170E+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
Dose Locations:
3
Location 1:
Control Room
8
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
Location 2:
EAB
9
1
4
0.0000E+00 2.6200E-04
2.0000E+00 2.6200E-04
4.0000E+00 2.6200E-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 3:
LPZ
9
1
6
0.0000E+00 1.3100E-04
2.0000E+00 6.6100E-05
8.0000E+00 4.6900E-05
2.4000E+01 2.2300E-05
9.6000E+01 7.9600E-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
Effective Volume Location:
1
6
0.0000E+00 3.2200E-04
2.0000E+00 2.7700E-04
8.0000E+00 1.3100E-04
2.4000E+01 7.9100E-05
9.6000E+01 6.1000E-05
7.2000E+02 0.0000E+00
Simulation Parameters:
4
0.0000E+00 1.0000E-01
8.0000E+00 1.0000E+00
2.4000E+01 2.4000E+01
7.2000E+02 0.0000E+00
Output Filename:
C:\Users\jun\Documents\TVA Browns Ferry Nuclear\RADTRAD\QA Calc - 85\TBRoofFinal.o0
1
1
1
1
1
End of Scenario File

StackBase ESF.psf

Radtrad 3.03 4/15/2001
Base of Stack Release-ESF Leakage
Nuclide Inventory File:
C:\Users\jun\Documents\TVA Browns Ferry Nuclear\RADTRAD\BFNESF.nif
Plant Power Level:
4.0310E+03
Compartments:
6
Compartment 1:
SP
3
1.4105E+05
0
0
0
0
0
Compartment 2:
RB
3
1.3110E+06
0
0
0
0
0
Compartment 3:
SR
3
3.4560E+04
0
0
0
0
0
Compartment 4:
CR
1
2.1000E+05
0
0
0
0
0
Compartment 5:
Environment
2
0.0000E+00
0
0

0
0
0
Compartment 6:
Dummy
3
1.0000E+06
0
0
0
0
0
Pathways:
6
Pathway 1:
SP to RB
1
2
2
Pathway 2:
RB to SR
2
3
2
Pathway 3:
SR to Environment
3
5
2
Pathway 4:
SR to Dummy
3
6
2
Pathway 5:
Environment to CR
5
4
2
Pathway 6:
CR to Environment
4
5
2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
1
1 1.0000E+00
c:\program files (x86)\radtrad3.03\defaults\fgr11&12.inp

C:\Users\jun\Documents\TVA Browns Ferry Nuclear\RADTRAD\BFN.RFT
0.0000E+00
1
9.5000E-01 4.8500E-02 1.5000E-03 1.0000E+00
Overlying Pool:
0
0.0000E+00
0
0
0
0
Compartments:
6
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
Compartment 4:
0
1
0
0
0
0
0
0
0

Compartment 5:
0
1
0
0
0
0
0
0
0
Compartment 6:
0
1
0
0
0
0
0
0
0
Pathways:
6
Pathway 1:
0
0
0
0
0
1
2
0.0000E+00 2.6740E+00 1.0000E+02 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 2:
0
0
0
0
0
1
2
0.0000E+00 2.4750E+04 9.0000E+01 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 3:
0
0
0
0
0
1
2
0.0000E+00 2.0000E+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
Pathway 4:
0
0
0
0
0
1
2
0.0000E+00 2.4740E+04 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 6.7170E+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 6:
0
0
0

0
0
1
2
0.0000E+00 6.7170E+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
Dose Locations:
3
Location 1:
Control Room
4
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
Location 2:
EAB
5
1
4
0.0000E+00 2.6200E-04
2.0000E+00 2.6200E-04
4.0000E+00 2.6200E-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 3:
LPZ
5
1
6
0.0000E+00 1.3100E-04
2.0000E+00 6.6100E-05
8.0000E+00 4.6900E-05
2.4000E+01 2.2300E-05

9.6000E+01 7.9600E-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
Effective Volume Location:
1
6
0.0000E+00 2.0000E-04
2.0000E+00 1.2800E-04
8.0000E+00 5.7200E-05
2.4000E+01 4.0500E-05
9.6000E+01 3.0900E-05
7.2000E+02 0.0000E+00
Simulation Parameters:
4
0.0000E+00 1.0000E-01
8.0000E+00 1.0000E+00
2.4000E+01 2.4000E+01
7.2000E+02 0.0000E+00
Output Filename:
C:\Users\jun\Documents\TVA Browns Ferry Nuclear\RADTRAD\QA Calc - 85 - Final\StackBase_ESF.o0
1
1
1
1
1
End of Scenario File

StackTop ESF.psf (Fumigation X/Q between 3.5 and 4 hours)

Radtrad 3.03 4/15/2001
Top of Stack -ESF Leakage
Nuclide Inventory File:
C:\Users\jun\Documents\TVA Browns Ferry Nuclear\RADTRAD\BFNESF.nif
Plant Power Level:
4.0310E+03
Compartments:
6
Compartment 1:
SP
3
1.4105E+05
0
0
0
0
0
Compartment 2:
RB
3
1.3110E+06
0
0
0
0
0
Compartment 3:
SR
3
3.4560E+04
0
0
0
0
0
Compartment 4:
CR
1
2.1000E+05
0
0
0
0
0
Compartment 5:
Environment
2
0.0000E+00
0
0

0
0
0
Compartment 6:
Dummy
3
1.0000E+06
0
0
0
0
0
Pathways:
6
Pathway 1:
SP to RB
1
2
2
Pathway 2:
RB to SR
2
3
2
Pathway 3:
SR to Dummy
3
6
2
Pathway 4:
SR to Environment
3
5
2
Pathway 5:
Environment to CR
5
4
2
Pathway 6:
CR to Environment
4
5
2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
1
1 1.0000E+00
c:\program files (x86)\radtrad3.03\defaults\fgr11&12.inp

C:\Users\jun\Documents\TVA Browns Ferry Nuclear\RADTRAD\BFN.RFT
0.0000E+00
1
9.5000E-01 4.8500E-02 1.5000E-03 1.0000E+00
Overlying Pool:
0
0.0000E+00
0
0
0
0
Compartments:
6
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
Compartment 4:
0
1
0
0
0
0
0
0
0

Compartment 5:
0
1
0
0
0
0
0
0
0
Compartment 6:
0
1
0
0
0
0
0
0
0
Pathways:
6
Pathway 1:
0
0
0
0
0
1
2
0.0000E+00 2.6740E+00 1.0000E+02 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 2:
0
0
0
0
0
1
2
0.0000E+00 2.4750E+04 9.0000E+01 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 3:
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
Pathway 4:
0
0
0
0
0
1
2
0.0000E+00 2.4740E+04 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 6.7170E+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 6:
0
0
0

0
0
1
2
0.0000E+00 6.7170E+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
Dose Locations:
3
Location 1:
Control Room
4
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
Location 2:
EAB
5
1
5
0.0000E+00 1.1900E-06
2.0000E+00 1.1900E-06
3.5000E+00 2.3500E-05
4.0000E+00 1.1900E-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:
LPZ
5
1
8
0.0000E+00 1.1300E-06
2.0000E+00 5.7500E-07
3.5000E+00 1.2600E-05

4.0000E+00 5.7500E-07
8.0000E+00 4.1000E-07
2.4000E+01 1.9700E-07
9.6000E+01 6.8800E-08
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
Effective Volume Location:
1
8
0.0000E+00 1.4100E-07
2.0000E+00 4.5000E-08
3.5000E+00 3.4000E-05
4.0000E+00 4.5000E-08
8.0000E+00 2.5400E-08
2.4000E+01 7.3600E-09
9.6000E+01 1.2400E-09
7.2000E+02 0.0000E+00
Simulation Parameters:
4
0.0000E+00 1.0000E-01
8.0000E+00 1.0000E+00
2.4000E+01 2.4000E+01
7.2000E+02 0.0000E+00
Output Filename:
C:\Users\jun\Documents\TVA Browns Ferry Nuclear\RADTRAD\QA Calc - 85\StackTop_ESF.o0
1
1
1
1
1
End of Scenario File

StackTop.psf (Fumigation X/Q for EAB between 2.5 and 3 hours)
Radtrad 3.03 4/15/2001
Run StackTop
Nuclide Inventory File:
c:\users\jun\documents\tva browns ferry nuclear\radtrad\bfn.nif
Plant Power Level:
4.0310E+03
Compartments:
9
Compartment 1:
DW
3
1.5900E+05
0
0
0
1
0
Compartment 2:
Torus
3
1.1940E+05
0
0
0
0
0
Compartment 3:
RB
3
1.3110E+06
0
0
0
0
0
Compartment 4:
SR
3
3.4560E+04
0
0
0
0
0
Compartment 5:
Condenser
3
1.2240E+05
0
0
0
0

0
Compartment 6:
TB
3
1.0000E+00
0
0
0
0
0
Compartment 7:
Dummy
3
1.0000E+06
0
0
0
0
0
Compartment 8:
CR
1
2.1000E+05
0
0
0
0
0
Compartment 9:
Environment
2
0.0000E+00
0
0
0
0
0
Pathways:
15
Pathway 1:
DW to Torus
1
2
2
Pathway 2:
Torus to DW
2
1
2
Pathway 3:
DW to RB
1
3

2
Pathway 4:
Torus to RB
2
3
2
Pathway 5:
RB to SR
3
4
2
Pathway 6:
Torus to SR
2
4
2
Pathway 7:
Torus to Environment
2
9
2
Pathway 8:
SR to Dummy
4
7
2
Pathway 9:
SR to Environment
4
9
2
Pathway 10:
DW to Condenser
1
5
2
Pathway 11:
DW to TB
1
6
2
Pathway 12:
Condenser to TB
5
6
2
Pathway 13:
TB to Dummy
6
7
2
Pathway 14:
Environment to CR

9
8
2
Pathway 15:
CR to Environment
8
9
2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
1
1 1.0000E+00
c:\program files (x86)\radtrad3.03\defaults\fgr11&12.inp
c:\users\jun\documents\tva browns ferry nuclear\radtrad\bfn.rft
0.0000E+00
1
9.5000E-01 4.8500E-02 1.5000E-03 1.0000E+00
Overlying Pool:
0
0.0000E+00
0
0
0
0
Compartments:
9
Compartment 1:
0
1
0
0
0
0
0
1
10
0.0000E+00 0.0000E+00
3.3000E-02 7.5000E-01
5.3300E-01 3.7000E-01
2.0330E+00 1.0600E+00
5.0330E+00 6.4000E-01
8.3670E+00 5.6000E-01
1.2033E+01 5.3000E-01
1.9478E+01 5.1000E-01
2.4033E+01 0.0000E+00
7.2000E+02 0.0000E+00
1
10
0.0000E+00 0.0000E+00

3.3000E-02 7.5000E-01
5.3300E-01 3.7000E-01
2.0330E+00 1.0600E+00
5.0330E+00 6.4000E-01
8.3670E+00 5.6000E-01
1.2033E+01 5.3000E-01
1.9478E+01 5.1000E-01
2.4033E+01 0.0000E+00
7.2000E+02 0.0000E+00
Compartment 2:
0
1
0
0
0
0
0
0
0
Compartment 3:
0
1
0
0
0
0
0
0
0
Compartment 4:
0
1
0
0
0
0
0
0
0
Compartment 5:
0
1
0
0
0
0
0
0
0
Compartment 6:
0
1
0

0
0
0
0
0
0
Compartment 7:
0
1
0
0
0
0
0
0
0
Compartment 8:
0
1
0
0
0
0
0
0
0
Compartment 9:
0
1
0
0
0
0
0
0
0
Pathways:
15
Pathway 1:
0
0
0
0
0
1
3
0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
2.0330E+00 1.1940E+05 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 2:
0
0
0
0
0
1
3
0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
2.0330E+00 1.1940E+05 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 3:
0
0
0
0
0
1
2
0.0000E+00 2.2080E+00 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 1.6580E+00 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 2.4750E+04 9.0000E+01 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 6:
0
0
0
0
0
1
7
0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
2.4000E+02 1.3900E+02 9.0000E+01 0.0000E+00 0.0000E+00
2.6400E+02 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
4.8000E+02 1.3900E+02 9.0000E+01 0.0000E+00 0.0000E+00
5.0400E+02 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
6.9600E+02 1.3900E+02 9.0000E+01 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 7:
0
0
0
0
0
1
3
0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
8.0000E+00 1.6700E-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
Pathway 8:

0
0
0
0
0
1
2
0.0000E+00 2.0000E+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
Pathway 9:
0
0
0
0
0
1
2
0.0000E+00 2.4740E+04 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 10:
0
0
0
0
0
1
2
0.0000E+00 3.6250E-01 9.9970E+01 9.9700E+01 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 11:
0
0
0
0
0

1
2
0.0000E+00 3.7880E-01 9.2900E+01 2.5300E+01 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 12:
0
0
0
0
0
1
2
0.0000E+00 1.1100E+00 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 13:
0
0
0
0
0
1
2
0.0000E+00 1.0000E+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 14:
0
0
0
0
0
1
2
0.0000E+00 6.7170E+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 15:
0
0
0
0
0
1
2
0.0000E+00 6.7170E+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
Dose Locations:
3
Location 1:
Control Room
8
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
Location 2:
EAB
9
1
5
0.0000E+00 1.1900E-06
2.5000E+00 2.3500E-05
3.0000E+00 1.1900E-06
4.0000E+00 1.1900E-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:
LPZ
 9
 1
 8
 0.0000E+00  1.1300E-06
 2.0000E+00  5.7500E-07
 3.5000E+00  1.2600E-05
 4.0000E+00  5.7500E-07
 8.0000E+00  4.1000E-07
 2.4000E+01  1.9700E-07
 9.6000E+01  6.8800E-08
 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
Effective Volume Location:
 1
 8
 0.0000E+00  1.4100E-07
 2.0000E+00  4.5000E-08
 3.5000E+00  3.4000E-05
 4.0000E+00  4.5000E-08
 8.0000E+00  2.5400E-08
 2.4000E+01  7.3600E-09
 9.6000E+01  1.2400E-09
 7.2000E+02  0.0000E+00
Simulation Parameters:
 4
 0.0000E+00  1.0000E-01
 8.0000E+00  1.0000E+00
 2.4000E+01  2.4000E+01
 7.2000E+02  0.0000E+00
Output Filename:
C:\Users\jun\Documents\TVA Browns Ferry Nuclear\RADTRAD\QA Calc\StackTopFinal.o1
 1
 1
 1
 1
 1
End of Scenario File
```

StackTop_ESF.psf (Fumigation X/Q for EAB between 2.5 and 3 hours)
Radtrad 3.03 4/15/2001
Top of Stack -ESF Leakage
Nuclide Inventory File:
C:\Users\jun\Documents\TVA Browns Ferry Nuclear\RADTRAD\BFNESF.nif
Plant Power Level:
4.0310E+03
Compartments:
6
Compartment 1:
SP
3
1.4105E+05
0
0
0
0
0
Compartment 2:
RB
3
1.3110E+06
0
0
0
0
0
Compartment 3:
SR
3
3.4560E+04
0
0
0
0
0
Compartment 4:
CR
1
2.1000E+05
0
0
0
0
0
Compartment 5:
Environment
2
0.0000E+00
0
0
0
0

0
Compartment 6:
Dummy
3
1.0000E+06
0
0
0
0
0
Pathways:
6
Pathway 1:
SP to RB
1
2
2
Pathway 2:
RB to SR
2
3
2
Pathway 3:
SR to Dummy
3
6
2
Pathway 4:
SR to Environment
3
5
2
Pathway 5:
Environment to CR
5
4
2
Pathway 6:
CR to Environment
4
5
2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
1
1 1.0000E+00
c:\program files (x86)\radtrad3.03\defaults\fgr11&12.inp
C:\Users\jun\Documents\TVA Browns Ferry Nuclear\RADTRAD\BFN.RFT
0.0000E+00

1
9.5000E-01 4.8500E-02 1.5000E-03 1.0000E+00
Overlying Pool:
0
0.0000E+00
0
0
0
0
Compartments:
6
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
Compartment 4:
0
1
0
0
0
0
0
0
0
Compartment 5:
0

1
0
0
0
0
0
0
0
Compartment 6:
0
1
0
0
0
0
0
0
0
Pathways:
6
Pathway 1:
0
0
0
0
0
1
2
0.0000E+00 2.6740E+00 1.0000E+02 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 2:
0
0
0
0
0
1
2
0.0000E+00 2.4750E+04 9.0000E+01 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 3:

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
Pathway 4:
0
0
0
0
0
1
2
0.0000E+00 2.4740E+04 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 6.7170E+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 6:
0
0
0
0
0

1
2
0.0000E+00 6.7170E+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
Dose Locations:
3
Location 1:
Control Room
4
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
Location 2:
EAB
5
1
5
0.0000E+00 1.1900E-06
2.5000E+00 2.3500E-05
3.0000E+00 1.1900E-06
4.0000E+00 1.1900E-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:
LPZ
5
1
8
0.0000E+00 1.1300E-06
2.0000E+00 5.7500E-07
3.5000E+00 1.2600E-05
4.0000E+00 5.7500E-07
8.0000E+00 4.1000E-07

2.4000E+01 1.9700E-07
9.6000E+01 6.8800E-08
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
Effective Volume Location:
1
8
0.0000E+00 1.4100E-07
2.0000E+00 4.5000E-08
3.5000E+00 3.4000E-05
4.0000E+00 4.5000E-08
8.0000E+00 2.5400E-08
2.4000E+01 7.3600E-09
9.6000E+01 1.2400E-09
7.2000E+02 0.0000E+00
Simulation Parameters:
4
0.0000E+00 1.0000E-01
8.0000E+00 1.0000E+00
2.4000E+01 2.4000E+01
7.2000E+02 0.0000E+00
Output Filename:
C:\Users\jun\Documents\TVA Browns Ferry Nuclear\RADTRAD\QA Calc - 85\StackTop_ESF.o0
1
1
1
1
1
End of Scenario File

Appendix I2 –RADTRAD Secondary Input Files

BFN.nif

```
Nuclide Inventory Name:Kr85 & I131 multplied Tbl 3  1.183-14
 Normalized MACCS Sample 3578 MWth BWR Core Inventory
 Power Level:
  0.1000E+01
 Nuclides:
  60
 Nuclide 001:
 Co-58
  7
  0.6117120000E+07
  0.5800E+02
  0.1430E+03
 none     0.0000E+00
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 002:
 Co-60
  7
  0.1663401096E+09
  0.6000E+02
  0.1425E+03
 none     0.0000E+00
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 003:
 Kr-85
  1
  0.3382974720E+09
  0.8500E+02
  0.3601E+03
 none     0.0000E+00
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 004:
 Kr-85m
  1
  0.1612800000E+05
  0.8500E+02
  0.7329E+04
 Kr-85    0.2100E+00
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 005:
 Kr-87
  1
  0.4578000000E+04
```

0.8700E+02
0.1446E+05
Rb-87 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 006:
Kr-88
1
0.1022400000E+05
0.8800E+02
0.2009E+05
Rb-88 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 007:
Rb-86
3
0.1612224000E+07
0.8600E+02
0.6372E+02
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 008:
Sr-89
5
0.4363200000E+07
0.8900E+02
0.2786E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 009:
Sr-90
5
0.9189573120E+09
0.9000E+02
0.3165E+04
Y-90 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 010:
Sr-91
5
0.3420000000E+05
0.9100E+02
0.3487E+05
Y-91m 0.5800E+00
Y-91 0.4200E+00

none 0.0000E+00
Nuclide 011:
Sr-92
5
0.9756000000E+04
0.9200E+02
0.3677E+05
Y-92 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 012:
Y-90
9
0.2304000000E+06
0.9000E+02
0.3293E+04
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 013:
Y-91
9
0.5055264000E+07
0.9100E+02
0.3583E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 014:
Y-92
9
0.1274400000E+05
0.9200E+02
0.3696E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 015:
Y-93
9
0.3636000000E+05
0.9300E+02
0.4147E+05
Zr-93 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 016:
Zr-95
9

0.5527872000E+07
0.9500E+02
0.4880E+05
Nb-95m 0.7000E-02
Nb-95 0.9900E+00
none 0.0000E+00
Nuclide 017:
Zr-97
9
0.6084000000E+05
0.9700E+02
0.4953E+05
Nb-97m 0.9500E+00
Nb-97 0.5300E-01
none 0.0000E+00
Nuclide 018:
Nb-95
9
0.3036960000E+07
0.9500E+02
0.4897E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 019:
Mo-99
7
0.2376000000E+06
0.9900E+02
0.5088E+05
Tc-99m 0.8800E+00
Tc-99 0.1200E+00
none 0.0000E+00
Nuclide 020:
Tc-99m
7
0.2167200000E+05
0.9900E+02
0.4454E+05
Tc-99 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 021:
Ru-103
7
0.3393792000E+07
0.1030E+03
0.4094E+05
Rh-103m 0.1000E+01

none 0.0000E+00
none 0.0000E+00
Nuclide 022:
Ru-105
7
0.1598400000E+05
0.1050E+03
0.2710E+05
Rh-105 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 023:
Ru-106
7
0.3181248000E+08
0.1060E+03
0.1488E+05
Rh-106 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 024:
Rh-105
7
0.1272960000E+06
0.1050E+03
0.2559E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 025:
Sb-127
4
0.3326400000E+06
0.1270E+03
0.2796E+04
Te-127m 0.1800E+00
Te-127 0.8200E+00
none 0.0000E+00
Nuclide 026:
Sb-129
4
0.1555200000E+05
0.1290E+03
0.8457E+04
Te-129m 0.2200E+00
Te-129 0.7700E+00
none 0.0000E+00
Nuclide 027:
Te-127

4
0.3366000000E+05
0.1270E+03
0.2773E+04
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 028:
Te-127m
4
0.9417600000E+07
0.1270E+03
0.3721E+03
Te-127 0.9800E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 029:
Te-129
4
0.4176000000E+04
0.1290E+03
0.8326E+04
I-129 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 030:
Te-129m
4
0.2903040000E+07
0.1290E+03
0.1615E+04
Te-129 0.6500E+00
I-129 0.3500E+00
none 0.0000E+00
Nuclide 031:
Te-131m
4
0.1080000000E+06
0.1310E+03
0.5155E+04
Te-131 0.2200E+00
I-131 0.7800E+00
none 0.0000E+00
Nuclide 032:
Te-132
4
0.2815200000E+06
0.1320E+03
0.3829E+05

I-132 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 033:
I-131
2
0.6946560000E+06
0.1310E+03
0.2669E+05
Xe-131m 0.1100E-01
none 0.0000E+00
none 0.0000E+00
Nuclide 034:
I-132
2
0.8280000000E+04
0.1320E+03
0.3885E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 035:
I-133
2
0.7488000000E+05
0.1330E+03
0.5534E+05
Xe-133m 0.2900E-01
Xe-133 0.9700E+00
none 0.0000E+00
Nuclide 036:
I-134
2
0.3156000000E+04
0.1340E+03
0.6141E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 037:
I-135
2
0.2379600000E+05
0.1350E+03
0.5250E+05
Xe-135m 0.1500E+00
Xe-135 0.8500E+00
none 0.0000E+00
Nuclide 038:

Xe-133
1
0.4531680000E+06
0.1330E+03
0.5504E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 039:
Xe-135
1
0.3272400000E+05
0.1350E+03
0.1971E+05
Cs-135 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 040:
Cs-134
3
0.6507177120E+08
0.1340E+03
0.5703E+04
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 041:
Cs-136
3
0.1131840000E+07
0.1360E+03
0.1941E+04
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 042:
Cs-137
3
0.9467280000E+09
0.1370E+03
0.4037E+04
Ba-137m 0.9500E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 043:
Ba-139
6
0.4962000000E+04
0.1390E+03

0.4930E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 044:
Ba-140
6
0.1100736000E+07
0.1400E+03
0.4909E+05
La-140 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 045:
La-140
9
0.1449792000E+06
0.1400E+03
0.5231E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 046:
La-141
9
0.1414800000E+05
0.1410E+03
0.4498E+05
Ce-141 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 047:
La-142
9
0.5550000000E+04
0.1420E+03
0.4397E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 048:
Ce-141
8
0.2808086400E+07
0.1410E+03
0.4535E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00

Nuclide 049:
Ce-143
8
0.1188000000E+06
0.1430E+03
0.4245E+05
Pr-143 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 050:
Ce-144
8
0.2456352000E+08
0.1440E+03
0.3810E+05
Pr-144m 0.1800E-01
Pr-144 0.9800E+00
none 0.0000E+00
Nuclide 051:
Pr-143
9
0.1171584000E+07
0.1430E+03
0.4113E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 052:
Nd-147
9
0.9486720000E+06
0.1470E+03
0.1806E+05
Pm-147 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 053:
Np-239
8
0.2034720000E+06
0.2390E+03
0.5201E+06
Pu-239 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 054:
Pu-238
8
0.2768863824E+10

0.2380E+03
0.2805E+03
U-234 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 055:
Pu-239
8
0.7594336440E+12
0.2390E+03
0.1234E+02
U-235 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 056:
Pu-240
8
0.2062920312E+12
0.2400E+03
0.1730E+02
U-236 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 057:
Pu-241
8
0.4544294400E+09
0.2410E+03
0.4450E+04
U-237 0.2400E-04
Am-241 0.1000E+01
none 0.0000E+00
Nuclide 058:
Am-241
9
0.1363919472E+11
0.2410E+03
0.5449E+01
Np-237 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 059:
Cm-242
9
0.1406592000E+08
0.2420E+03
0.1234E+04
Pu-238 0.1000E+01
none 0.0000E+00

none 0.0000E+00
Nuclide 060:
Cm-244
9
0.5715081360E+09
0.2440E+03
0.5697E+02
Pu-240 0.1000E+01
none 0.0000E+00
none 0.0000E+00
End of Nuclear Inventory File

BFNESF.nif

Nuclide Inventory Name:ESF Leakage
Normalized TVA BFN 4031 MWth BWR Core Inventory
Power Level:
0.1000E+01
Nuclides:
60
Nuclide 001:
Co-58
7
0.6117120000E+07
0.5800E+02
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 002:
Co-60
7
0.1663401096E+09
0.6000E+02
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 003:
Kr-85
1
0.3382974720E+09
0.8500E+02
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 004:
Kr-85m
1
0.1612800000E+05
0.8500E+02
0.0000E+00
Kr-85 0.2100E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 005:
Kr-87
1
0.4578000000E+04
0.8700E+02
0.0000E+00
Rb-87 0.1000E+01
none 0.0000E+00
none 0.0000E+00

Nuclide 006:
Kr-88
1
0.1022400000E+05
0.8800E+02
0.0000E+00
Rb-88 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 007:
Rb-86
3
0.1612224000E+07
0.8600E+02
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 008:
Sr-89
5
0.4363200000E+07
0.8900E+02
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 009:
Sr-90
5
0.9189573120E+09
0.9000E+02
0.0000E+00
Y-90 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 010:
Sr-91
5
0.3420000000E+05
0.9100E+02
0.0000E+00
Y-91m 0.5800E+00
Y-91 0.4200E+00
none 0.0000E+00
Nuclide 011:
Sr-92
5
0.9756000000E+04
0.9200E+02
0.0000E+00
Y-92 0.1000E+01
none 0.0000E+00

none 0.0000E+00
Nuclide 012:
Y-90
9
0.2304000000E+06
0.9000E+02
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 013:
Y-91
9
0.5055264000E+07
0.9100E+02
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 014:
Y-92
9
0.1274400000E+05
0.9200E+02
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 015:
Y-93
9
0.3636000000E+05
0.9300E+02
0.0000E+00
Zr-93 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 016:
Zr-95
9
0.5527872000E+07
0.9500E+02
0.0000E+00
Nb-95m 0.7000E-02
Nb-95 0.9900E+00
none 0.0000E+00
Nuclide 017:
Zr-97
9
0.6084000000E+05
0.9700E+02
0.0000E+00
Nb-97m 0.9500E+00

Nb-97 0.5300E-01
none 0.0000E+00
Nuclide 018:
Nb-95
9
0.3036960000E+07
0.9500E+02
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 019:
Mo-99
7
0.2376000000E+06
0.9900E+02
0.0000E+00
Tc-99m 0.8800E+00
Tc-99 0.1200E+00
none 0.0000E+00
Nuclide 020:
Tc-99m
7
0.2167200000E+05
0.9900E+02
0.0000E+00
Tc-99 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 021:
Ru-103
7
0.3393792000E+07
0.1030E+03
0.0000E+00
Rh-103m 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 022:
Ru-105
7
0.1598400000E+05
0.1050E+03
0.0000E+00
Rh-105 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 023:
Ru-106
7
0.3181248000E+08
0.1060E+03
0.0000E+00

Rh-106 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 024:
Rh-105
7
0.1272960000E+06
0.1050E+03
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 025:
Sb-127
4
0.3326400000E+06
0.1270E+03
0.0000E+00
Te-127m 0.1800E+00
Te-127 0.8200E+00
none 0.0000E+00
Nuclide 026:
Sb-129
4
0.1555200000E+05
0.1290E+03
0.0000E+00
Te-129m 0.2200E+00
Te-129 0.7700E+00
none 0.0000E+00
Nuclide 027:
Te-127
4
0.3366000000E+05
0.1270E+03
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 028:
Te-127m
4
0.9417600000E+07
0.1270E+03
0.0000E+00
Te-127 0.9800E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 029:
Te-129
4
0.4176000000E+04
0.1290E+03

0.0000E+00
I-129 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 030:
Te-129m
4
0.2903040000E+07
0.1290E+03
0.0000E+00
Te-129 0.6500E+00
I-129 0.3500E+00
none 0.0000E+00
Nuclide 031:
Te-131m
4
0.1080000000E+06
0.1310E+03
0.0000E+00
Te-131 0.2200E+00
I-131 0.7800E+00
none 0.0000E+00
Nuclide 032:
Te-132
4
0.2815200000E+06
0.1320E+03
0.0000E+00
I-132 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 033:
I-131
2
0.6946560000E+06
0.1310E+03
0.5338E+05
Xe-131m 0.1100E-01
none 0.0000E+00
none 0.0000E+00
Nuclide 034:
I-132
2
0.8280000000E+04
0.1320E+03
0.7770E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 035:
I-133
2
0.7488000000E+05

0.1330E+03
0.1107E+06
Xe-133m 0.2900E-01
Xe-133 0.9700E+00
none 0.0000E+00
Nuclide 036:
I-134
2
0.3156000000E+04
0.1340E+03
0.1228E+06
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 037:
I-135
2
0.2379600000E+05
0.1350E+03
0.1050E+06
Xe-135m 0.1500E+00
Xe-135 0.8500E+00
none 0.0000E+00
Nuclide 038:
Xe-133
1
0.4531680000E+06
0.1330E+03
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 039:
Xe-135
1
0.3272400000E+05
0.1350E+03
0.0000E+00
Cs-135 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 040:
Cs-134
3
0.6507177120E+08
0.1340E+03
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 041:
Cs-136
3

0.1131840000E+07
0.1360E+03
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 042:
Cs-137
3
0.9467280000E+09
0.1370E+03
0.0000E+00
Ba-137m 0.9500E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 043:
Ba-139
6
0.4962000000E+04
0.1390E+03
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 044:
Ba-140
6
0.1100736000E+07
0.1400E+03
0.0000E+00
La-140 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 045:
La-140
9
0.1449792000E+06
0.1400E+03
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 046:
La-141
9
0.1414800000E+05
0.1410E+03
0.0000E+00
Ce-141 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 047:
La-142

9
0.5550000000E+04
0.1420E+03
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 048:
Ce-141
8
0.2808086400E+07
0.1410E+03
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 049:
Ce-143
8
0.1188000000E+06
0.1430E+03
0.0000E+00
Pr-143 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 050:
Ce-144
8
0.2456352000E+08
0.1440E+03
0.0000E+00
Pr-144m 0.1800E-01
Pr-144 0.9800E+00
none 0.0000E+00
Nuclide 051:
Pr-143
9
0.1171584000E+07
0.1430E+03
0.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 052:
Nd-147
9
0.9486720000E+06
0.1470E+03
0.0000E+00
Pm-147 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 053:

Np-239
8
0.2034720000E+06
0.2390E+03
0.0000E+00
Pu-239 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 054:
Pu-238
8
0.2768863824E+10
0.2380E+03
0.0000E+00
U-234 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 055:
Pu-239
8
0.7594336440E+12
0.2390E+03
0.0000E+00
U-235 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 056:
Pu-240
8
0.2062920312E+12
0.2400E+03
0.0000E+00
U-236 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 057:
Pu-241
8
0.4544294400E+09
0.2410E+03
0.0000E+00
U-237 0.2400E-04
Am-241 0.1000E+01
none 0.0000E+00
Nuclide 058:
Am-241
9
0.1363919472E+11
0.2410E+03
0.0000E+00
Np-237 0.1000E+01
none 0.0000E+00
none 0.0000E+00

Nuclide 059:
Cm-242
9
0.1406592000E+08
0.2420E+03
0.0000E+00
Pu-238 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 060:
Cm-244
9
0.5715081360E+09
0.2440E+03
0.0000E+00
Pu-240 0.1000E+01
none 0.0000E+00
none 0.0000E+00
End of Nuclear Inventory File

BFN.rft

Release Fraction and Timing Name:
BWR, RG 1.183, Table 1 Section 3.2
Duration (h): Design Basis Accident
0.3333E-01 0.5000E+00 0.1500E+01 0.0000E+00
Noble Gases:
0.0000E+00 0.5000E-01 0.9500E+00 0.0000E+00
Iodine:
0.0000E+00 0.5000E-01 0.2500E+00 0.0000E+00
Cesium:
0.0000E+00 0.5000E-01 0.2000E+00 0.0000E+00
Tellurium:
0.0000E+00 0.0000E+00 0.0500E+00 0.0000E+00
Strontium:
0.0000E+00 0.0000E+00 0.2000E-01 0.0000E+00
Barium:
0.0000E+00 0.0000E+00 0.2000E-01 0.0000E+00
Ruthenium:
0.0000E+00 0.0000E+00 0.2500E-02 0.0000E+00
Cerium:
0.0000E+00 0.0000E+00 0.5000E-03 0.0000E+00
Lanthanum:
0.0000E+00 0.0000E+00 0.2000E-03 0.0000E+00
Non-Radioactive Aerosols (kg):
0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
End of Release File

FGR11&12.inp

FGRDCF 10/24/95 03:24:50 beta-test version 1.10, minor FORTRAN fixes 5/4/95
Implicit daughter halflives (m) less than 90 and less than 0.100 of parent
9 ORGANS DEFINED IN THIS FILE:
GONADS
BREAST
LUNGS
RED MARR
BONE SUR
THYROID
REMAINDER
EFFECTIVE
SKIN(FGR)
60 NUCLIDES DEFINED IN THIS FILE:
Co-58 Y
Co-60 Y
Kr-85
Kr-85m
Kr-87
Kr-88
Rb-86 D
Sr-89 Y
Sr-90 Y
Sr-91 Y Including:Y-91m
Sr-92 Y
Y-90 Y
Y-91 Y
Y-92 Y
Y-93 Y
Zr-95 D
Zr-97 Y Including:Nb-97m , Including:Nb-97
Nb-95 Y
Mo-99 Y
Tc-99m D
Ru-103 Y Including:Rh-103m
Ru-105 Y
Ru-106 Y Including:Rh-106
Rh-105 Y
Sb-127 W
Sb-129 W
Te-127 W
Te-127m W
Te-129 W
Te-129m W Including:Te-129
Te-131m W Including:Te-131
Te-132 W

I-131 D
I-132 D
I-133 D
I-134 D
I-135 D Including:Xe-135m
Xe-133
Xe-135
Cs-134 D
Cs-136 D
Cs-137 D Including:Ba-137m
Ba-139 D
Ba-140 D
La-140 W
La-141 D
La-142 D
Ce-141 Y
Ce-143 Y
Ce-144 Y Including:Pr-144m, Including:Pr-144
Pr-143 Y
Nd-147 Y
Np-239 W
Pu-238 Y
Pu-239 Y
Pu-240 Y
Pu-241 Y
Am-241 W
Cm-242 W
Cm-244 W

CLOUDSHINE GROUND GROUND GROUND INHALED INHALED INGESTION
SHINE 8HR SHINE 7DAY SHINE RATE ACUTE CHRONIC

Co-58
GONADS 4.660E-14 2.867E-11 5.828E-10 9.970E-16-1.000E+00 6.170E-10 1.040E-09
BREAST 5.300E-14 2.737E-11 5.565E-10 9.520E-16-1.000E+00 9.370E-10 1.790E-10
LUNGS 4.640E-14 2.617E-11 5.319E-10 9.100E-16-1.000E+00 1.600E-08 8.530E-11
RED MARR 4.530E-14 2.671E-11 5.430E-10 9.290E-16-1.000E+00 9.230E-10 2.600E-10
BONE SUR 7.410E-14 3.795E-11 7.716E-10 1.320E-15-1.000E+00 6.930E-10 1.250E-10
THYROID 4.770E-14 2.720E-11 5.530E-10 9.460E-16-1.000E+00 8.720E-10 6.310E-11
REMAINDER 4.440E-14 2.585E-11 5.255E-10 8.990E-16-1.000E+00 1.890E-09 1.580E-09
EFFECTIVE 4.760E-14 2.732E-11 5.553E-10 9.500E-16-1.000E+00 2.940E-09 8.090E-10
SKIN(FGR) 5.580E-14 3.278E-11 6.664E-10 1.140E-15-1.000E+00 0.000E+00 0.000E+00
Co-60
GONADS 1.230E-13 7.056E-11 1.480E-09 2.450E-15-1.000E+00 4.760E-09 3.190E-09
BREAST 1.390E-13 6.739E-11 1.413E-09 2.340E-15-1.000E+00 1.840E-08 1.100E-09
LUNGS 1.240E-13 6.537E-11 1.371E-09 2.270E-15-1.000E+00 3.450E-07 8.770E-10
RED MARR 1.230E-13 6.710E-11 1.407E-09 2.330E-15-1.000E+00 1.720E-08 1.320E-09
BONE SUR 1.780E-13 8.956E-11 1.879E-09 3.110E-15-1.000E+00 1.350E-08 9.390E-10
THYROID 1.270E-13 6.480E-11 1.359E-09 2.250E-15-1.000E+00 1.620E-08 7.880E-10
REMAINDER 1.200E-13 6.508E-11 1.365E-09 2.260E-15-1.000E+00 3.600E-08 4.970E-09
EFFECTIVE 1.260E-13 6.768E-11 1.419E-09 2.350E-15-1.000E+00 5.910E-08 2.770E-09

SKIN(FGR) 1.450E-13 7.948E-11 1.667E-09 2.760E-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
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
Rb-86
GONADS 4.710E-15 2.788E-12 5.187E-11 9.740E-17-1.000E+00 1.340E-09 2.150E-09
BREAST 5.340E-15 2.662E-12 4.953E-11 9.300E-17-1.000E+00 1.330E-09 2.140E-09
LUNGS 4.710E-15 2.553E-12 4.750E-11 8.920E-17-1.000E+00 3.300E-09 2.140E-09
RED MARR 4.640E-15 2.619E-12 4.873E-11 9.150E-17-1.000E+00 2.320E-09 3.720E-09
BONE SUR 7.050E-15 3.635E-12 6.764E-11 1.270E-16-1.000E+00 4.270E-09 6.860E-09
THYROID 4.840E-15 2.599E-12 4.836E-11 9.080E-17-1.000E+00 1.330E-09 2.140E-09
REMAINDER 4.520E-15 2.542E-12 4.729E-11 8.880E-17-1.000E+00 1.380E-09 2.330E-09

EFFECTIVE 4.810E-15 2.665E-12 4.958E-11 9.310E-17-1.000E+00 1.790E-09 2.530E-09
SKIN(FGR) 4.850E-14 2.210E-10 4.111E-09 7.720E-15-1.000E+00 0.000E+00 0.000E+00
Sr-89
GONADS 7.730E-17 7.155E-14 1.436E-12 2.490E-18-1.000E+00 7.950E-12 8.050E-12
BREAST 9.080E-17 7.212E-14 1.447E-12 2.510E-18-1.000E+00 7.960E-12 7.980E-12
LUNGS 7.080E-17 5.689E-14 1.142E-12 1.980E-18-1.000E+00 8.350E-08 7.970E-12
RED MARR 6.390E-17 5.345E-14 1.073E-12 1.860E-18-1.000E+00 1.070E-10 1.080E-10
BONE SUR 1.940E-16 1.560E-13 3.131E-12 5.430E-18-1.000E+00 1.590E-10 1.610E-10
THYROID 7.600E-17 6.063E-14 1.217E-12 2.110E-18-1.000E+00 7.960E-12 7.970E-12
REMAINDER 6.710E-17 5.603E-14 1.124E-12 1.950E-18-1.000E+00 3.970E-09 8.250E-09
EFFECTIVE 7.730E-17 6.523E-14 1.309E-12 2.270E-18-1.000E+00 1.120E-08 2.500E-09
SKIN(FGR) 3.690E-14 1.914E-10 3.841E-09 6.660E-15-1.000E+00 0.000E+00 0.000E+00
Sr-90
GONADS 7.780E-18 9.590E-15 2.014E-13 3.330E-19-1.000E+00 2.690E-10 5.040E-11
BREAST 9.490E-18 1.008E-14 2.116E-13 3.500E-19-1.000E+00 2.690E-10 5.040E-11
LUNGS 6.440E-18 6.307E-15 1.324E-13 2.190E-19-1.000E+00 2.860E-06 5.040E-11
RED MARR 5.440E-18 5.558E-15 1.167E-13 1.930E-19-1.000E+00 3.280E-08 6.450E-09
BONE SUR 2.280E-17 2.393E-14 5.025E-13 8.310E-19-1.000E+00 7.090E-08 1.390E-08
THYROID 7.330E-18 7.171E-15 1.506E-13 2.490E-19-1.000E+00 2.690E-10 5.040E-11
REMAINDER 6.110E-18 6.422E-15 1.348E-13 2.230E-19-1.000E+00 5.730E-09 6.700E-09
EFFECTIVE 7.530E-18 8.179E-15 1.717E-13 2.840E-19-1.000E+00 3.510E-07 3.230E-09
SKIN(FGR) 9.200E-15 4.032E-12 8.465E-11 1.400E-16-1.000E+00 0.000E+00 0.000E+00
Sr-91
GONADS 4.819E-14 2.155E-11 5.062E-11 1.026E-15-1.000E+00 5.669E-11 2.520E-10
BREAST 5.477E-14 2.059E-11 4.838E-11 9.806E-16-1.000E+00 1.775E-11 3.676E-11
LUNGS 4.803E-14 1.970E-11 4.626E-11 9.376E-16-1.000E+00 2.170E-09 1.055E-11
RED MARR 4.691E-14 2.011E-11 4.722E-11 9.570E-16-1.000E+00 2.275E-11 5.659E-11
BONE SUR 7.674E-14 2.852E-11 6.709E-11 1.360E-15-1.000E+00 1.306E-11 2.070E-11
THYROID 4.938E-14 2.035E-11 4.782E-11 9.693E-16-1.000E+00 9.930E-12 1.968E-12
REMAINDER 4.610E-14 1.948E-11 4.573E-11 9.268E-16-1.000E+00 5.802E-10 2.557E-09
EFFECTIVE 4.924E-14 2.057E-11 4.832E-11 9.793E-16-1.000E+00 4.547E-10 8.455E-10
SKIN(FGR) 9.938E-14 1.748E-10 3.987E-10 8.080E-15-1.000E+00 0.000E+00 0.000E+00
Sr-92
GONADS 6.610E-14 1.593E-11 1.830E-11 1.300E-15-1.000E+00 1.020E-11 8.180E-11
BREAST 7.480E-14 1.520E-11 1.745E-11 1.240E-15-1.000E+00 6.490E-12 1.700E-11
LUNGS 6.670E-14 1.483E-11 1.703E-11 1.210E-15-1.000E+00 1.050E-09 7.220E-12
RED MARR 6.620E-14 1.520E-11 1.745E-11 1.240E-15-1.000E+00 6.980E-12 2.290E-11
BONE SUR 9.490E-14 2.010E-11 2.308E-11 1.640E-15-1.000E+00 4.360E-12 8.490E-12
THYROID 6.820E-14 1.446E-11 1.661E-11 1.180E-15-1.000E+00 3.920E-12 1.300E-12
REMAINDER 6.450E-14 1.471E-11 1.689E-11 1.200E-15-1.000E+00 2.900E-10 1.720E-09
EFFECTIVE 6.790E-14 1.532E-11 1.759E-11 1.250E-15-1.000E+00 2.180E-10 5.430E-10
SKIN(FGR) 8.560E-14 2.280E-11 2.618E-11 1.860E-15-1.000E+00 0.000E+00 0.000E+00
Y-90
GONADS 1.890E-16 1.586E-13 1.601E-12 5.750E-18-1.000E+00 5.170E-13 1.430E-14
BREAST 2.200E-16 1.578E-13 1.593E-12 5.720E-18-1.000E+00 5.170E-13 1.270E-14
LUNGS 1.770E-16 1.313E-13 1.326E-12 4.760E-18-1.000E+00 9.310E-09 1.260E-14
RED MARR 1.620E-16 1.261E-13 1.273E-12 4.570E-18-1.000E+00 1.520E-11 3.700E-13
BONE SUR 4.440E-16 3.228E-13 3.259E-12 1.170E-17-1.000E+00 1.510E-11 3.670E-13
THYROID 1.870E-16 1.385E-13 1.398E-12 5.020E-18-1.000E+00 5.170E-13 1.260E-14

REMAINDER 1.680E-16 1.291E-13 1.303E-12 4.680E-18-1.000E+00 3.870E-09 9.680E-09
EFFECTIVE 1.900E-16 1.468E-13 1.482E-12 5.320E-18-1.000E+00 2.280E-09 2.910E-09
SKIN(FGR) 6.240E-14 2.897E-10 2.924E-09 1.050E-14-1.000E+00 0.000E+00 0.000E+00
Y-91
GONADS 2.560E-16 1.756E-13 3.546E-12 6.110E-18-1.000E+00 8.200E-12 3.540E-12
BREAST 2.930E-16 1.713E-13 3.459E-12 5.960E-18-1.000E+00 8.920E-12 5.540E-13
LUNGS 2.500E-16 1.526E-13 3.082E-12 5.310E-18-1.000E+00 9.870E-08 2.020E-13
RED MARR 2.410E-16 1.521E-13 3.070E-12 5.290E-18-1.000E+00 3.190E-10 6.590E-12
BONE SUR 4.560E-16 2.903E-13 5.862E-12 1.010E-17-1.000E+00 3.180E-10 6.130E-12
THYROID 2.600E-16 1.564E-13 3.157E-12 5.440E-18-1.000E+00 8.500E-12 1.290E-13
REMAINDER 2.390E-16 1.509E-13 3.047E-12 5.250E-18-1.000E+00 4.200E-09 8.570E-09
EFFECTIVE 2.600E-16 1.650E-13 3.332E-12 5.740E-18-1.000E+00 1.320E-08 2.570E-09
SKIN(FGR) 3.850E-14 1.989E-10 4.016E-09 6.920E-15-1.000E+00 0.000E+00 0.000E+00
Y-92
GONADS 1.270E-14 3.855E-12 4.872E-12 2.650E-16-1.000E+00 2.610E-12 1.960E-11
BREAST 1.440E-14 3.680E-12 4.652E-12 2.530E-16-1.000E+00 1.500E-12 3.550E-12
LUNGS 1.270E-14 3.535E-12 4.468E-12 2.430E-16-1.000E+00 1.240E-09 1.390E-12
RED MARR 1.250E-14 3.608E-12 4.560E-12 2.480E-16-1.000E+00 2.070E-12 4.910E-12
BONE SUR 1.950E-14 5.091E-12 6.435E-12 3.500E-16-1.000E+00 1.510E-12 1.750E-12
THYROID 1.300E-14 3.579E-12 4.523E-12 2.460E-16-1.000E+00 1.050E-12 1.770E-13
REMAINDER 1.220E-14 3.506E-12 4.431E-12 2.410E-16-1.000E+00 2.030E-10 1.700E-09
EFFECTIVE 1.300E-14 3.680E-12 4.652E-12 2.530E-16-1.000E+00 2.110E-10 5.150E-10
SKIN(FGR) 1.140E-13 2.022E-10 2.556E-10 1.390E-14-1.000E+00 0.000E+00 0.000E+00
Y-93
GONADS 4.670E-15 2.108E-12 4.989E-12 9.510E-17-1.000E+00 5.310E-12 2.200E-11
BREAST 5.300E-15 2.026E-12 4.794E-12 9.140E-17-1.000E+00 1.740E-12 3.130E-12
LUNGS 4.680E-15 1.937E-12 4.585E-12 8.740E-17-1.000E+00 2.520E-09 8.670E-13
RED MARR 4.580E-15 1.972E-12 4.669E-12 8.900E-17-1.000E+00 4.040E-12 4.930E-12
BONE SUR 7.580E-15 2.948E-12 6.977E-12 1.330E-16-1.000E+00 3.140E-12 1.730E-12
THYROID 4.790E-15 1.908E-12 4.516E-12 8.610E-17-1.000E+00 9.260E-13 1.260E-13
REMAINDER 4.510E-15 1.919E-12 4.543E-12 8.660E-17-1.000E+00 9.250E-10 4.090E-09
EFFECTIVE 4.800E-15 2.021E-12 4.784E-12 9.120E-17-1.000E+00 5.820E-10 1.230E-09
SKIN(FGR) 8.500E-14 2.726E-10 6.452E-10 1.230E-14-1.000E+00 0.000E+00 0.000E+00
Zr-95
GONADS 3.530E-14 2.182E-11 4.421E-10 7.590E-16-1.000E+00 1.880E-09 8.160E-10
BREAST 4.010E-14 2.084E-11 4.223E-10 7.250E-16-1.000E+00 1.910E-09 1.050E-10
LUNGS 3.510E-14 1.989E-11 4.030E-10 6.920E-16-1.000E+00 2.170E-09 2.340E-11
RED MARR 3.430E-14 2.030E-11 4.112E-10 7.060E-16-1.000E+00 1.300E-08 2.140E-10
BONE SUR 5.620E-14 2.875E-11 5.824E-10 1.000E-15-1.000E+00 1.030E-07 4.860E-10
THYROID 3.610E-14 2.076E-11 4.205E-10 7.220E-16-1.000E+00 1.440E-09 8.270E-12
REMAINDER 3.360E-14 1.963E-11 3.978E-10 6.830E-16-1.000E+00 2.280E-09 2.530E-09
EFFECTIVE 3.600E-14 2.078E-11 4.211E-10 7.230E-16-1.000E+00 6.390E-09 1.020E-09
SKIN(FGR) 4.500E-14 2.561E-11 5.190E-10 8.910E-16-1.000E+00 0.000E+00 0.000E+00
Zr-97
GONADS 4.331E-14 2.179E-11 7.799E-11 9.253E-16-1.000E+00 1.840E-10 6.228E-10
BREAST 4.928E-14 2.083E-11 7.455E-11 8.846E-16-1.000E+00 4.706E-11 8.137E-11
LUNGS 4.322E-14 1.992E-11 7.127E-11 8.456E-16-1.000E+00 4.108E-09 1.770E-11
RED MARR 4.224E-14 2.034E-11 7.279E-11 8.634E-16-1.000E+00 6.376E-11 1.302E-10
BONE SUR 6.897E-14 2.881E-11 1.031E-10 1.224E-15-1.000E+00 3.504E-11 4.558E-11

THYROID 4.443E-14 2.061E-11 7.377E-11 8.755E-16-1.000E+00 2.315E-11 2.671E-12
REMAINDER 4.139E-14 1.966E-11 7.035E-11 8.345E-16-1.000E+00 2.041E-09 6.990E-09
EFFECTIVE 4.432E-14 2.078E-11 7.438E-11 8.824E-16-1.000E+00 1.171E-09 2.283E-09
SKIN(FGR) 9.835E-14 2.281E-10 8.148E-10 9.587E-15-1.000E+00 0.000E+00 0.000E+00
Nb-95
GONADS 3.660E-14 2.253E-11 4.435E-10 7.850E-16-1.000E+00 4.320E-10 8.050E-10
BREAST 4.160E-14 2.150E-11 4.231E-10 7.490E-16-1.000E+00 4.070E-10 1.070E-10
LUNGS 3.650E-14 2.055E-11 4.045E-10 7.160E-16-1.000E+00 8.320E-09 2.740E-11
RED MARR 3.560E-14 2.101E-11 4.135E-10 7.320E-16-1.000E+00 4.420E-10 1.990E-10
BONE SUR 5.790E-14 2.957E-11 5.819E-10 1.030E-15-1.000E+00 5.130E-10 2.940E-10
THYROID 3.750E-14 2.144E-11 4.220E-10 7.470E-16-1.000E+00 3.580E-10 1.180E-11
REMAINDER 3.490E-14 2.032E-11 4.000E-10 7.080E-16-1.000E+00 1.070E-09 1.470E-09
EFFECTIVE 3.740E-14 2.147E-11 4.226E-10 7.480E-16-1.000E+00 1.570E-09 6.950E-10
SKIN(FGR) 4.300E-14 2.598E-11 5.112E-10 9.050E-16-1.000E+00 0.000E+00 0.000E+00
Mo-99
GONADS 7.130E-15 4.282E-12 4.403E-11 1.550E-16-1.000E+00 9.510E-11 2.180E-10
BREAST 8.130E-15 4.116E-12 4.233E-11 1.490E-16-1.000E+00 2.750E-11 3.430E-11
LUNGS 7.060E-15 3.867E-12 3.977E-11 1.400E-16-1.000E+00 4.290E-09 1.510E-11
RED MARR 6.820E-15 3.923E-12 4.034E-11 1.420E-16-1.000E+00 5.240E-11 8.320E-11
BONE SUR 1.240E-14 6.105E-12 6.278E-11 2.210E-16-1.000E+00 4.130E-11 6.320E-11
THYROID 7.270E-15 4.033E-12 4.147E-11 1.460E-16-1.000E+00 1.520E-11 1.030E-11
REMAINDER 6.740E-15 3.812E-12 3.920E-11 1.380E-16-1.000E+00 1.740E-09 4.280E-09
EFFECTIVE 7.280E-15 4.061E-12 4.176E-11 1.470E-16-1.000E+00 1.070E-09 1.360E-09
SKIN(FGR) 3.140E-14 1.039E-10 1.068E-09 3.760E-15-1.000E+00 0.000E+00 0.000E+00
Tc-99m
GONADS 5.750E-15 2.334E-12 3.877E-12 1.240E-16-1.000E+00 2.770E-12 9.750E-12
BREAST 6.650E-15 2.258E-12 3.752E-12 1.200E-16-1.000E+00 2.150E-12 3.570E-12
LUNGS 5.490E-15 2.127E-12 3.533E-12 1.130E-16-1.000E+00 2.280E-11 3.140E-12
RED MARR 4.910E-15 2.070E-12 3.439E-12 1.100E-16-1.000E+00 3.360E-12 6.290E-12
BONE SUR 1.630E-14 5.383E-12 8.942E-12 2.860E-16-1.000E+00 2.620E-12 4.060E-12
THYROID 5.750E-15 2.145E-12 3.564E-12 1.140E-16-1.000E+00 5.010E-11 8.460E-11
REMAINDER 5.150E-15 2.070E-12 3.439E-12 1.100E-16-1.000E+00 1.020E-11 3.340E-11
EFFECTIVE 5.890E-15 2.277E-12 3.783E-12 1.210E-16-1.000E+00 8.800E-12 1.680E-11
SKIN(FGR) 7.140E-15 2.710E-12 4.502E-12 1.440E-16-1.000E+00 0.000E+00 0.000E+00
Ru-103
GONADS 2.191E-14 1.404E-11 2.783E-10 4.892E-16-1.000E+00 3.070E-10 5.720E-10
BREAST 2.512E-14 1.350E-11 2.677E-10 4.705E-16-1.000E+00 3.110E-10 1.200E-10
LUNGS 2.180E-14 1.273E-11 2.522E-10 4.432E-16-1.000E+00 1.561E-08 7.310E-11
RED MARR 2.100E-14 1.287E-11 2.551E-10 4.483E-16-1.000E+00 3.190E-10 1.660E-10
BONE SUR 3.892E-14 1.958E-11 3.882E-10 6.823E-16-1.000E+00 2.370E-10 9.631E-11
THYROID 2.241E-14 1.331E-11 2.639E-10 4.638E-16-1.000E+00 2.570E-10 6.250E-11
REMAINDER 2.080E-14 1.248E-11 2.472E-10 4.346E-16-1.000E+00 1.250E-09 2.110E-09
EFFECTIVE 2.251E-14 1.332E-11 2.641E-10 4.642E-16-1.000E+00 2.421E-09 8.271E-10
SKIN(FGR) 2.774E-14 1.785E-11 3.543E-10 6.229E-16-1.000E+00 0.000E+00 0.000E+00
Ru-105
GONADS 3.720E-14 1.327E-11 1.861E-11 8.070E-16-1.000E+00 1.590E-11 9.670E-11
BREAST 4.240E-14 1.271E-11 1.783E-11 7.730E-16-1.000E+00 6.610E-12 1.590E-11
LUNGS 3.700E-14 1.210E-11 1.697E-11 7.360E-16-1.000E+00 5.730E-10 6.210E-12
RED MARR 3.590E-14 1.230E-11 1.725E-11 7.480E-16-1.000E+00 7.700E-12 2.350E-11

BONE SUR 6.280E-14 1.809E-11 2.537E-11 1.100E-15-1.000E+00 4.620E-12 8.890E-12
THYROID 3.800E-14 1.260E-11 1.766E-11 7.660E-16-1.000E+00 4.150E-12 1.820E-12
REMAINDER 3.540E-14 1.189E-11 1.667E-11 7.230E-16-1.000E+00 1.610E-10 8.540E-10
EFFECTIVE 3.810E-14 1.265E-11 1.773E-11 7.690E-16-1.000E+00 1.230E-10 2.870E-10
SKIN(FGR) 6.730E-14 7.368E-11 1.033E-10 4.480E-15-1.000E+00 0.000E+00 0.000E+00
Ru-106
GONADS 1.010E-14 6.411E-12 1.340E-10 2.230E-16-1.000E+00 1.300E-09 1.640E-09
BREAST 1.160E-14 6.152E-12 1.286E-10 2.140E-16-1.000E+00 1.780E-09 1.440E-09
LUNGS 1.010E-14 5.836E-12 1.220E-10 2.030E-16-1.000E+00 1.040E-06 1.420E-09
RED MARR 9.750E-15 5.893E-12 1.232E-10 2.050E-16-1.000E+00 1.760E-09 1.460E-09
BONE SUR 1.720E-14 8.883E-12 1.856E-10 3.090E-16-1.000E+00 1.610E-09 1.430E-09
THYROID 1.030E-14 6.066E-12 1.268E-10 2.110E-16-1.000E+00 1.720E-09 1.410E-09
REMAINDER 9.630E-15 5.721E-12 1.196E-10 1.990E-16-1.000E+00 1.200E-08 2.110E-08
EFFECTIVE 1.040E-14 6.095E-12 1.274E-10 2.120E-16-1.000E+00 1.290E-07 7.400E-09
SKIN(FGR) 1.090E-13 4.082E-10 8.531E-09 1.420E-14-1.000E+00 0.000E+00 0.000E+00
Rh-105
GONADS 3.640E-15 2.127E-12 1.411E-11 7.980E-17-1.000E+00 2.110E-11 5.800E-11
BREAST 4.160E-15 2.063E-12 1.369E-11 7.740E-17-1.000E+00 5.610E-12 8.970E-12
LUNGS 3.570E-15 1.935E-12 1.284E-11 7.260E-17-1.000E+00 9.580E-10 3.860E-12
RED MARR 3.380E-15 1.946E-12 1.291E-11 7.300E-17-1.000E+00 7.770E-12 1.470E-11
BONE SUR 7.530E-15 3.332E-12 2.210E-11 1.250E-16-1.000E+00 4.460E-12 6.750E-12
THYROID 3.680E-15 1.983E-12 1.316E-11 7.440E-17-1.000E+00 2.880E-12 2.910E-12
REMAINDER 3.390E-15 1.885E-12 1.250E-11 7.070E-17-1.000E+00 4.530E-10 1.270E-09
EFFECTIVE 3.720E-15 2.031E-12 1.347E-11 7.620E-17-1.000E+00 2.580E-10 3.990E-10
SKIN(FGR) 1.070E-14 4.691E-12 3.112E-11 1.760E-16-1.000E+00 0.000E+00 0.000E+00
Sb-127
GONADS 3.260E-14 1.985E-11 2.441E-10 7.100E-16-1.000E+00 2.520E-10 6.140E-10
BREAST 3.720E-14 1.904E-11 2.341E-10 6.810E-16-1.000E+00 9.120E-11 7.600E-11
LUNGS 3.240E-14 1.809E-11 2.224E-10 6.470E-16-1.000E+00 6.940E-09 1.570E-11
RED MARR 3.140E-14 1.834E-11 2.255E-10 6.560E-16-1.000E+00 1.610E-10 1.330E-10
BONE SUR 5.520E-14 2.720E-11 3.345E-10 9.730E-16-1.000E+00 1.340E-10 5.240E-11
THYROID 3.330E-14 1.884E-11 2.317E-10 6.740E-16-1.000E+00 6.150E-11 4.640E-12
REMAINDER 3.090E-14 1.775E-11 2.183E-10 6.350E-16-1.000E+00 2.330E-09 5.870E-09
EFFECTIVE 3.330E-14 1.890E-11 2.324E-10 6.760E-16-1.000E+00 1.630E-09 1.950E-09
SKIN(FGR) 5.580E-14 7.967E-11 9.799E-10 2.850E-15-1.000E+00 0.000E+00 0.000E+00
Sb-129
GONADS 6.970E-14 2.336E-11 3.231E-11 1.440E-15-1.000E+00 2.150E-11 1.510E-10
BREAST 7.910E-14 2.222E-11 3.074E-11 1.370E-15-1.000E+00 1.280E-11 2.560E-11
LUNGS 6.980E-14 2.141E-11 2.962E-11 1.320E-15-1.000E+00 8.980E-10 9.390E-12
RED MARR 6.860E-14 2.190E-11 3.029E-11 1.350E-15-1.000E+00 1.700E-11 3.670E-11
BONE SUR 1.070E-13 3.033E-11 4.196E-11 1.870E-15-1.000E+00 1.460E-11 1.340E-11
THYROID 7.160E-14 2.174E-11 3.007E-11 1.340E-15-1.000E+00 9.720E-12 1.470E-12
REMAINDER 6.710E-14 2.125E-11 2.939E-11 1.310E-15-1.000E+00 1.870E-10 1.450E-09
EFFECTIVE 7.140E-14 2.238E-11 3.096E-11 1.380E-15-1.000E+00 1.740E-10 4.840E-10
SKIN(FGR) 1.050E-13 8.273E-11 1.144E-10 5.100E-15-1.000E+00 0.000E+00 0.000E+00
Te-127
GONADS 2.370E-16 1.191E-13 2.661E-13 5.480E-18-1.000E+00 2.020E-12 4.020E-12
BREAST 2.730E-16 1.158E-13 2.588E-13 5.330E-18-1.000E+00 1.880E-12 3.000E-12
LUNGS 2.320E-16 1.060E-13 2.370E-13 4.880E-18-1.000E+00 4.270E-10 2.890E-12

RED MARR 2.210E-16 1.058E-13 2.365E-13 4.870E-18-1.000E+00 4.090E-12 6.570E-12
BONE SUR 4.650E-16 1.862E-13 4.162E-13 8.570E-18-1.000E+00 4.090E-12 6.460E-12
THYROID 2.400E-16 1.106E-13 2.472E-13 5.090E-18-1.000E+00 1.840E-12 2.860E-12
REMAINDER 2.210E-16 1.036E-13 2.316E-13 4.770E-18-1.000E+00 1.110E-10 6.130E-10
EFFECTIVE 2.420E-16 1.125E-13 2.515E-13 5.180E-18-1.000E+00 8.600E-11 1.870E-10
SKIN(FGR) 1.140E-14 1.173E-11 2.622E-11 5.400E-16-1.000E+00 0.000E+00 0.000E+00
Te-127m
GONADS 1.900E-16 4.689E-13 9.642E-12 1.630E-17-1.000E+00 1.100E-10 1.250E-10
BREAST 2.690E-16 5.150E-13 1.059E-11 1.790E-17-1.000E+00 1.100E-10 9.740E-11
LUNGS 7.620E-17 1.602E-13 3.295E-12 5.570E-18-1.000E+00 3.340E-08 9.620E-11
RED MARR 6.430E-17 1.249E-13 2.567E-12 4.340E-18-1.000E+00 5.360E-09 5.430E-09
BONE SUR 3.940E-16 9.005E-13 1.852E-11 3.130E-17-1.000E+00 2.040E-08 2.070E-08
THYROID 1.500E-16 2.779E-13 5.714E-12 9.660E-18-1.000E+00 9.660E-11 9.430E-11
REMAINDER 8.640E-17 1.999E-13 4.111E-12 6.950E-18-1.000E+00 1.660E-09 2.980E-09
EFFECTIVE 1.470E-16 3.251E-13 6.684E-12 1.130E-17-1.000E+00 5.810E-09 2.230E-09
SKIN(FGR) 8.490E-16 1.496E-12 3.076E-11 5.200E-17-1.000E+00 0.000E+00 0.000E+00
Te-129
GONADS 2.710E-15 3.889E-13 3.922E-13 6.510E-17-1.000E+00 5.050E-13 1.590E-12
BREAST 3.120E-15 3.800E-13 3.832E-13 6.360E-17-1.000E+00 5.390E-13 6.050E-13
LUNGS 2.640E-15 3.298E-13 3.326E-13 5.520E-17-1.000E+00 1.530E-10 4.910E-13
RED MARR 2.540E-15 3.298E-13 3.326E-13 5.520E-17-1.000E+00 6.190E-13 7.640E-13
BONE SUR 4.880E-15 5.753E-13 5.802E-13 9.630E-17-1.000E+00 6.220E-13 5.400E-13
THYROID 2.740E-15 3.525E-13 3.555E-13 5.900E-17-1.000E+00 5.090E-13 3.360E-13
REMAINDER 2.520E-15 3.262E-13 3.289E-13 5.460E-17-1.000E+00 7.280E-12 1.790E-10
EFFECTIVE 2.750E-15 3.590E-13 3.621E-13 6.010E-17-1.000E+00 2.090E-11 5.450E-11
SKIN(FGR) 3.570E-14 3.429E-11 3.458E-11 5.740E-15-1.000E+00 0.000E+00 0.000E+00
Te-129m
GONADS 3.321E-15 2.206E-12 4.799E-11 8.561E-17-1.000E+00 1.783E-10 2.420E-10
BREAST 3.838E-15 2.181E-12 4.739E-11 8.454E-17-1.000E+00 1.694E-10 1.664E-10
LUNGS 3.176E-15 1.741E-12 3.815E-11 6.808E-17-1.000E+00 4.040E-08 1.593E-10
RED MARR 3.071E-15 1.729E-12 3.793E-11 6.768E-17-1.000E+00 3.100E-09 3.500E-09
BONE SUR 5.772E-15 3.287E-12 7.147E-11 1.275E-16-1.000E+00 7.050E-09 7.990E-09
THYROID 3.341E-15 1.923E-12 4.201E-11 7.495E-17-1.000E+00 1.563E-10 1.572E-10
REMAINDER 3.048E-15 1.746E-12 3.822E-11 6.819E-17-1.000E+00 3.275E-09 7.196E-09
EFFECTIVE 3.337E-15 1.974E-12 4.308E-11 7.686E-17-1.000E+00 6.484E-09 2.925E-09
SKIN(FGR) 3.811E-14 1.501E-10 3.360E-09 6.001E-15-1.000E+00 0.000E+00 0.000E+00
Te-131m
GONADS 7.292E-14 4.020E-11 2.343E-10 1.535E-15-1.000E+00 2.345E-10 7.415E-10
BREAST 8.286E-14 3.853E-11 2.246E-10 1.472E-15-1.000E+00 9.309E-11 1.361E-10
LUNGS 7.265E-14 3.657E-11 2.131E-10 1.397E-15-1.000E+00 2.296E-09 6.335E-11
RED MARR 7.097E-14 3.736E-11 2.178E-10 1.427E-15-1.000E+00 1.417E-10 2.435E-10
BONE SUR 1.174E-13 5.467E-11 3.189E-10 2.090E-15-1.000E+00 2.276E-10 3.248E-10
THYROID 7.471E-14 3.741E-11 2.181E-10 1.429E-15-1.000E+00 3.669E-08 4.383E-08
REMAINDER 6.965E-14 3.626E-11 2.113E-10 1.385E-15-1.000E+00 9.509E-10 3.153E-09
EFFECTIVE 7.463E-14 3.825E-11 2.229E-10 1.461E-15-1.000E+00 1.758E-09 2.514E-09
SKIN(FGR) 1.038E-13 1.033E-10 6.188E-10 4.056E-15-1.000E+00 0.000E+00 0.000E+00
Te-132
GONADS 1.020E-14 6.812E-12 7.706E-11 2.450E-16-1.000E+00 4.150E-10 5.410E-10
BREAST 1.180E-14 6.756E-12 7.643E-11 2.430E-16-1.000E+00 3.630E-10 3.500E-10

LUNGS 9.650E-15 5.727E-12 6.479E-11 2.060E-16-1.000E+00 1.670E-09 3.300E-10
RED MARR 8.950E-15 5.588E-12 6.322E-11 2.010E-16-1.000E+00 4.270E-10 4.440E-10
BONE SUR 2.420E-14 1.273E-11 1.441E-10 4.580E-16-1.000E+00 7.120E-10 8.300E-10
THYROID 1.020E-14 5.978E-12 6.762E-11 2.150E-16-1.000E+00 6.280E-08 5.950E-08
REMAINDER 9.160E-15 5.644E-12 6.385E-11 2.030E-16-1.000E+00 7.890E-10 1.490E-09
EFFECTIVE 1.030E-14 6.339E-12 7.171E-11 2.280E-16-1.000E+00 2.550E-09 2.540E-09
SKIN(FGR) 1.390E-14 8.313E-12 9.405E-11 2.990E-16-1.000E+00 0.000E+00 0.000E+00
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-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-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
Cs-134
GONADS 7.400E-14 4.607E-11 9.646E-10 1.600E-15-1.000E+00 1.300E-08 2.060E-08
BREAST 8.430E-14 4.406E-11 9.224E-10 1.530E-15-1.000E+00 1.080E-08 1.720E-08
LUNGS 7.370E-14 4.204E-11 8.802E-10 1.460E-15-1.000E+00 1.180E-08 1.760E-08
RED MARR 7.190E-14 4.262E-11 8.922E-10 1.480E-15-1.000E+00 1.180E-08 1.870E-08
BONE SUR 1.200E-13 6.105E-11 1.278E-09 2.120E-15-1.000E+00 1.100E-08 1.740E-08
THYROID 7.570E-14 4.377E-11 9.163E-10 1.520E-15-1.000E+00 1.110E-08 1.760E-08
REMAINDER 7.060E-14 4.147E-11 8.681E-10 1.440E-15-1.000E+00 1.390E-08 2.210E-08
EFFECTIVE 7.570E-14 4.377E-11 9.163E-10 1.520E-15-1.000E+00 1.250E-08 1.980E-08
SKIN(FGR) 9.450E-14 6.249E-11 1.308E-09 2.170E-15-1.000E+00 0.000E+00 0.000E+00
Cs-136
GONADS 1.040E-13 6.223E-11 1.102E-09 2.180E-15-1.000E+00 1.880E-09 3.040E-09
BREAST 1.180E-13 5.966E-11 1.056E-09 2.090E-15-1.000E+00 1.670E-09 2.650E-09
LUNGS 1.040E-13 5.710E-11 1.011E-09 2.000E-15-1.000E+00 2.320E-09 2.620E-09
RED MARR 1.010E-13 5.824E-11 1.031E-09 2.040E-15-1.000E+00 1.860E-09 2.950E-09
BONE SUR 1.660E-13 8.422E-11 1.491E-09 2.950E-15-1.000E+00 1.700E-09 2.710E-09
THYROID 1.070E-13 5.852E-11 1.036E-09 2.050E-15-1.000E+00 1.730E-09 2.740E-09
REMAINDER 9.950E-14 5.652E-11 1.001E-09 1.980E-15-1.000E+00 2.190E-09 3.520E-09
EFFECTIVE 1.060E-13 5.966E-11 1.056E-09 2.090E-15-1.000E+00 1.980E-09 3.040E-09
SKIN(FGR) 1.250E-13 7.251E-11 1.284E-09 2.540E-15-1.000E+00 0.000E+00 0.000E+00
Cs-137

GONADS 2.669E-14 1.669E-11 3.530E-10 5.840E-16-1.000E+00 8.760E-09 1.390E-08
BREAST 3.047E-14 1.596E-11 3.376E-10 5.585E-16-1.000E+00 7.840E-09 1.240E-08
LUNGS 2.649E-14 1.517E-11 3.209E-10 5.309E-16-1.000E+00 8.820E-09 1.270E-08
RED MARR 2.583E-14 1.542E-11 3.260E-10 5.394E-16-1.000E+00 8.300E-09 1.320E-08
BONE SUR 4.382E-14 2.238E-11 4.734E-10 7.832E-16-1.000E+00 7.940E-09 1.260E-08
THYROID 2.725E-14 1.588E-11 3.358E-10 5.556E-16-1.000E+00 7.930E-09 1.260E-08
REMAINDER 2.536E-14 1.490E-11 3.152E-10 5.215E-16-1.000E+00 9.120E-09 1.450E-08
EFFECTIVE 2.725E-14 1.585E-11 3.353E-10 5.546E-16-1.000E+00 8.630E-09 1.350E-08
SKIN(FGR) 4.392E-14 5.253E-11 1.110E-09 1.836E-15-1.000E+00 0.000E+00 0.000E+00
Ba-139
GONADS 2.130E-15 3.368E-13 3.429E-13 4.790E-17-1.000E+00 2.560E-12 1.560E-12
BREAST 2.450E-15 3.297E-13 3.357E-13 4.690E-17-1.000E+00 2.460E-12 5.170E-13
LUNGS 2.030E-15 3.002E-13 3.057E-13 4.270E-17-1.000E+00 2.530E-10 3.890E-13
RED MARR 1.870E-15 2.932E-13 2.985E-13 4.170E-17-1.000E+00 3.410E-12 8.590E-13
BONE SUR 5.290E-15 6.841E-13 6.965E-13 9.730E-17-1.000E+00 2.490E-12 4.380E-13
THYROID 2.130E-15 3.044E-13 3.100E-13 4.330E-17-1.000E+00 2.400E-12 2.660E-13
REMAINDER 1.920E-15 2.932E-13 2.985E-13 4.170E-17-1.000E+00 4.820E-11 3.570E-10
EFFECTIVE 2.170E-15 3.227E-13 3.286E-13 4.590E-17-1.000E+00 4.640E-11 1.080E-10
SKIN(FGR) 6.160E-14 7.241E-11 7.373E-11 1.030E-14-1.000E+00 0.000E+00 0.000E+00
Ba-140
GONADS 8.410E-15 5.451E-12 9.607E-11 1.910E-16-1.000E+00 4.300E-10 9.960E-10
BREAST 9.640E-15 5.280E-12 9.305E-11 1.850E-16-1.000E+00 2.870E-10 1.590E-10
LUNGS 8.270E-15 4.852E-12 8.550E-11 1.700E-16-1.000E+00 1.660E-09 6.630E-11
RED MARR 7.930E-15 4.880E-12 8.601E-11 1.710E-16-1.000E+00 1.290E-09 4.390E-10
BONE SUR 1.550E-14 8.020E-12 1.413E-10 2.810E-16-1.000E+00 2.410E-09 5.530E-10
THYROID 8.530E-15 5.109E-12 9.003E-11 1.790E-16-1.000E+00 2.560E-10 5.250E-11
REMAINDER 7.890E-15 4.766E-12 8.399E-11 1.670E-16-1.000E+00 1.410E-09 7.370E-09
EFFECTIVE 8.580E-15 5.137E-12 9.053E-11 1.800E-16-1.000E+00 1.010E-09 2.560E-09
SKIN(FGR) 2.520E-14 5.565E-11 9.808E-10 1.950E-15-1.000E+00 0.000E+00 0.000E+00
La-140
GONADS 1.140E-13 6.027E-11 4.425E-10 2.240E-15-1.000E+00 4.540E-10 1.340E-09
BREAST 1.290E-13 5.758E-11 4.228E-10 2.140E-15-1.000E+00 1.450E-10 1.800E-10
LUNGS 1.150E-13 5.596E-11 4.109E-10 2.080E-15-1.000E+00 4.210E-09 4.010E-11
RED MARR 1.140E-13 5.731E-11 4.208E-10 2.130E-15-1.000E+00 2.140E-10 2.810E-10
BONE SUR 1.690E-13 7.776E-11 5.709E-10 2.890E-15-1.000E+00 1.410E-10 9.770E-11
THYROID 1.180E-13 5.462E-11 4.010E-10 2.030E-15-1.000E+00 6.870E-11 6.400E-12
REMAINDER 1.110E-13 5.569E-11 4.089E-10 2.070E-15-1.000E+00 2.120E-09 6.260E-09
EFFECTIVE 1.170E-13 5.812E-11 4.267E-10 2.160E-15-1.000E+00 1.310E-09 2.280E-09
SKIN(FGR) 1.660E-13 2.217E-10 1.628E-09 8.240E-15-1.000E+00 0.000E+00 0.000E+00
La-141
GONADS 2.330E-15 7.315E-13 9.675E-13 4.740E-17-1.000E+00 1.010E-11 3.770E-12
BREAST 2.640E-15 7.007E-13 9.267E-13 4.540E-17-1.000E+00 9.840E-12 7.070E-13
LUNGS 2.340E-15 6.713E-13 8.879E-13 4.350E-17-1.000E+00 6.460E-10 2.720E-13
RED MARR 2.310E-15 6.852E-13 9.063E-13 4.440E-17-1.000E+00 2.930E-11 1.070E-12
BONE SUR 3.490E-15 9.923E-13 1.312E-12 6.430E-17-1.000E+00 1.200E-10 6.060E-13
THYROID 2.390E-15 6.590E-13 8.716E-13 4.270E-17-1.000E+00 9.400E-12 5.290E-14
REMAINDER 2.260E-15 6.682E-13 8.838E-13 4.330E-17-1.000E+00 2.280E-10 1.240E-09
EFFECTIVE 2.390E-15 7.007E-13 9.267E-13 4.540E-17-1.000E+00 1.570E-10 3.740E-10
SKIN(FGR) 6.580E-14 1.667E-10 2.204E-10 1.080E-14-1.000E+00 0.000E+00 0.000E+00

La-142
GONADS 1.400E-13 1.978E-11 2.034E-11 2.540E-15-1.000E+00 1.660E-11 6.990E-11
BREAST 1.570E-13 1.885E-11 1.938E-11 2.420E-15-1.000E+00 1.130E-11 1.540E-11
LUNGS 1.420E-13 1.846E-11 1.898E-11 2.370E-15-1.000E+00 3.010E-10 8.400E-12
RED MARR 1.420E-13 1.900E-11 1.954E-11 2.440E-15-1.000E+00 1.360E-11 1.930E-11
BONE SUR 1.950E-13 2.484E-11 2.554E-11 3.190E-15-1.000E+00 1.110E-11 7.400E-12
THYROID 1.450E-13 1.768E-11 1.818E-11 2.270E-15-1.000E+00 8.740E-12 1.160E-12
REMAINDER 1.380E-13 1.853E-11 1.906E-11 2.380E-15-1.000E+00 8.070E-11 5.200E-10
EFFECTIVE 1.440E-13 1.916E-11 1.970E-11 2.460E-15-1.000E+00 6.840E-11 1.790E-10
SKIN(FGR) 2.160E-13 9.111E-11 9.368E-11 1.170E-14-1.000E+00 0.000E+00 0.000E+00
Ce-141
GONADS 3.380E-15 2.213E-12 4.332E-11 7.710E-17-1.000E+00 5.540E-11 1.080E-10
BREAST 3.930E-15 2.170E-12 4.247E-11 7.560E-17-1.000E+00 4.460E-11 1.110E-11
LUNGS 3.170E-15 1.951E-12 3.820E-11 6.800E-17-1.000E+00 1.670E-08 1.430E-12
RED MARR 2.830E-15 1.860E-12 3.641E-11 6.480E-17-1.000E+00 8.960E-11 3.390E-11
BONE SUR 9.410E-15 5.166E-12 1.011E-10 1.800E-16-1.000E+00 2.540E-10 2.300E-11
THYROID 3.350E-15 2.003E-12 3.922E-11 6.980E-17-1.000E+00 2.550E-11 1.800E-13
REMAINDER 2.980E-15 1.894E-12 3.708E-11 6.600E-17-1.000E+00 1.260E-09 2.500E-09
EFFECTIVE 3.430E-15 2.118E-12 4.146E-11 7.380E-17-1.000E+00 2.420E-09 7.830E-10
SKIN(FGR) 1.020E-14 3.788E-12 7.416E-11 1.320E-16-1.000E+00 0.000E+00 0.000E+00
Ce-143
GONADS 1.280E-14 7.900E-12 4.958E-11 2.980E-16-1.000E+00 7.530E-11 2.120E-10
BREAST 1.470E-14 7.688E-12 4.825E-11 2.900E-16-1.000E+00 1.660E-11 2.320E-11
LUNGS 1.230E-14 6.893E-12 4.325E-11 2.600E-16-1.000E+00 3.880E-09 3.820E-12
RED MARR 1.170E-14 6.787E-12 4.259E-11 2.560E-16-1.000E+00 2.960E-11 5.070E-11
BONE SUR 2.520E-14 1.323E-11 8.302E-11 4.990E-16-1.000E+00 1.640E-11 1.610E-11
THYROID 1.280E-14 7.211E-12 4.525E-11 2.720E-16-1.000E+00 6.230E-12 4.350E-13
REMAINDER 1.170E-14 6.734E-12 4.226E-11 2.540E-16-1.000E+00 1.420E-09 3.890E-09
EFFECTIVE 1.290E-14 7.396E-12 4.642E-11 2.790E-16-1.000E+00 9.160E-10 1.230E-09
SKIN(FGR) 3.960E-14 1.058E-10 6.638E-10 3.990E-15-1.000E+00 0.000E+00 0.000E+00
Ce-144
GONADS 2.725E-15 6.328E-13 1.319E-11 6.088E-17-1.000E+00 2.390E-10 6.987E-11
BREAST 3.129E-15 6.274E-13 1.307E-11 5.922E-17-1.000E+00 3.480E-10 1.223E-11
LUNGS 2.639E-15 5.228E-13 1.089E-11 5.362E-17-1.000E+00 7.911E-07 6.551E-12
RED MARR 2.507E-15 4.755E-13 9.907E-12 5.247E-17-1.000E+00 2.880E-09 8.923E-11
BONE SUR 5.441E-15 1.646E-12 3.429E-11 1.127E-16-1.000E+00 4.720E-09 1.280E-10
THYROID 2.753E-15 5.529E-13 1.152E-11 5.418E-17-1.000E+00 2.920E-10 5.154E-12
REMAINDER 2.534E-15 5.086E-13 1.060E-11 5.283E-17-1.000E+00 1.910E-08 1.890E-08
EFFECTIVE 2.773E-15 5.909E-13 1.231E-11 5.766E-17-1.000E+00 1.010E-07 5.711E-09
SKIN(FGR) 8.574E-14 7.648E-13 1.594E-11 1.250E-14-1.000E+00 0.000E+00 0.000E+00
Pr-143
GONADS 2.130E-17 2.264E-14 4.032E-13 7.930E-19-1.000E+00 4.370E-18 8.990E-18
BREAST 2.550E-17 2.330E-14 4.149E-13 8.160E-19-1.000E+00 2.220E-18 1.090E-18
LUNGS 1.860E-17 1.642E-14 2.923E-13 5.750E-19-1.000E+00 1.330E-08 1.910E-19
RED MARR 1.620E-17 1.493E-14 2.659E-13 5.230E-19-1.000E+00 1.480E-11 1.030E-12
BONE SUR 5.930E-17 5.454E-14 9.711E-13 1.910E-18-1.000E+00 1.490E-11 1.030E-12
THYROID 2.050E-17 1.802E-14 3.208E-13 6.310E-19-1.000E+00 1.680E-18 2.660E-20
REMAINDER 1.760E-17 1.642E-14 2.923E-13 5.750E-19-1.000E+00 1.970E-09 4.220E-09
EFFECTIVE 2.100E-17 2.002E-14 3.564E-13 7.010E-19-1.000E+00 2.190E-09 1.270E-09

SKIN(FGR) 1.760E-14 5.711E-11 1.017E-09 2.000E-15-1.000E+00 0.000E+00 0.000E+00
Nd-147
GONADS 6.130E-15 4.218E-12 7.235E-11 1.480E-16-1.000E+00 8.410E-11 1.790E-10
BREAST 7.120E-15 4.132E-12 7.088E-11 1.450E-16-1.000E+00 3.450E-11 1.870E-11
LUNGS 5.820E-15 3.648E-12 6.257E-11 1.280E-16-1.000E+00 1.060E-08 2.440E-12
RED MARR 5.400E-15 3.505E-12 6.013E-11 1.230E-16-1.000E+00 9.190E-11 5.050E-11
BONE SUR 1.320E-14 8.265E-12 1.418E-10 2.900E-16-1.000E+00 3.260E-10 2.220E-11
THYROID 6.120E-15 3.876E-12 6.648E-11 1.360E-16-1.000E+00 1.820E-11 2.640E-13
REMAINDER 5.530E-15 3.562E-12 6.111E-11 1.250E-16-1.000E+00 1.760E-09 3.760E-09
EFFECTIVE 6.190E-15 3.961E-12 6.795E-11 1.390E-16-1.000E+00 1.850E-09 1.180E-09
SKIN(FGR) 1.950E-14 3.135E-11 5.377E-10 1.100E-15-1.000E+00 0.000E+00 0.000E+00
Np-239
GONADS 7.530E-15 4.691E-12 4.380E-11 1.710E-16-1.000E+00 7.450E-11 1.620E-10
BREAST 8.730E-15 4.636E-12 4.329E-11 1.690E-16-1.000E+00 1.630E-11 1.720E-11
LUNGS 7.180E-15 4.115E-12 3.842E-11 1.500E-16-1.000E+00 2.360E-09 2.400E-12
RED MARR 6.500E-15 4.005E-12 3.740E-11 1.460E-16-1.000E+00 2.080E-10 4.660E-11
BONE SUR 2.000E-14 1.001E-11 9.349E-11 3.650E-16-1.000E+00 2.030E-09 3.590E-11
THYROID 7.520E-15 4.197E-12 3.919E-11 1.530E-16-1.000E+00 7.620E-12 2.070E-13
REMAINDER 6.760E-15 4.005E-12 3.740E-11 1.460E-16-1.000E+00 9.590E-10 2.770E-09
EFFECTIVE 7.690E-15 4.471E-12 4.175E-11 1.630E-16-1.000E+00 6.780E-10 8.820E-10
SKIN(FGR) 1.600E-14 7.215E-12 6.737E-11 2.630E-16-1.000E+00 0.000E+00 0.000E+00
Pu-238
GONADS 6.560E-18 4.291E-14 9.011E-13 1.490E-18-1.000E+00 1.040E-05 2.330E-09
BREAST 1.270E-17 5.558E-14 1.167E-12 1.930E-18-1.000E+00 4.400E-10 1.800E-13
LUNGS 1.060E-18 2.267E-15 4.759E-14 7.870E-20-1.000E+00 3.200E-04 8.640E-14
RED MARR 1.680E-18 5.587E-15 1.173E-13 1.940E-19-1.000E+00 5.800E-05 1.270E-08
BONE SUR 9.300E-18 3.514E-14 7.378E-13 1.220E-18-1.000E+00 7.250E-04 1.580E-07
THYROID 4.010E-18 9.792E-15 2.056E-13 3.400E-19-1.000E+00 3.860E-10 7.990E-14
REMAINDER 1.990E-18 9.216E-15 1.935E-13 3.200E-19-1.000E+00 2.740E-05 2.180E-08
EFFECTIVE 4.880E-18 2.413E-14 5.068E-13 8.380E-19-1.000E+00 7.790E-05 1.340E-08
SKIN(FGR) 4.090E-17 2.776E-13 5.830E-12 9.640E-18-1.000E+00 0.000E+00 0.000E+00
Pu-239
GONADS 4.840E-18 1.768E-14 3.713E-13 6.140E-19-1.000E+00 1.200E-05 2.640E-09
BREAST 7.550E-18 2.238E-14 4.699E-13 7.770E-19-1.000E+00 3.990E-10 1.210E-13
LUNGS 2.650E-18 2.267E-15 4.760E-14 7.870E-20-1.000E+00 3.230E-04 7.890E-14
RED MARR 2.670E-18 3.456E-15 7.258E-14 1.200E-19-1.000E+00 6.570E-05 1.410E-08
BONE SUR 9.470E-18 1.673E-14 3.514E-13 5.810E-19-1.000E+00 8.210E-04 1.760E-07
THYROID 3.880E-18 5.126E-15 1.077E-13 1.780E-19-1.000E+00 3.750E-10 7.500E-14
REMAINDER 2.860E-18 4.838E-15 1.016E-13 1.680E-19-1.000E+00 3.020E-05 2.120E-08
EFFECTIVE 4.240E-18 1.057E-14 2.220E-13 3.670E-19-1.000E+00 8.330E-05 1.400E-08
SKIN(FGR) 1.860E-17 1.057E-13 2.220E-12 3.670E-18-1.000E+00 0.000E+00 0.000E+00
Pu-240
GONADS 6.360E-18 4.118E-14 8.649E-13 1.430E-18-1.000E+00 1.200E-05 2.640E-09
BREAST 1.230E-17 5.328E-14 1.119E-12 1.850E-18-1.000E+00 4.330E-10 1.730E-13
LUNGS 1.090E-18 2.249E-15 4.723E-14 7.810E-20-1.000E+00 3.230E-04 8.220E-14
RED MARR 1.650E-18 5.386E-15 1.131E-13 1.870E-19-1.000E+00 6.570E-05 1.410E-08
BONE SUR 9.260E-18 3.398E-14 7.137E-13 1.180E-18-1.000E+00 8.210E-04 1.760E-07
THYROID 3.920E-18 9.446E-15 1.984E-13 3.280E-19-1.000E+00 3.760E-10 7.510E-14
REMAINDER 1.960E-18 8.870E-15 1.863E-13 3.080E-19-1.000E+00 3.020E-05 2.130E-08

EFFECTIVE 4.750E-18 2.313E-14 4.857E-13 8.030E-19-1.000E+00 8.330E-05 1.400E-08
SKIN(FGR) 3.920E-17 2.644E-13 5.552E-12 9.180E-18-1.000E+00 0.000E+00 0.000E+00
Pu-241
GONADS 7.190E-20 6.653E-17 1.396E-15 2.310E-21-1.000E+00 2.760E-07 5.660E-11
BREAST 8.670E-20 7.229E-17 1.517E-15 2.510E-21-1.000E+00 2.140E-11 2.790E-15
LUNGS 6.480E-20 4.090E-17 8.584E-16 1.420E-21-1.000E+00 3.180E-06 4.480E-15
RED MARR 5.630E-20 4.003E-17 8.403E-16 1.390E-21-1.000E+00 1.430E-06 2.780E-10
BONE SUR 2.190E-19 1.385E-16 2.908E-15 4.810E-21-1.000E+00 1.780E-05 3.480E-09
THYROID 6.980E-20 4.522E-17 9.491E-16 1.570E-21-1.000E+00 9.150E-12 1.010E-15
REMAINDER 6.090E-20 4.291E-17 9.007E-16 1.490E-21-1.000E+00 6.020E-07 1.850E-10
EFFECTIVE 7.250E-20 5.558E-17 1.167E-15 1.930E-21-1.000E+00 1.340E-06 2.070E-10
SKIN(FGR) 1.170E-19 2.033E-16 4.268E-15 7.060E-21-1.000E+00 0.000E+00 0.000E+00
Am-241
GONADS 8.580E-16 9.360E-13 1.966E-11 3.250E-17-1.000E+00 3.250E-05 2.700E-07
BREAST 1.070E-15 1.014E-12 2.129E-11 3.520E-17-1.000E+00 2.670E-09 2.620E-11
LUNGS 6.740E-16 5.789E-13 1.216E-11 2.010E-17-1.000E+00 1.840E-05 3.360E-11
RED MARR 5.210E-16 4.838E-13 1.016E-11 1.680E-17-1.000E+00 1.740E-04 1.450E-06
BONE SUR 2.870E-15 2.678E-12 5.625E-11 9.300E-17-1.000E+00 2.170E-03 1.810E-05
THYROID 7.830E-16 6.365E-13 1.337E-11 2.210E-17-1.000E+00 1.600E-09 1.320E-11
REMAINDER 6.340E-16 5.933E-13 1.246E-11 2.060E-17-1.000E+00 7.820E-05 6.660E-07
EFFECTIVE 8.180E-16 7.920E-13 1.663E-11 2.750E-17-1.000E+00 1.200E-04 9.840E-07
SKIN(FGR) 1.280E-15 2.396E-12 5.032E-11 8.320E-17-1.000E+00 0.000E+00 0.000E+00
Cm-242
GONADS 7.830E-18 4.893E-14 1.013E-12 1.700E-18-1.000E+00 5.700E-07 5.200E-09
BREAST 1.480E-17 6.159E-14 1.275E-12 2.140E-18-1.000E+00 9.440E-10 8.950E-12
LUNGS 1.130E-18 3.022E-15 6.257E-14 1.050E-19-1.000E+00 1.550E-05 8.840E-12
RED MARR 1.890E-18 6.562E-15 1.359E-13 2.280E-19-1.000E+00 3.900E-06 3.570E-08
BONE SUR 1.060E-17 4.231E-14 8.759E-13 1.470E-18-1.000E+00 4.870E-05 4.460E-07
THYROID 4.910E-18 1.261E-14 2.610E-13 4.380E-19-1.000E+00 9.410E-10 8.820E-12
REMAINDER 2.270E-18 1.079E-14 2.235E-13 3.750E-19-1.000E+00 2.450E-06 4.020E-08
EFFECTIVE 5.690E-18 2.751E-14 5.697E-13 9.560E-19-1.000E+00 4.670E-06 3.100E-08
SKIN(FGR) 4.290E-17 2.700E-13 5.589E-12 9.380E-18-1.000E+00 0.000E+00 0.000E+00
Cm-244
GONADS 6.900E-18 4.522E-14 9.492E-13 1.570E-18-1.000E+00 1.590E-05 1.330E-07
BREAST 1.330E-17 5.702E-14 1.197E-12 1.980E-18-1.000E+00 1.040E-09 8.820E-12
LUNGS 7.080E-19 2.592E-15 5.441E-14 9.000E-20-1.000E+00 1.930E-05 8.810E-12
RED MARR 1.460E-18 5.875E-15 1.233E-13 2.040E-19-1.000E+00 9.380E-05 7.820E-07
BONE SUR 8.820E-18 3.859E-14 8.101E-13 1.340E-18-1.000E+00 1.170E-03 9.770E-06
THYROID 4.190E-18 1.146E-14 2.406E-13 3.980E-19-1.000E+00 1.010E-09 8.440E-12
REMAINDER 1.810E-18 9.821E-15 2.062E-13 3.410E-19-1.000E+00 4.780E-05 4.150E-07
EFFECTIVE 4.910E-18 2.529E-14 5.308E-13 8.780E-19-1.000E+00 6.700E-05 5.450E-07
SKIN(FGR) 3.910E-17 2.506E-13 5.260E-12 8.700E-18-1.000E+00 0.000E+00 0.000E+00

Appendix I3 –RADTRAD Output Files (Excerpts)

RADTRAD Output File Excerpts

StackBase.o0 (Excerpts)

##

I-131 Summary

##

Time (hr)	DW I-131 (Curies)	Torus I-131 (Curies)	RB I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	3.4444E+06	0.0000E+00	4.7988E+02
0.533	4.4756E+06	0.0000E+00	8.2208E+02
0.533	4.4786E+06	0.0000E+00	8.2300E+02
0.900	9.6135E+06	0.0000E+00	2.3165E+03
1.200	1.3665E+07	0.0000E+00	4.1451E+03
1.500	1.7283E+07	0.0000E+00	6.2544E+03
1.800	2.0512E+07	0.0000E+00	8.4764E+03
2.000	2.2469E+07	0.0000E+00	9.9642E+03
2.033	2.2778E+07	0.0000E+00	1.0208E+04
2.033	2.2443E+07	3.3287E+05	1.0210E+04
2.400	1.0878E+07	8.2512E+06	1.2020E+04
2.700	9.0707E+06	6.8805E+06	1.2234E+04
3.000	7.5646E+06	5.7380E+06	1.1774E+04
3.300	6.3094E+06	4.7859E+06	1.0937E+04
3.600	5.2632E+06	3.9922E+06	9.9160E+03
3.900	4.3912E+06	3.3308E+06	8.8356E+03
4.000	4.1341E+06	3.1358E+06	8.4765E+03
4.300	3.4502E+06	2.6170E+06	7.4295E+03
4.600	2.8801E+06	2.1846E+06	6.4532E+03
4.900	2.4050E+06	1.8242E+06	5.5658E+03
5.033	2.2206E+06	1.6842E+06	5.2028E+03
5.400	1.9460E+06	1.4702E+06	4.3384E+03
5.700	1.7449E+06	1.3182E+06	3.7687E+03
6.000	1.5649E+06	1.1822E+06	3.2929E+03
6.300	1.4037E+06	1.0605E+06	2.8914E+03
6.600	1.2595E+06	9.5144E+05	2.5493E+03
6.900	1.1303E+06	8.5386E+05	2.2554E+03
7.200	1.0147E+06	7.6649E+05	2.0011E+03
7.500	9.1116E+05	6.8829E+05	1.7797E+03
7.800	8.1849E+05	6.1827E+05	1.5859E+03
8.000	7.6217E+05	5.7572E+05	1.4699E+03
8.300	6.8510E+05	5.1749E+05	1.3133E+03
8.367	6.6902E+05	5.0535E+05	1.2809E+03
8.667	6.0980E+05	4.6026E+05	1.1478E+03
8.967	5.5585E+05	4.1954E+05	1.0322E+03
9.300	5.0180E+05	3.7873E+05	9.2048E+02
9.600	4.5784E+05	3.4554E+05	8.3234E+02
9.900	4.1795E+05	3.1543E+05	7.5413E+02
10.200	3.8174E+05	2.8809E+05	6.8442E+02

12.033	2.2279E+05	1.6809E+05	3.8863E+02
19.478	4.5898E+04	3.4543E+04	6.8629E+01
24.000	3.0631E+04	2.3021E+04	4.1852E+01
24.033	3.0576E+04	2.2980E+04	4.1758E+01
96.000	2.1942E+04	1.6477E+04	2.8285E+01
240.000	1.1280E+04	8.4709E+03	1.4542E+01
264.000	4.9222E+03	3.6938E+03	6.5158E+00
480.000	1.8136E+03	1.3619E+03	2.3379E+00
504.000	7.9136E+02	5.9387E+02	1.0476E+00
696.000	3.2577E+02	2.4464E+02	4.1996E-01
720.000	1.4215E+02	1.0668E+02	1.8817E-01

Time (hr)	SR I-131 (Curies)	Condenser I-131 (Curies)	TB I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	1.6372E+00	1.8705E-01	8.6434E-03
0.533	2.9023E+00	3.4492E-01	1.1240E-02
0.533	2.9057E+00	3.4537E-01	1.1247E-02
0.900	8.3976E+00	1.1111E+00	2.4142E-02
1.200	1.5276E+01	2.1838E+00	3.4337E-02
1.500	2.3296E+01	3.6509E+00	4.3457E-02
1.800	3.1796E+01	5.5038E+00	5.1616E-02
2.000	3.7507E+01	6.9496E+00	5.6572E-02
2.033	3.8444E+01	7.2042E+00	5.7355E-02
2.033	3.8454E+01	7.2067E+00	5.6880E-02
2.400	4.5856E+01	8.8887E+00	2.7510E-02
2.700	4.7002E+01	1.0200E+01	2.3039E-02
3.000	4.5465E+01	1.1480E+01	1.9312E-02
3.300	4.2412E+01	1.2732E+01	1.6206E-02
3.600	3.8607E+01	1.3960E+01	1.3617E-02
3.900	3.4540E+01	1.5168E+01	1.1459E-02
4.000	3.3182E+01	1.5567E+01	1.0823E-02
4.300	2.9212E+01	1.6754E+01	9.1298E-03
4.600	2.5498E+01	1.7926E+01	7.7189E-03
4.900	2.2115E+01	1.9086E+01	6.5428E-03
5.033	2.0730E+01	1.9596E+01	6.0861E-03
5.400	1.7410E+01	2.0998E+01	5.4059E-03
5.700	1.5222E+01	2.2136E+01	4.9077E-03
6.000	1.3396E+01	2.3267E+01	4.4616E-03
6.300	1.1856E+01	2.4393E+01	4.0622E-03
6.600	1.0545E+01	2.5513E+01	3.7046E-03
6.900	9.4182E+00	2.6628E+01	3.3843E-03
7.200	8.4437E+00	2.7738E+01	3.0976E-03
7.500	7.5955E+00	2.8843E+01	2.8408E-03
7.800	6.8532E+00	2.9943E+01	2.6109E-03
8.000	6.4091E+00	3.0674E+01	2.4711E-03
8.300	5.8093E+00	3.1767E+01	2.2797E-03
8.367	5.6853E+00	3.2011E+01	2.2398E-03
8.667	5.1746E+00	3.3099E+01	2.0926E-03
8.967	4.7309E+00	3.4183E+01	1.9584E-03
9.300	4.3026E+00	3.5382E+01	1.8240E-03

9.600	3.9646E+00	3.6458E+01	1.7145E-03
9.900	3.6646E+00	3.7531E+01	1.6151E-03
10.200	3.3973E+00	3.8600E+01	1.5249E-03
12.033	2.2615E+00	4.5060E+01	1.1274E-03
19.478	1.0143E+00	7.0152E+01	6.7293E-04
24.000	8.9667E-01	8.4564E+01	6.2508E-04
24.033	8.9621E-01	8.4667E+01	6.2487E-04
96.000	6.3641E-01	2.4516E+02	4.6500E-04
240.000	3.2718E-01	3.2600E+02	2.5720E-04
264.000	5.2753E+00	3.1494E+02	1.2789E-04
480.000	5.2602E-02	1.7574E+02	5.2535E-05
504.000	8.4813E-01	1.6231E+02	3.0688E-05
696.000	9.4490E-03	8.0792E+01	1.3901E-05
720.000	1.5235E-01	7.3727E+01	9.5546E-06

Time (hr)	Dummy I-131 (Curies)	CR I-131 (Curies)	Environment I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	1.8492E+01	3.7251E-06	6.9215E-03
0.533	3.9274E+01	8.7634E-06	1.7304E-02
0.533	3.9338E+01	8.7789E-06	1.7337E-02
0.900	1.6137E+02	3.7086E-05	8.5207E-02
1.200	3.6475E+02	8.1239E-05	2.0713E-01
1.500	6.8206E+02	1.4403E-04	4.0733E-01
1.800	1.1215E+03	2.2109E-04	6.9402E-01
2.000	1.4832E+03	2.7784E-04	9.3463E-01
2.033	1.5481E+03	2.7787E-04	9.7814E-01
2.033	1.5488E+03	2.7787E-04	9.7858E-01
2.400	2.2888E+03	2.9748E-04	1.5231E+00
2.700	2.9333E+03	3.1730E-04	2.0097E+00
3.000	3.5658E+03	3.2702E-04	2.4929E+00
3.300	4.1609E+03	3.2462E-04	2.9515E+00
3.600	4.7054E+03	3.1199E-04	3.3738E+00
3.900	5.1940E+03	2.9211E-04	3.7547E+00
4.000	5.3442E+03	2.8439E-04	3.8723E+00
4.300	5.7580E+03	2.5927E-04	4.1970E+00
4.600	6.1190E+03	2.3284E-04	4.4817E+00
4.900	6.4315E+03	2.0664E-04	4.7293E+00
5.033	6.5558E+03	1.9538E-04	4.8282E+00
5.400	6.8593E+03	1.6625E-04	5.0703E+00
5.700	7.0710E+03	1.4534E-04	5.2399E+00
6.000	7.2558E+03	1.2723E-04	5.3886E+00
6.300	7.4181E+03	1.1171E-04	5.5199E+00
6.600	7.5612E+03	9.8467E-05	5.6364E+00
6.900	7.6880E+03	8.7149E-05	5.7402E+00
7.200	7.8005E+03	7.7450E-05	5.8331E+00
7.500	7.9007E+03	6.9100E-05	5.9165E+00
7.800	7.9901E+03	6.1877E-05	5.9916E+00
8.000	8.0444E+03	5.7595E-05	6.0377E+00
8.300	8.1325E+03	4.1069E-05	6.1012E+00
8.367	8.1509E+03	3.8380E-05	6.1146E+00

8.667	8.2281E+03	2.9307E-05	6.1711E+00
8.967	8.2978E+03	2.3533E-05	6.2226E+00
9.300	8.3674E+03	1.9356E-05	6.2748E+00
9.600	8.4240E+03	1.6777E-05	6.3178E+00
9.900	8.4754E+03	1.4874E-05	6.3575E+00
10.200	8.5223E+03	1.3401E-05	6.3942E+00
12.033	8.7328E+03	8.3435E-06	6.5705E+00
19.478	9.0357E+03	3.4119E-06	6.9363E+00
24.000	9.1012E+03	2.9638E-06	7.0843E+00
24.033	9.1016E+03	2.9093E-06	7.0854E+00
96.000	9.3873E+03	1.4791E-06	8.9686E+00
240.000	8.1202E+03	5.8016E-07	1.1288E+01
264.000	1.5544E+04	9.5026E-06	1.8115E+01
480.000	7.8032E+03	9.3275E-08	1.8795E+01
504.000	8.4614E+03	1.5278E-06	1.9892E+01
696.000	4.3531E+03	1.6755E-08	1.9994E+01
720.000	4.2281E+03	2.7443E-07	2.0192E+01

##
Cumulative Dose Summary
##

	Control Room		EAB		LPZ	
Time	Thyroid	TEDE	Thyroid	TEDE	Thyroid	TEDE
(hr)	(rem)	(rem)	(rem)	(rem)	(rem)	(rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.400	1.1971E-04	4.6441E-06	9.7195E-04	4.6833E-05	4.8598E-04	2.3416E-05
0.533	3.8361E-04	1.4874E-05	2.4264E-03	1.1648E-04	1.2132E-03	5.8241E-05
0.533	3.8454E-04	1.4910E-05	2.4311E-03	1.1670E-04	1.2155E-03	5.8352E-05
0.900	2.8747E-03	1.1262E-04	1.1935E-02	5.9021E-04	5.9674E-03	2.9511E-04
1.200	8.4714E-03	3.4552E-04	2.9088E-02	1.5501E-03	1.4544E-02	7.7504E-04
1.500	1.9306E-02	8.2336E-04	5.7318E-02	3.2386E-03	2.8659E-02	1.6193E-03
1.800	3.6996E-02	1.6365E-03	9.7748E-02	5.7459E-03	4.8874E-02	2.8730E-03
2.000	5.3173E-02	2.3984E-03	1.3165E-01	7.8869E-03	6.5827E-02	3.9434E-03
2.033	5.6146E-02	2.5396E-03	1.3778E-01	8.2752E-03	6.7372E-02	4.0414E-03
2.033	5.6176E-02	2.5410E-03	1.3784E-01	8.2792E-03	6.7388E-02	4.0424E-03
2.400	9.0131E-02	4.1707E-03	2.1443E-01	1.3188E-02	8.6712E-02	5.2809E-03
2.700	1.2000E-01	5.6261E-03	2.8268E-01	1.7620E-02	1.0393E-01	6.3991E-03
3.000	1.5127E-01	7.1644E-03	3.5028E-01	2.2063E-02	1.2098E-01	7.5200E-03
3.300	1.8282E-01	8.7262E-03	4.1422E-01	2.6324E-02	1.3712E-01	8.5949E-03
3.600	2.1353E-01	1.0254E-02	4.7293E-01	3.0297E-02	1.5193E-01	9.5973E-03
3.900	2.4257E-01	1.1705E-02	5.2573E-01	3.3934E-02	1.6525E-01	1.0515E-02
4.000	2.5177E-01	1.2166E-02	5.4199E-01	3.5069E-02	1.6935E-01	1.0801E-02
4.300	2.7779E-01	1.3470E-02	5.8681E-01	3.8243E-02	1.8066E-01	1.1602E-02
4.600	3.0125E-01	1.4649E-02	6.2598E-01	4.1083E-02	1.9054E-01	1.2319E-02
4.900	3.2214E-01	1.5701E-02	6.5995E-01	4.3613E-02	1.9911E-01	1.2957E-02
5.033	3.3059E-01	1.6127E-02	6.7348E-01	4.4641E-02	2.0252E-01	1.3216E-02
5.400	3.5149E-01	1.7183E-02	7.0653E-01	4.7218E-02	2.1086E-01	1.3866E-02
5.700	3.6617E-01	1.7925E-02	7.2961E-01	4.9078E-02	2.1668E-01	1.4335E-02
6.000	3.7897E-01	1.8574E-02	7.4978E-01	5.0751E-02	2.2177E-01	1.4758E-02
6.300	3.9015E-01	1.9141E-02	7.6754E-01	5.2266E-02	2.2625E-01	1.5140E-02

6.600	3.9996E-01	1.9639E-02	7.8324E-01	5.3642E-02	2.3022E-01	1.5487E-02
6.900	4.0860E-01	2.0077E-02	7.9719E-01	5.4897E-02	2.3374E-01	1.5804E-02
7.200	4.1624E-01	2.0465E-02	8.0964E-01	5.6047E-02	2.3688E-01	1.6094E-02
7.500	4.2303E-01	2.0809E-02	8.2079E-01	5.7103E-02	2.3969E-01	1.6360E-02
7.800	4.2907E-01	2.1116E-02	8.3080E-01	5.8075E-02	2.4222E-01	1.6606E-02
8.000	4.3274E-01	2.1302E-02	8.3692E-01	5.8682E-02	2.4376E-01	1.6759E-02
8.300	4.3722E-01	2.1529E-02	8.4125E-01	5.9340E-02	2.4453E-01	1.6876E-02
8.367	4.3803E-01	2.1571E-02	8.4216E-01	5.9481E-02	2.4470E-01	1.6901E-02
8.667	4.4111E-01	2.1726E-02	8.4600E-01	6.0087E-02	2.4538E-01	1.7010E-02
8.967	4.4351E-01	2.1847E-02	8.4949E-01	6.0656E-02	2.4601E-01	1.7112E-02
9.300	4.4566E-01	2.1956E-02	8.5301E-01	6.1248E-02	2.4664E-01	1.7218E-02
9.600	4.4730E-01	2.2038E-02	8.5591E-01	6.1750E-02	2.4716E-01	1.7308E-02
9.900	4.4872E-01	2.2110E-02	8.5857E-01	6.2224E-02	2.4763E-01	1.7393E-02
10.200	4.5000E-01	2.2174E-02	8.6103E-01	6.2672E-02	2.4807E-01	1.7473E-02
12.033	4.5574E-01	2.2456E-02	8.7270E-01	6.4973E-02	2.5016E-01	1.7885E-02
19.478	4.6644E-01	2.2936E-02	8.9612E-01	7.0540E-02	2.5436E-01	1.8881E-02
24.000	4.7034E-01	2.3086E-02	9.0516E-01	7.2634E-02	2.5597E-01	1.9256E-02
24.033	4.7036E-01	2.3086E-02	9.0524E-01	7.2648E-02	2.5598E-01	1.9257E-02
96.000	4.8914E-01	2.3743E-02	1.0377E+00	9.0006E-02	2.6726E-01	2.0735E-02
240.000	5.0012E-01	2.4121E-02	1.1903E+00	1.0642E-01	2.7189E-01	2.1233E-02
264.000	5.3143E-01	2.5199E-02	1.6368E+00	1.4935E-01	2.8546E-01	2.2538E-02
480.000	5.3518E-01	2.5330E-02	1.6813E+00	1.5318E-01	2.8681E-01	2.2654E-02
504.000	5.4022E-01	2.5510E-02	1.7531E+00	1.5857E-01	2.8899E-01	2.2818E-02
696.000	5.4079E-01	2.5532E-02	1.7598E+00	1.5904E-01	2.8919E-01	2.2832E-02
720.000	5.4169E-01	2.5568E-02	1.7727E+00	1.5990E-01	2.8959E-01	2.2858E-02

##
Worst Two-Hour Doses
##

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
2.0	7.1335E-03	4.1034E-01	2.7182E-02

StackTop.o0 (Fumigation X/Q between 3.5 and 4 hours) (Excerpts)
##
I-131 Summary
##

Time (hr)	DW I-131 (Curies)	Torus I-131 (Curies)	RB I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	3.4444E+06	0.0000E+00	4.7988E+02
0.533	4.4756E+06	0.0000E+00	8.2208E+02
0.533	4.4786E+06	0.0000E+00	8.2300E+02
0.900	9.6135E+06	0.0000E+00	2.3165E+03
1.200	1.3665E+07	0.0000E+00	4.1451E+03
1.500	1.7283E+07	0.0000E+00	6.2544E+03
1.800	2.0512E+07	0.0000E+00	8.4764E+03
2.000	2.2469E+07	0.0000E+00	9.9642E+03
2.033	2.2778E+07	0.0000E+00	1.0208E+04
2.033	2.2443E+07	3.3287E+05	1.0210E+04
2.400	1.0878E+07	8.2512E+06	1.2020E+04
2.700	9.0707E+06	6.8805E+06	1.2234E+04
3.000	7.5646E+06	5.7380E+06	1.1774E+04
3.300	6.3094E+06	4.7859E+06	1.0937E+04
3.500	5.5909E+06	4.2409E+06	1.0268E+04
3.800	4.6644E+06	3.5380E+06	9.1969E+03
4.000	4.1341E+06	3.1358E+06	8.4765E+03
4.300	3.4502E+06	2.6170E+06	7.4295E+03
4.600	2.8801E+06	2.1846E+06	6.4532E+03
4.900	2.4050E+06	1.8242E+06	5.5658E+03
5.033	2.2206E+06	1.6842E+06	5.2028E+03
5.400	1.9460E+06	1.4702E+06	4.3384E+03
5.700	1.7449E+06	1.3182E+06	3.7687E+03
6.000	1.5649E+06	1.1822E+06	3.2929E+03
6.300	1.4037E+06	1.0605E+06	2.8914E+03
6.600	1.2595E+06	9.5144E+05	2.5493E+03
6.900	1.1303E+06	8.5386E+05	2.2554E+03
7.200	1.0147E+06	7.6649E+05	2.0011E+03
7.500	9.1116E+05	6.8829E+05	1.7797E+03
7.800	8.1849E+05	6.1827E+05	1.5859E+03
8.000	7.6217E+05	5.7572E+05	1.4699E+03
8.300	6.8510E+05	5.1749E+05	1.3133E+03
8.367	6.6902E+05	5.0535E+05	1.2809E+03
8.667	6.0980E+05	4.6026E+05	1.1478E+03
8.967	5.5585E+05	4.1954E+05	1.0322E+03
9.300	5.0180E+05	3.7873E+05	9.2048E+02
9.600	4.5784E+05	3.4554E+05	8.3234E+02
9.900	4.1795E+05	3.1543E+05	7.5413E+02
10.200	3.8174E+05	2.8809E+05	6.8442E+02
12.033	2.2279E+05	1.6809E+05	3.8863E+02
19.478	4.5898E+04	3.4543E+04	6.8629E+01
24.000	3.0631E+04	2.3021E+04	4.1852E+01
24.033	3.0576E+04	2.2980E+04	4.1758E+01

96.000	2.1942E+04	1.6477E+04	2.8285E+01
240.000	1.1280E+04	8.4709E+03	1.4542E+01
264.000	4.9222E+03	3.6938E+03	6.5158E+00
480.000	1.8136E+03	1.3619E+03	2.3379E+00
504.000	7.9136E+02	5.9387E+02	1.0476E+00
696.000	3.2577E+02	2.4464E+02	4.1996E-01
720.000	1.4215E+02	1.0668E+02	1.8817E-01

	SR	Condenser	TB
Time (hr)	I-131 (Curies)	I-131 (Curies)	I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	1.6372E+00	1.8705E-01	8.6434E-03
0.533	2.9023E+00	3.4492E-01	1.1240E-02
0.533	2.9057E+00	3.4537E-01	1.1247E-02
0.900	8.3976E+00	1.1111E+00	2.4142E-02
1.200	1.5276E+01	2.1838E+00	3.4337E-02
1.500	2.3296E+01	3.6509E+00	4.3457E-02
1.800	3.1796E+01	5.5038E+00	5.1616E-02
2.000	3.7507E+01	6.9496E+00	5.6572E-02
2.033	3.8444E+01	7.2042E+00	5.7355E-02
2.033	3.8454E+01	7.2067E+00	5.6880E-02
2.400	4.5856E+01	8.8887E+00	2.7510E-02
2.700	4.7002E+01	1.0200E+01	2.3039E-02
3.000	4.5465E+01	1.1480E+01	1.9312E-02
3.300	4.2412E+01	1.2732E+01	1.6206E-02
3.500	3.9924E+01	1.3553E+01	1.4428E-02
3.800	3.5903E+01	1.4768E+01	1.2135E-02
4.000	3.3182E+01	1.5567E+01	1.0823E-02
4.300	2.9212E+01	1.6754E+01	9.1298E-03
4.600	2.5498E+01	1.7926E+01	7.7189E-03
4.900	2.2115E+01	1.9086E+01	6.5428E-03
5.033	2.0730E+01	1.9596E+01	6.0861E-03
5.400	1.7410E+01	2.0998E+01	5.4059E-03
5.700	1.5222E+01	2.2136E+01	4.9077E-03
6.000	1.3396E+01	2.3267E+01	4.4616E-03
6.300	1.1856E+01	2.4393E+01	4.0622E-03
6.600	1.0545E+01	2.5513E+01	3.7046E-03
6.900	9.4182E+00	2.6628E+01	3.3843E-03
7.200	8.4437E+00	2.7738E+01	3.0976E-03
7.500	7.5955E+00	2.8843E+01	2.8408E-03
7.800	6.8532E+00	2.9943E+01	2.6109E-03
8.000	6.4091E+00	3.0674E+01	2.4711E-03
8.300	5.8093E+00	3.1767E+01	2.2797E-03
8.367	5.6853E+00	3.2011E+01	2.2398E-03
8.667	5.1746E+00	3.3099E+01	2.0926E-03
8.967	4.7309E+00	3.4183E+01	1.9584E-03
9.300	4.3026E+00	3.5382E+01	1.8240E-03
9.600	3.9646E+00	3.6458E+01	1.7145E-03
9.900	3.6646E+00	3.7531E+01	1.6151E-03
10.200	3.3973E+00	3.8600E+01	1.5249E-03
12.033	2.2615E+00	4.5060E+01	1.1274E-03

19.478	1.0143E+00	7.0152E+01	6.7293E-04
24.000	8.9667E-01	8.4564E+01	6.2508E-04
24.033	8.9621E-01	8.4667E+01	6.2487E-04
96.000	6.3641E-01	2.4516E+02	4.6500E-04
240.000	3.2718E-01	3.2600E+02	2.5720E-04
264.000	5.2753E+00	3.1494E+02	1.2789E-04
480.000	5.2602E-02	1.7574E+02	5.2535E-05
504.000	8.4813E-01	1.6231E+02	3.0688E-05
696.000	9.4490E-03	8.0792E+01	1.3901E-05
720.000	1.5235E-01	7.3727E+01	9.5546E-06

Time (hr)	Dummy I-131 (Curies)	CR I-131 (Curies)	Environment I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	9.9385E+00	3.2486E-06	8.5619E+00
0.533	1.7893E+01	7.6424E-06	2.1405E+01
0.533	1.7915E+01	7.6560E-06	2.1446E+01
0.900	5.6126E+01	3.2342E-05	1.0540E+02
1.200	1.0896E+02	7.0847E-05	2.5622E+02
1.500	1.7918E+02	1.2561E-04	5.0387E+02
1.800	2.6493E+02	1.9281E-04	8.5850E+02
2.000	3.2991E+02	2.4230E-04	1.1561E+03
2.033	3.4119E+02	2.3485E-04	1.2100E+03
2.033	3.4131E+02	2.3478E-04	1.2105E+03
2.400	4.1010E+02	1.8566E-04	1.8841E+03
2.700	4.5549E+02	1.6961E-04	2.4859E+03
3.000	4.9349E+02	1.5997E-04	3.0837E+03
3.300	5.2528E+02	1.5115E-04	3.6510E+03
3.500	5.4355E+02	1.4472E-04	4.0047E+03
3.800	5.6720E+02	3.9907E-02	4.4934E+03
4.000	5.8079E+02	5.3650E-02	4.7900E+03
4.300	5.9840E+02	3.0178E-02	5.1917E+03
4.600	6.1317E+02	1.6989E-02	5.5438E+03
4.900	6.2556E+02	9.5753E-03	5.8501E+03
5.033	6.3040E+02	7.4302E-03	5.9725E+03
5.400	6.4246E+02	3.6994E-03	6.2720E+03
5.700	6.5121E+02	2.1005E-03	6.4817E+03
6.000	6.5909E+02	1.1997E-03	6.6657E+03
6.300	6.6618E+02	6.9134E-04	6.8281E+03
6.600	6.7257E+02	4.0385E-04	6.9722E+03
6.900	6.7833E+02	2.4069E-04	7.1006E+03
7.200	6.8353E+02	1.4759E-04	7.2155E+03
7.500	6.8823E+02	9.4029E-05	7.3187E+03
7.800	6.9247E+02	6.2845E-05	7.4117E+03
8.000	6.9507E+02	4.9511E-05	7.4686E+03
8.300	6.9867E+02	3.3436E-05	7.5610E+03
8.367	6.9942E+02	3.0861E-05	7.5804E+03
8.667	7.0263E+02	2.2331E-05	7.6624E+03
8.967	7.0558E+02	1.7101E-05	7.7372E+03
9.300	7.0857E+02	1.3492E-05	7.8129E+03
9.600	7.1104E+02	1.1377E-05	7.8752E+03

9.900	7.1332E+02	9.8907E-06	7.9326E+03
10.200	7.1542E+02	8.7898E-06	7.9856E+03
12.033	7.2528E+02	5.2859E-06	8.2378E+03
19.478	7.4298E+02	2.0057E-06	8.7390E+03
24.000	7.4863E+02	1.7116E-06	8.9326E+03
24.033	7.4867E+02	1.6365E-06	8.9339E+03
96.000	7.8505E+02	3.4931E-07	1.1381E+04
240.000	7.0067E+02	3.0256E-08	1.4396E+04
264.000	6.7456E+02	4.7235E-07	2.2852E+04
480.000	3.8304E+02	4.8644E-09	2.3736E+04
504.000	3.5797E+02	7.5942E-08	2.5095E+04
696.000	1.9653E+02	8.7380E-10	2.5227E+04
720.000	1.8207E+02	1.3641E-08	2.5472E+04

##

Cumulative Dose Summary

##

	Control Room		EAB		LPZ	
Time	Thyroid	TEDE	Thyroid	TEDE	Thyroid	TEDE
(hr)	(rem)	(rem)	(rem)	(rem)	(rem)	(rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.400	1.0440E-04	4.0500E-06	5.4609E-03	2.6313E-04	5.1855E-03	2.4986E-04
0.533	3.3454E-04	1.2971E-05	1.3633E-02	6.5444E-04	1.2945E-02	6.2145E-04
0.533	3.3535E-04	1.3003E-05	1.3659E-02	6.5569E-04	1.2970E-02	6.2263E-04
0.900	2.5070E-03	9.8213E-05	6.7055E-02	3.3161E-03	6.3674E-02	3.1489E-03
1.200	7.3878E-03	3.0133E-04	1.6343E-01	8.7090E-03	1.5519E-01	8.2699E-03
1.500	1.6837E-02	7.1804E-04	3.2204E-01	1.8196E-02	3.0580E-01	1.7278E-02
1.800	3.2264E-02	1.4272E-03	5.4919E-01	3.2283E-02	5.2150E-01	3.0655E-02
2.000	4.6371E-02	2.0916E-03	7.3969E-01	4.4312E-02	7.0240E-01	4.2078E-02
2.033	4.8924E-02	2.2128E-03	7.7410E-01	4.6494E-02	7.1902E-01	4.3132E-02
2.033	4.8949E-02	2.2140E-03	7.7445E-01	4.6516E-02	7.1919E-01	4.3143E-02
2.400	7.3444E-02	3.3844E-03	1.2048E+00	7.4097E-02	9.2712E-01	5.6470E-02
2.700	9.0585E-02	4.2143E-03	1.5882E+00	9.8998E-02	1.1124E+00	6.8502E-02
3.000	1.0651E-01	4.9935E-03	1.9680E+00	1.2396E-01	1.2959E+00	8.0564E-02
3.300	1.2153E-01	5.7345E-03	2.3273E+00	1.4790E-01	1.4695E+00	9.2130E-02
3.500	1.3103E-01	6.2057E-03	2.5508E+00	1.6298E-01	1.5775E+00	9.9418E-02
3.800	2.2578E+00	1.1297E-01	8.6315E+00	5.7929E-01	4.8378E+00	3.2263E-01
4.000	5.2796E+00	2.6481E-01	1.2314E+01	8.3546E-01	6.8120E+00	4.5998E-01
4.300	9.1941E+00	4.6159E-01	1.2565E+01	8.5329E-01	6.9337E+00	4.6860E-01
4.600	1.1390E+01	5.7198E-01	1.2785E+01	8.6924E-01	7.0400E+00	4.7631E-01
4.900	1.2623E+01	6.3398E-01	1.2976E+01	8.8346E-01	7.1323E+00	4.8317E-01
5.033	1.2980E+01	6.5191E-01	1.3052E+01	8.8924E-01	7.1690E+00	4.8596E-01
5.400	1.3601E+01	6.8314E-01	1.3238E+01	9.0371E-01	7.2587E+00	4.9296E-01
5.700	1.3868E+01	6.9659E-01	1.3368E+01	9.1416E-01	7.3214E+00	4.9801E-01
6.000	1.4020E+01	7.0422E-01	1.3481E+01	9.2356E-01	7.3761E+00	5.0255E-01
6.300	1.4106E+01	7.0859E-01	1.3581E+01	9.3207E-01	7.4243E+00	5.0666E-01
6.600	1.4157E+01	7.1112E-01	1.3669E+01	9.3980E-01	7.4670E+00	5.1040E-01
6.900	1.4186E+01	7.1260E-01	1.3747E+01	9.4686E-01	7.5049E+00	5.1381E-01
7.200	1.4204E+01	7.1350E-01	1.3817E+01	9.5332E-01	7.5387E+00	5.1693E-01
7.500	1.4215E+01	7.1405E-01	1.3880E+01	9.5925E-01	7.5689E+00	5.1979E-01

7.800	1.4222E+01	7.1441E-01	1.3936E+01	9.6471E-01	7.5961E+00	5.2244E-01
8.000	1.4225E+01	7.1459E-01	1.3971E+01	9.6812E-01	7.6127E+00	5.2408E-01
8.300	1.4229E+01	7.1478E-01	1.3999E+01	9.7219E-01	7.6226E+00	5.2548E-01
8.367	1.4230E+01	7.1481E-01	1.4005E+01	9.7306E-01	7.6247E+00	5.2578E-01
8.667	1.4232E+01	7.1493E-01	1.4031E+01	9.7680E-01	7.6334E+00	5.2707E-01
8.967	1.4234E+01	7.1503E-01	1.4054E+01	9.8030E-01	7.6414E+00	5.2828E-01
9.300	1.4235E+01	7.1510E-01	1.4077E+01	9.8394E-01	7.6494E+00	5.2953E-01
9.600	1.4237E+01	7.1516E-01	1.4096E+01	9.8702E-01	7.6560E+00	5.3059E-01
9.900	1.4238E+01	7.1521E-01	1.4114E+01	9.8992E-01	7.6620E+00	5.3159E-01
10.200	1.4238E+01	7.1526E-01	1.4130E+01	9.9266E-01	7.6676E+00	5.3254E-01
12.033	1.4242E+01	7.1544E-01	1.4206E+01	1.0066E+00	7.6938E+00	5.3735E-01
19.478	1.4249E+01	7.1575E-01	1.4352E+01	1.0398E+00	7.7441E+00	5.4879E-01
24.000	1.4251E+01	7.1583E-01	1.4406E+01	1.0522E+00	7.7627E+00	5.5304E-01
24.033	1.4251E+01	7.1583E-01	1.4406E+01	1.0522E+00	7.7627E+00	5.5305E-01
96.000	1.4255E+01	7.1599E-01	1.5189E+01	1.1544E+00	7.8922E+00	5.6997E-01
240.000	1.4256E+01	7.1601E-01	1.6089E+01	1.2512E+00	7.9443E+00	5.7556E-01
264.000	1.4258E+01	7.1607E-01	1.8601E+01	1.4928E+00	8.0895E+00	5.8953E-01
480.000	1.4258E+01	7.1607E-01	1.8864E+01	1.5155E+00	8.1047E+00	5.9084E-01
504.000	1.4258E+01	7.1608E-01	1.9268E+01	1.5459E+00	8.1281E+00	5.9260E-01
696.000	1.4258E+01	7.1608E-01	1.9307E+01	1.5487E+00	8.1304E+00	5.9276E-01
720.000	1.4258E+01	7.1609E-01	1.9380E+01	1.5536E+00	8.1346E+00	5.9304E-01

##
Worst Two-Hour Doses
##

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
2.0	2.2248E-01	1.1574E+01	7.9114E-01

TBRoof.o0 (Excerpts)
##
I-131 Summary
##

Time (hr)	DW I-131 (Curies)	Torus I-131 (Curies)	RB I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	3.4444E+06	0.0000E+00	4.7988E+02
0.533	4.4756E+06	0.0000E+00	8.2208E+02
0.533	4.4786E+06	0.0000E+00	8.2300E+02
0.900	9.6135E+06	0.0000E+00	2.3165E+03
1.200	1.3665E+07	0.0000E+00	4.1451E+03
1.500	1.7283E+07	0.0000E+00	6.2544E+03
1.800	2.0512E+07	0.0000E+00	8.4764E+03
2.000	2.2469E+07	0.0000E+00	9.9642E+03
2.033	2.2778E+07	0.0000E+00	1.0208E+04
2.033	2.2443E+07	3.3287E+05	1.0210E+04
2.400	1.0878E+07	8.2512E+06	1.2020E+04
2.700	9.0707E+06	6.8805E+06	1.2234E+04
3.000	7.5646E+06	5.7380E+06	1.1774E+04
3.300	6.3094E+06	4.7859E+06	1.0937E+04
3.600	5.2632E+06	3.9922E+06	9.9160E+03
3.900	4.3912E+06	3.3308E+06	8.8356E+03
4.000	4.1341E+06	3.1358E+06	8.4765E+03
4.300	3.4502E+06	2.6170E+06	7.4295E+03
4.600	2.8801E+06	2.1846E+06	6.4532E+03
4.900	2.4050E+06	1.8242E+06	5.5658E+03
5.033	2.2206E+06	1.6842E+06	5.2028E+03
5.400	1.9460E+06	1.4702E+06	4.3384E+03
5.700	1.7449E+06	1.3182E+06	3.7687E+03
6.000	1.5649E+06	1.1822E+06	3.2929E+03
6.300	1.4037E+06	1.0605E+06	2.8914E+03
6.600	1.2595E+06	9.5144E+05	2.5493E+03
6.900	1.1303E+06	8.5386E+05	2.2554E+03
7.200	1.0147E+06	7.6649E+05	2.0011E+03
7.500	9.1116E+05	6.8829E+05	1.7797E+03
7.800	8.1849E+05	6.1827E+05	1.5859E+03
8.000	7.6217E+05	5.7572E+05	1.4699E+03
8.300	6.8510E+05	5.1749E+05	1.3133E+03
8.367	6.6902E+05	5.0535E+05	1.2809E+03
8.667	6.0980E+05	4.6026E+05	1.1478E+03
8.967	5.5585E+05	4.1954E+05	1.0322E+03
9.300	5.0180E+05	3.7873E+05	9.2048E+02
9.600	4.5784E+05	3.4554E+05	8.3234E+02
9.900	4.1795E+05	3.1543E+05	7.5413E+02
10.200	3.8174E+05	2.8809E+05	6.8442E+02
12.033	2.2279E+05	1.6809E+05	3.8863E+02
19.478	4.5898E+04	3.4543E+04	6.8629E+01
24.000	3.0631E+04	2.3021E+04	4.1852E+01
24.033	3.0576E+04	2.2980E+04	4.1758E+01

96.000	2.1942E+04	1.6477E+04	2.8285E+01
240.000	1.1280E+04	8.4709E+03	1.4542E+01
264.000	4.9222E+03	3.6938E+03	6.5158E+00
480.000	1.8136E+03	1.3619E+03	2.3379E+00
504.000	7.9136E+02	5.9387E+02	1.0476E+00
696.000	3.2577E+02	2.4464E+02	4.1996E-01
720.000	1.4215E+02	1.0668E+02	1.8817E-01

Time (hr)	SR I-131 (Curies)	Condenser I-131 (Curies)	TB I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	1.6378E+00	1.8705E-01	8.6434E-03
0.533	2.9033E+00	3.4492E-01	1.1240E-02
0.533	2.9068E+00	3.4537E-01	1.1247E-02
0.900	8.4009E+00	1.1111E+00	2.4142E-02
1.200	1.5282E+01	2.1838E+00	3.4337E-02
1.500	2.3305E+01	3.6509E+00	4.3457E-02
1.800	3.1808E+01	5.5038E+00	5.1616E-02
2.000	3.7522E+01	6.9496E+00	5.6572E-02
2.033	3.8460E+01	7.2042E+00	5.7355E-02
2.033	3.8469E+01	7.2067E+00	5.6880E-02
2.400	4.5875E+01	8.8887E+00	2.7510E-02
2.700	4.7021E+01	1.0200E+01	2.3039E-02
3.000	4.5483E+01	1.1480E+01	1.9312E-02
3.300	4.2429E+01	1.2732E+01	1.6206E-02
3.600	3.8623E+01	1.3960E+01	1.3617E-02
3.900	3.4554E+01	1.5168E+01	1.1459E-02
4.000	3.3195E+01	1.5567E+01	1.0823E-02
4.300	2.9224E+01	1.6754E+01	9.1298E-03
4.600	2.5509E+01	1.7926E+01	7.7189E-03
4.900	2.2124E+01	1.9086E+01	6.5428E-03
5.033	2.0738E+01	1.9596E+01	6.0861E-03
5.400	1.7417E+01	2.0998E+01	5.4059E-03
5.700	1.5228E+01	2.2136E+01	4.9077E-03
6.000	1.3401E+01	2.3267E+01	4.4616E-03
6.300	1.1861E+01	2.4393E+01	4.0622E-03
6.600	1.0549E+01	2.5513E+01	3.7046E-03
6.900	9.4220E+00	2.6628E+01	3.3843E-03
7.200	8.4472E+00	2.7738E+01	3.0976E-03
7.500	7.5986E+00	2.8843E+01	2.8408E-03
7.800	6.8560E+00	2.9943E+01	2.6109E-03
8.000	6.4118E+00	3.0674E+01	2.4711E-03
8.300	5.8117E+00	3.1767E+01	2.2797E-03
8.367	5.6876E+00	3.2011E+01	2.2398E-03
8.667	5.1767E+00	3.3099E+01	2.0926E-03
8.967	4.7328E+00	3.4183E+01	1.9584E-03
9.300	4.3044E+00	3.5382E+01	1.8240E-03
9.600	3.9662E+00	3.6458E+01	1.7145E-03
9.900	3.6661E+00	3.7531E+01	1.6151E-03
10.200	3.3986E+00	3.8600E+01	1.5249E-03
12.033	2.2624E+00	4.5060E+01	1.1274E-03

19.478	1.0147E+00	7.0152E+01	6.7293E-04
24.000	8.9703E-01	8.4564E+01	6.2508E-04
24.033	8.9657E-01	8.4667E+01	6.2487E-04
96.000	6.3667E-01	2.4516E+02	4.6500E-04
240.000	3.2732E-01	3.2600E+02	2.5720E-04
264.000	5.2774E+00	3.1494E+02	1.2789E-04
480.000	5.2624E-02	1.7574E+02	5.2535E-05
504.000	8.4847E-01	1.6231E+02	3.0688E-05
696.000	9.4528E-03	8.0792E+01	1.3901E-05
720.000	1.5241E-01	7.3727E+01	9.5546E-06

Time (hr)	Dummy I-131 (Curies)	CR I-131 (Curies)	Environment I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	8.5668E+00	8.0863E-03	9.9344E+00
0.533	2.1415E+01	1.3462E-02	1.7884E+01
0.533	2.1456E+01	1.3477E-02	1.7906E+01
0.900	1.0542E+02	3.5903E-02	5.6088E+01
1.200	2.5619E+02	6.1802E-02	1.0888E+02
1.500	5.0369E+02	8.9748E-02	1.7903E+02
1.800	8.5795E+02	1.1743E-01	2.6472E+02
2.000	1.1552E+03	1.3514E-01	3.2966E+02
2.033	1.2089E+03	1.3643E-01	3.4094E+02
2.033	1.2094E+03	1.3644E-01	3.4105E+02
2.400	1.8817E+03	1.0998E-01	4.0977E+02
2.700	2.4818E+03	9.1793E-02	4.5514E+02
3.000	3.0772E+03	7.6711E-02	4.9315E+02
3.300	3.6414E+03	6.4184E-02	5.2502E+02
3.600	4.1602E+03	5.3766E-02	5.5179E+02
3.900	4.6273E+03	4.5096E-02	5.7429E+02
4.000	4.7711E+03	4.2541E-02	5.8097E+02
4.300	5.1680E+03	3.5750E-02	5.9888E+02
4.600	5.5147E+03	3.0092E-02	6.1400E+02
4.900	5.8153E+03	2.5378E-02	6.2680E+02
5.033	5.9350E+03	2.3548E-02	6.3184E+02
5.400	6.2269E+03	1.9538E-02	6.4448E+02
5.700	6.4301E+03	1.7134E-02	6.5375E+02
6.000	6.6074E+03	1.5220E-02	6.6218E+02
6.300	6.7629E+03	1.3641E-02	6.6984E+02
6.600	6.8998E+03	1.2302E-02	6.7682E+02
6.900	7.0210E+03	1.1145E-02	6.8320E+02
7.200	7.1285E+03	1.0133E-02	6.8903E+02
7.500	7.2241E+03	9.2404E-03	6.9437E+02
7.800	7.3095E+03	8.4485E-03	6.9927E+02
8.000	7.3613E+03	7.9696E-03	7.0232E+02
8.300	7.4458E+03	5.8195E-03	7.0659E+02
8.367	7.4635E+03	5.4700E-03	7.0750E+02
8.667	7.5376E+03	4.2984E-03	7.1139E+02
8.967	7.6044E+03	3.5606E-03	7.1504E+02
9.300	7.6712E+03	3.0308E-03	7.1881E+02
9.600	7.7253E+03	2.7038E-03	7.2199E+02

9.900	7.7746E+03	2.4612E-03	7.2499E+02
10.200	7.8194E+03	2.2714E-03	7.2781E+02
12.033	8.0203E+03	1.5919E-03	7.4218E+02
19.478	8.3059E+03	8.8594E-04	7.7892E+02
24.000	8.3658E+03	8.1479E-04	7.9640E+02
24.033	8.3662E+03	7.9477E-04	7.9652E+02
96.000	8.6158E+03	3.6464E-04	1.0297E+03
240.000	7.4311E+03	1.5553E-04	1.3324E+03
264.000	1.4893E+04	7.8290E-05	1.3588E+03
480.000	7.4319E+03	3.1769E-05	1.4684E+03
504.000	8.1163E+03	1.8711E-05	1.4742E+03
696.000	4.1632E+03	8.4062E-06	1.4985E+03
720.000	4.0525E+03	5.8055E-06	1.5002E+03

##

Cumulative Dose Summary

##

	Control Room		EAB		LPZ	
Time	Thyroid	TEDE	Thyroid	TEDE	Thyroid	TEDE
(hr)	(rem)	(rem)	(rem)	(rem)	(rem)	(rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.400	3.5553E-01	1.3784E-02	1.3955E+00	7.0308E-02	6.9777E-01	3.5154E-02
0.533	8.1785E-01	3.1694E-02	2.5092E+00	1.2621E-01	1.2546E+00	6.3105E-02
0.533	8.1929E-01	3.1750E-02	2.5123E+00	1.2637E-01	1.2562E+00	6.3183E-02
0.900	3.6162E+00	1.4474E-01	7.8938E+00	4.4180E-01	3.9469E+00	2.2090E-01
1.200	8.3588E+00	3.5459E-01	1.5380E+01	9.4557E-01	7.6900E+00	4.7278E-01
1.500	1.5767E+01	6.9993E-01	2.5329E+01	1.6429E+00	1.2665E+01	8.2147E-01
1.800	2.5908E+01	1.1870E+00	3.7463E+01	2.5094E+00	1.8732E+01	1.2547E+00
2.000	3.4138E+01	1.5889E+00	4.6643E+01	3.1704E+00	2.3322E+01	1.5852E+00
2.033	3.5596E+01	1.6605E+00	4.8235E+01	3.2850E+00	2.3723E+01	1.6141E+00
2.033	3.5611E+01	1.6612E+00	4.8251E+01	3.2862E+00	2.3727E+01	1.6144E+00
2.400	5.0282E+01	2.3850E+00	5.7938E+01	3.9986E+00	2.6171E+01	1.7941E+00
2.700	6.0063E+01	2.8706E+00	6.4307E+01	4.4843E+00	2.7778E+01	1.9167E+00
3.000	6.8206E+01	3.2767E+00	6.9624E+01	4.9046E+00	2.9119E+01	2.0227E+00
3.300	7.4995E+01	3.6166E+00	7.4068E+01	5.2696E+00	3.0241E+01	2.1148E+00
3.600	8.0660E+01	3.9010E+00	7.7787E+01	5.5880E+00	3.1179E+01	2.1951E+00
3.900	8.5393E+01	4.1394E+00	8.0903E+01	5.8671E+00	3.1965E+01	2.2655E+00
4.000	8.6792E+01	4.2100E+00	8.1826E+01	5.9524E+00	3.2198E+01	2.2871E+00
4.300	9.0525E+01	4.3986E+00	8.4294E+01	6.1881E+00	3.2821E+01	2.3465E+00
4.600	9.3654E+01	4.5570E+00	8.6371E+01	6.3969E+00	3.3345E+01	2.3992E+00
4.900	9.6281E+01	4.6903E+00	8.8124E+01	6.5827E+00	3.3787E+01	2.4461E+00
5.033	9.7308E+01	4.7425E+00	8.8811E+01	6.6586E+00	3.3960E+01	2.4652E+00
5.400	9.9784E+01	4.8685E+00	9.0533E+01	6.8534E+00	3.4395E+01	2.5144E+00
5.700	1.0151E+02	4.9562E+00	9.1791E+01	6.9995E+00	3.4712E+01	2.5512E+00
6.000	1.0302E+02	5.0334E+00	9.2930E+01	7.1348E+00	3.4999E+01	2.5854E+00
6.300	1.0437E+02	5.1021E+00	9.3963E+01	7.2604E+00	3.5260E+01	2.6171E+00
6.600	1.0558E+02	5.1636E+00	9.4902E+01	7.3771E+00	3.5497E+01	2.6465E+00
6.900	1.0666E+02	5.2189E+00	9.5755E+01	7.4858E+00	3.5712E+01	2.6739E+00
7.200	1.0765E+02	5.2690E+00	9.6533E+01	7.5871E+00	3.5908E+01	2.6995E+00
7.500	1.0854E+02	5.3143E+00	9.7244E+01	7.6818E+00	3.6088E+01	2.7234E+00

7.800	1.0936E+02	5.3554E+00	9.7894E+01	7.7704E+00	3.6252E+01	2.7457E+00
8.000	1.0986E+02	5.3808E+00	9.8297E+01	7.8263E+00	3.6354E+01	2.7598E+00
8.300	1.1048E+02	5.4122E+00	9.8587E+01	7.8935E+00	3.6405E+01	2.7719E+00
8.367	1.1060E+02	5.4180E+00	9.8649E+01	7.9080E+00	3.6416E+01	2.7745E+00
8.667	1.1104E+02	5.4402E+00	9.8912E+01	7.9708E+00	3.6464E+01	2.7857E+00
8.967	1.1139E+02	5.4580E+00	9.9158E+01	8.0304E+00	3.6508E+01	2.7964E+00
9.300	1.1172E+02	5.4744E+00	9.9411E+01	8.0930E+00	3.6553E+01	2.8076E+00
9.600	1.1198E+02	5.4872E+00	9.9624E+01	8.1465E+00	3.6591E+01	2.8172E+00
9.900	1.1222E+02	5.4986E+00	9.9824E+01	8.1975E+00	3.6627E+01	2.8263E+00
10.200	1.1243E+02	5.5090E+00	1.0001E+02	8.2461E+00	3.6660E+01	2.8350E+00
12.033	1.1345E+02	5.5581E+00	1.0096E+02	8.5006E+00	3.6830E+01	2.8805E+00
19.478	1.1583E+02	5.6603E+00	1.0330E+02	9.1520E+00	3.7248E+01	2.9971E+00
24.000	1.1688E+02	5.6996E+00	1.0436E+02	9.4061E+00	3.7439E+01	3.0426E+00
24.033	1.1688E+02	5.6998E+00	1.0437E+02	9.4078E+00	3.7440E+01	3.0428E+00
96.000	1.2143E+02	5.8578E+00	1.2076E+02	1.1563E+01	3.8835E+01	3.2262E+00
240.000	1.2425E+02	5.9539E+00	1.4066E+02	1.3707E+01	3.9439E+01	3.2913E+00
264.000	1.2450E+02	5.9623E+00	1.4239E+02	1.3873E+01	3.9492E+01	3.2964E+00
480.000	1.2552E+02	5.9965E+00	1.4955E+02	1.4483E+01	3.9710E+01	3.3149E+00
504.000	1.2557E+02	5.9983E+00	1.4993E+02	1.4511E+01	3.9721E+01	3.3158E+00
696.000	1.2580E+02	6.0060E+00	1.5152E+02	1.4619E+01	3.9770E+01	3.3191E+00
720.000	1.2581E+02	6.0065E+00	1.5163E+02	1.4625E+01	3.9773E+01	3.3193E+00

##
Worst Two-Hour Doses
##

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.9	1.4415E+00	5.9958E+01	4.3227E+00

StackBase_ESF.o0 (Excerpts)
##
I-131 Summary
##

Time (hr)	SP I-131 (Curies)	RB I-131 (Curies)	SR I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	7.8768E+06	7.1854E+01	1.6805E+00
0.533	1.0735E+07	1.2749E+02	3.0839E+00
0.900	2.2868E+07	3.7146E+02	9.2642E+00
1.200	3.3546E+07	6.7639E+02	1.7134E+01
1.500	4.4198E+07	1.0474E+03	2.6794E+01
1.800	5.4823E+07	1.4651E+03	3.7717E+01
2.000	6.1891E+07	1.7624E+03	4.5510E+01
2.033	6.3068E+07	1.8131E+03	4.6841E+01
2.400	6.5328E+07	2.3073E+03	6.0106E+01
2.700	6.5236E+07	2.5846E+03	6.7614E+01
3.000	6.5143E+07	2.7805E+03	7.2918E+01
3.300	6.5051E+07	2.9184E+03	7.6655E+01
3.600	6.4959E+07	3.0152E+03	7.9277E+01
3.900	6.4866E+07	3.0827E+03	8.1107E+01
4.000	6.4836E+07	3.1002E+03	8.1582E+01
4.300	6.4744E+07	3.1413E+03	8.2699E+01
4.600	6.4652E+07	3.1693E+03	8.3458E+01
4.900	6.4560E+07	3.1878E+03	8.3964E+01
5.200	6.4469E+07	3.1997E+03	8.4288E+01
5.500	6.4377E+07	3.2068E+03	8.4484E+01
5.800	6.4286E+07	3.2105E+03	8.4588E+01
6.100	6.4195E+07	3.2119E+03	8.4627E+01
6.400	6.4104E+07	3.2115E+03	8.4621E+01
6.700	6.4013E+07	3.2099E+03	8.4581E+01
7.000	6.3922E+07	3.2075E+03	8.4519E+01
7.300	6.3832E+07	3.2045E+03	8.4440E+01
7.600	6.3741E+07	3.2010E+03	8.4349E+01
7.900	6.3651E+07	3.1972E+03	8.4250E+01
8.000	6.3621E+07	3.1959E+03	8.4216E+01
8.300	6.3531E+07	3.1918E+03	8.4109E+01
8.600	6.3440E+07	3.1877E+03	8.3999E+01
8.900	6.3350E+07	3.1834E+03	8.3887E+01
9.200	6.3261E+07	3.1790E+03	8.3773E+01
9.500	6.3171E+07	3.1747E+03	8.3657E+01
9.800	6.3081E+07	3.1703E+03	8.3541E+01
10.100	6.2992E+07	3.1658E+03	8.3424E+01
10.400	6.2903E+07	3.1614E+03	8.3307E+01
24.000	5.8984E+07	2.9645E+03	7.8120E+01
96.000	4.1961E+07	2.1089E+03	5.5574E+01
720.000	2.1933E+06	1.1024E+02	2.9049E+00

Time (hr)	CR I-131 (Curies)	Environment I-131 (Curies)	Dummy I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00

0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	3.7480E-06	6.9496E-03	8.5953E+00
0.533	9.0686E-06	1.7838E-02	2.2059E+01
0.900	4.0324E-05	9.2002E-02	1.1374E+02
1.200	8.9902E-05	2.2764E-01	2.8134E+02
1.500	1.6242E-04	4.5509E-01	5.6231E+02
1.800	2.5529E-04	7.9012E-01	9.7599E+02
2.000	3.2670E-04	1.0788E+00	1.3324E+03
2.033	3.2743E-04	1.1323E+00	1.3983E+03
2.400	3.6427E-04	1.8177E+00	2.2440E+03
2.700	4.1156E-04	2.4851E+00	3.0668E+03
3.000	4.5815E-04	3.2185E+00	3.9704E+03
3.300	4.9846E-04	3.9985E+00	4.9307E+03
3.600	5.3104E-04	4.8113E+00	5.9305E+03
3.900	5.5630E-04	5.6471E+00	6.9575E+03
4.000	5.6327E-04	5.9295E+00	7.3044E+03
4.300	5.8049E-04	6.7854E+00	8.3548E+03
4.600	5.9308E-04	7.6509E+00	9.4161E+03
4.900	6.0213E-04	8.5229E+00	1.0484E+04
5.200	6.0849E-04	9.3992E+00	1.1557E+04
5.500	6.1287E-04	1.0278E+01	1.2631E+04
5.800	6.1579E-04	1.1159E+01	1.3706E+04
6.100	6.1765E-04	1.2040E+01	1.4781E+04
6.400	6.1873E-04	1.2921E+01	1.5855E+04
6.700	6.1926E-04	1.3802E+01	1.6927E+04
7.000	6.1939E-04	1.4683E+01	1.7998E+04
7.300	6.1922E-04	1.5563E+01	1.9067E+04
7.600	6.1886E-04	1.6442E+01	2.0133E+04
7.900	6.1835E-04	1.7320E+01	2.1197E+04
8.000	6.1815E-04	1.7612E+01	2.1551E+04
8.300	4.6800E-04	1.8489E+01	2.2612E+04
8.600	3.8350E-04	1.9364E+01	2.3670E+04
8.900	3.3588E-04	2.0238E+01	2.4726E+04
9.200	3.0897E-04	2.1111E+01	2.5779E+04
9.500	2.9369E-04	2.1983E+01	2.6829E+04
9.800	2.8494E-04	2.2854E+01	2.7877E+04
10.100	2.7986E-04	2.3723E+01	2.8922E+04
10.400	2.7684E-04	2.4592E+01	2.9964E+04
24.000	2.5644E-04	6.2637E+01	7.4523E+04
96.000	1.2917E-04	2.2786E+02	2.3664E+05
720.000	5.1514E-06	6.1383E+02	1.3853E+05

##

Cumulative Dose Summary

##

	Control Room		EAB		LPZ	
Time	Thyroid	TEDE	Thyroid	TEDE	Thyroid	TEDE
(hr)	(rem)	(rem)	(rem)	(rem)	(rem)	(rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.400	1.1835E-04	3.7654E-06	9.6978E-04	3.4933E-05	4.8489E-04	1.7467E-05
0.533	3.8752E-04	1.2318E-05	2.4854E-03	8.9084E-05	1.2427E-03	4.4542E-05

0.900	3.0346E-03	9.6268E-05	1.2772E-02	4.5307E-04	6.3861E-03	2.2653E-04
1.200	9.1018E-03	2.8834E-04	3.1508E-02	1.1110E-03	1.5754E-02	5.5551E-04
1.500	2.0980E-02	6.6383E-04	6.2811E-02	2.2044E-03	3.1405E-02	1.1022E-03
1.800	4.0697E-02	1.2864E-03	1.0875E-01	3.8019E-03	5.4374E-02	1.9009E-03
2.000	5.9051E-02	1.8654E-03	1.4822E-01	5.1705E-03	7.4111E-02	2.5852E-03
2.033	6.2488E-02	1.9737E-03	1.5551E-01	5.4228E-03	7.5950E-02	2.6489E-03
2.400	1.0201E-01	3.2191E-03	2.4887E-01	8.6490E-03	9.9503E-02	3.4628E-03
2.700	1.3846E-01	4.3666E-03	3.3942E-01	1.1768E-02	1.2235E-01	4.2496E-03
3.000	1.7925E-01	5.6497E-03	4.3860E-01	1.5173E-02	1.4737E-01	5.1087E-03
3.300	2.2398E-01	7.0559E-03	5.4374E-01	1.8772E-02	1.7390E-01	6.0168E-03
3.600	2.7197E-01	8.5631E-03	6.5295E-01	2.2501E-02	2.0145E-01	6.9576E-03
3.900	3.2248E-01	1.0149E-02	7.6488E-01	2.6315E-02	2.2969E-01	7.9197E-03
4.000	3.3977E-01	1.0691E-02	8.0263E-01	2.7599E-02	2.3921E-01	8.2437E-03
4.300	3.9267E-01	1.2350E-02	9.1678E-01	3.1477E-02	2.6801E-01	9.2222E-03
4.600	4.4678E-01	1.4047E-02	1.0319E+00	3.5381E-02	2.9705E-01	1.0207E-02
4.900	5.0171E-01	1.5768E-02	1.1475E+00	3.9295E-02	3.2622E-01	1.1195E-02
5.200	5.5719E-01	1.7505E-02	1.2633E+00	4.3212E-02	3.5544E-01	1.2183E-02
5.500	6.1299E-01	1.9251E-02	1.3792E+00	4.7124E-02	3.8467E-01	1.3170E-02
5.800	6.6896E-01	2.1003E-02	1.4949E+00	5.1026E-02	4.1387E-01	1.4154E-02
6.100	7.2499E-01	2.2755E-02	1.6104E+00	5.4917E-02	4.4301E-01	1.5136E-02
6.400	7.8100E-01	2.4506E-02	1.7256E+00	5.8793E-02	4.7207E-01	1.6114E-02
6.700	8.3693E-01	2.6253E-02	1.8405E+00	6.2654E-02	5.0105E-01	1.7088E-02
7.000	8.9273E-01	2.7996E-02	1.9550E+00	6.6498E-02	5.2993E-01	1.8058E-02
7.300	9.4839E-01	2.9734E-02	2.0690E+00	7.0325E-02	5.5872E-01	1.9023E-02
7.600	1.0039E+00	3.1466E-02	2.1827E+00	7.4135E-02	5.8739E-01	1.9984E-02
7.900	1.0592E+00	3.3192E-02	2.2960E+00	7.7927E-02	6.1597E-01	2.0941E-02
8.000	1.0776E+00	3.3766E-02	2.3336E+00	7.9187E-02	6.2547E-01	2.1259E-02
8.300	1.1254E+00	3.5257E-02	2.3916E+00	8.1256E-02	6.3584E-01	2.1629E-02
8.600	1.1629E+00	3.6427E-02	2.4493E+00	8.3315E-02	6.4618E-01	2.1998E-02
8.900	1.1946E+00	3.7416E-02	2.5068E+00	8.5363E-02	6.5647E-01	2.2364E-02
9.200	1.2231E+00	3.8301E-02	2.5641E+00	8.7401E-02	6.6673E-01	2.2729E-02
9.500	1.2496E+00	3.9128E-02	2.6212E+00	8.9428E-02	6.7695E-01	2.3092E-02
9.800	1.2750E+00	3.9920E-02	2.6781E+00	9.1446E-02	6.8713E-01	2.3453E-02
10.100	1.2998E+00	4.0692E-02	2.7348E+00	9.3454E-02	6.9727E-01	2.3813E-02
10.400	1.3242E+00	4.1451E-02	2.7912E+00	9.5452E-02	7.0738E-01	2.4170E-02
24.000	2.3345E+00	7.2755E-02	5.1685E+00	1.7758E-01	1.1329E+00	3.8873E-02
96.000	3.9824E+00	1.2323E-01	1.6780E+01	5.4442E-01	2.1213E+00	7.0096E-02
720.000	5.8011E+00	1.7864E-01	4.2073E+01	1.3247E+00	2.8897E+00	9.3803E-02

##
Worst Two-Hour Doses
##

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
4.1	2.0273E-03	7.6974E-01	2.6025E-02

StackTop_ESF.o0 (Fumigation X/Q between 3.5 and 4 hours) (Excerpts)

\##

I-131 Summary

\##

Time (hr)	SP I-131 (Curies)	RB I-131 (Curies)	SR I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	7.8768E+06	7.1854E+01	1.6811E+00
0.533	1.0735E+07	1.2749E+02	3.0850E+00
0.900	2.2868E+07	3.7146E+02	9.2677E+00
1.200	3.3546E+07	6.7639E+02	1.7141E+01
1.500	4.4198E+07	1.0474E+03	2.6805E+01
1.800	5.4823E+07	1.4651E+03	3.7732E+01
2.000	6.1891E+07	1.7624E+03	4.5528E+01
2.033	6.3068E+07	1.8131E+03	4.6860E+01
2.400	6.5328E+07	2.3073E+03	6.0130E+01
2.700	6.5236E+07	2.5846E+03	6.7641E+01
3.000	6.5143E+07	2.7805E+03	7.2947E+01
3.300	6.5051E+07	2.9184E+03	7.6686E+01
3.500	6.4989E+07	2.9867E+03	7.8536E+01
3.800	6.4897E+07	3.0628E+03	8.0602E+01
4.000	6.4836E+07	3.1002E+03	8.1615E+01
4.300	6.4744E+07	3.1413E+03	8.2733E+01
4.600	6.4652E+07	3.1693E+03	8.3492E+01
4.900	6.4560E+07	3.1878E+03	8.3997E+01
5.200	6.4469E+07	3.1997E+03	8.4322E+01
5.500	6.4377E+07	3.2068E+03	8.4518E+01
5.800	6.4286E+07	3.2105E+03	8.4622E+01
6.100	6.4195E+07	3.2119E+03	8.4662E+01
6.400	6.4104E+07	3.2115E+03	8.4655E+01
6.700	6.4013E+07	3.2099E+03	8.4616E+01
7.000	6.3922E+07	3.2075E+03	8.4553E+01
7.300	6.3832E+07	3.2045E+03	8.4474E+01
7.600	6.3741E+07	3.2010E+03	8.4383E+01
7.900	6.3651E+07	3.1972E+03	8.4284E+01
8.000	6.3621E+07	3.1959E+03	8.4250E+01
8.300	6.3531E+07	3.1918E+03	8.4143E+01
8.600	6.3440E+07	3.1877E+03	8.4033E+01
8.900	6.3350E+07	3.1834E+03	8.3921E+01
9.200	6.3261E+07	3.1790E+03	8.3807E+01
9.500	6.3171E+07	3.1747E+03	8.3691E+01
9.800	6.3081E+07	3.1703E+03	8.3575E+01
10.100	6.2992E+07	3.1658E+03	8.3458E+01
10.400	6.2903E+07	3.1614E+03	8.3341E+01
24.000	5.8984E+07	2.9645E+03	7.8152E+01
96.000	4.1961E+07	2.1089E+03	5.5596E+01
720.000	2.1933E+06	1.1024E+02	2.9061E+00

Time (hr)	CR I-131 (Curies)	Environment I-131 (Curies)	Dummy I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	3.2697E-06	8.5995E+00	3.4754E-03
0.533	7.9114E-06	2.2074E+01	8.9196E-03
0.900	3.5179E-05	1.1385E+02	4.5990E-02
1.200	7.8432E-05	2.8169E+02	1.1376E-01
1.500	1.4170E-04	5.6317E+02	2.2738E-01
1.800	2.2272E-04	9.7776E+02	3.9465E-01
2.000	2.8502E-04	1.3351E+03	5.3877E-01
2.033	2.7647E-04	1.4012E+03	5.6543E-01
2.400	2.2470E-04	2.2494E+03	9.0740E-01
2.700	2.1624E-04	3.0753E+03	1.2401E+00
3.000	2.2021E-04	3.9829E+03	1.6055E+00
3.300	2.2859E-04	4.9481E+03	1.9938E+00
3.500	2.3467E-04	5.6150E+03	2.2619E+00
3.800	8.4274E-02	6.6409E+03	2.6740E+00
4.000	1.1975E-01	7.3377E+03	2.9536E+00
4.300	6.7379E-02	8.3968E+03	3.3784E+00
4.600	3.7962E-02	9.4679E+03	3.8075E+00
4.900	2.1439E-02	1.0547E+04	4.2395E+00
5.200	1.2160E-02	1.1631E+04	4.6731E+00
5.500	6.9478E-03	1.2719E+04	5.1075E+00
5.800	4.0206E-03	1.3809E+04	5.5423E+00
6.100	2.3765E-03	1.4899E+04	5.9769E+00
6.400	1.4531E-03	1.5990E+04	6.4112E+00
6.700	9.3440E-04	1.7080E+04	6.8449E+00
7.000	6.4298E-04	1.8170E+04	7.2778E+00
7.300	4.7919E-04	1.9259E+04	7.7099E+00
7.600	3.8708E-04	2.0347E+04	8.1411E+00
7.900	3.3520E-04	2.1433E+04	8.5714E+00
8.000	3.2354E-04	2.1795E+04	8.7146E+00
8.300	2.4810E-04	2.2880E+04	9.1435E+00
8.600	2.0565E-04	2.3963E+04	9.5713E+00
8.900	1.8171E-04	2.5045E+04	9.9982E+00
9.200	1.6818E-04	2.6125E+04	1.0424E+01
9.500	1.6049E-04	2.7204E+04	1.0849E+01
9.800	1.5607E-04	2.8282E+04	1.1272E+01
10.100	1.5350E-04	2.9358E+04	1.1695E+01
10.400	1.5197E-04	3.0432E+04	1.2117E+01
24.000	1.4092E-04	7.7513E+04	3.0135E+01
96.000	2.9048E-05	2.8198E+05	9.5688E+01
720.000	2.5582E-07	7.5961E+05	5.6015E+01

###

Cumulative Dose Summary

###

Time (hr)	Control Room Thyroid (rem)	Control Room TEDE (rem)	EAB Thyroid (rem)	EAB TEDE (rem)	LPZ Thyroid (rem)	LPZ TEDE (rem)

0.000 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
0.033 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00
0.400 1.0324E-04 3.2848E-06 5.4505E-03 1.9634E-04 5.1756E-03 1.8644E-04
0.533 3.3806E-04 1.0746E-05 1.3969E-02 5.0069E-04 1.3265E-02 4.7544E-04
0.900 2.6474E-03 8.3984E-05 7.1786E-02 2.5465E-03 6.8167E-02 2.4181E-03
1.200 7.9406E-03 2.5155E-04 1.7709E-01 6.2446E-03 1.6816E-01 5.9297E-03
1.500 1.8303E-02 5.7913E-04 3.5303E-01 1.2390E-02 3.3523E-01 1.1765E-02
1.800 3.5505E-02 1.1223E-03 6.1123E-01 2.1369E-02 5.8041E-01 2.0291E-02
2.000 5.1518E-02 1.6274E-03 8.3310E-01 2.9061E-02 7.9109E-01 2.7596E-02
2.033 5.4468E-02 1.7204E-03 8.7408E-01 3.0479E-02 8.1089E-01 2.8281E-02
2.400 8.2789E-02 2.6129E-03 1.3988E+00 4.8613E-02 1.0644E+00 3.7043E-02
2.700 1.0339E-01 3.2615E-03 1.9077E+00 6.6142E-02 1.3104E+00 4.5513E-02
3.000 1.2380E-01 3.9033E-03 2.4652E+00 8.5281E-02 1.5797E+00 5.4761E-02
3.300 1.4475E-01 4.5618E-03 3.0562E+00 1.0551E-01 1.8653E+00 6.4537E-02
3.500 1.5914E-01 5.0138E-03 3.4634E+00 1.1942E-01 2.0620E+00 7.1258E-02
3.800 4.3961E+00 1.3804E-01 1.5800E+01 5.4003E-01 8.6768E+00 2.9677E-01
4.000 1.0748E+01 3.3739E-01 2.4158E+01 8.2445E-01 1.3158E+01 4.4927E-01
4.300 1.9193E+01 6.0228E-01 2.4800E+01 8.4625E-01 1.3468E+01 4.5981E-01
4.600 2.3933E+01 7.5085E-01 2.5447E+01 8.6819E-01 1.3781E+01 4.7041E-01
4.900 2.6598E+01 8.3434E-01 2.6097E+01 8.9019E-01 1.4095E+01 4.8104E-01
5.200 2.8101E+01 8.8141E-01 2.6748E+01 9.1221E-01 1.4409E+01 4.9168E-01
5.500 2.8954E+01 9.0809E-01 2.7399E+01 9.3419E-01 1.4724E+01 5.0230E-01
5.800 2.9442E+01 9.2337E-01 2.8049E+01 9.5613E-01 1.5038E+01 5.1290E-01
6.100 2.9726E+01 9.3225E-01 2.8699E+01 9.7800E-01 1.5352E+01 5.2347E-01
6.400 2.9896E+01 9.3756E-01 2.9346E+01 9.9978E-01 1.5665E+01 5.3399E-01
6.700 3.0002E+01 9.4087E-01 2.9992E+01 1.0215E+00 1.5977E+01 5.4448E-01
7.000 3.0072E+01 9.4306E-01 3.0635E+01 1.0431E+00 1.6288E+01 5.5492E-01
7.300 3.0122E+01 9.4461E-01 3.1276E+01 1.0646E+00 1.6597E+01 5.6531E-01
7.600 3.0160E+01 9.4581E-01 3.1915E+01 1.0860E+00 1.6906E+01 5.7566E-01
7.900 3.0192E+01 9.4681E-01 3.2552E+01 1.1073E+00 1.7214E+01 5.8596E-01
8.000 3.0202E+01 9.4712E-01 3.2763E+01 1.1144E+00 1.7316E+01 5.8938E-01
8.300 3.0227E+01 9.4790E-01 3.3089E+01 1.1260E+00 1.7428E+01 5.9339E-01
8.600 3.0247E+01 9.4853E-01 3.3414E+01 1.1376E+00 1.7540E+01 5.9737E-01
8.900 3.0264E+01 9.4906E-01 3.3737E+01 1.1491E+00 1.7651E+01 6.0134E-01
9.200 3.0280E+01 9.4954E-01 3.4059E+01 1.1606E+00 1.7762E+01 6.0529E-01
9.500 3.0294E+01 9.4999E-01 3.4380E+01 1.1720E+00 1.7873E+01 6.0921E-01
9.800 3.0308E+01 9.5042E-01 3.4700E+01 1.1833E+00 1.7983E+01 6.1312E-01
10.100 3.0322E+01 9.5085E-01 3.5018E+01 1.1946E+00 1.8093E+01 6.1701E-01
10.400 3.0335E+01 9.5126E-01 3.5335E+01 1.2058E+00 1.8202E+01 6.2088E-01
24.000 3.0890E+01 9.6846E-01 4.8697E+01 1.6675E+00 2.2806E+01 7.7993E-01
96.000 3.1270E+01 9.8009E-01 1.1396E+02 3.7294E+00 3.3610E+01 1.1213E+00
720.000 3.1362E+01 9.8289E-01 2.5613E+02 8.1153E+00 4.1830E+01 1.3748E+00

##
Worst Two-Hour Doses
##

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
3.5	6.7129E-02	2.3935E+01	8.1477E-01

StackTop.o0 (Fumigation X/Q for EAB between 2.5 and 3 hours) (Excerpts)

###

I-131 Summary

###

Time (hr)	SP I-131 (Curies)	RB I-131 (Curies)	SR I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	3.4444E+06	0.0000E+00	4.7988E+02
0.533	4.4756E+06	0.0000E+00	8.2208E+02
0.533	4.4786E+06	0.0000E+00	8.2300E+02
0.900	9.6135E+06	0.0000E+00	2.3165E+03
1.200	1.3665E+07	0.0000E+00	4.1451E+03
1.500	1.7283E+07	0.0000E+00	6.2544E+03
1.800	2.0512E+07	0.0000E+00	8.4764E+03
2.000	2.2469E+07	0.0000E+00	9.9642E+03
2.033	2.2778E+07	0.0000E+00	1.0208E+04
2.033	2.2443E+07	3.3287E+05	1.0210E+04
2.400	1.0878E+07	8.2512E+06	1.2020E+04
2.500	1.0238E+07	7.7663E+06	1.2190E+04
2.800	8.5379E+06	6.4763E+06	1.2138E+04
3.000	7.5646E+06	5.7380E+06	1.1774E+04
3.300	6.3094E+06	4.7859E+06	1.0937E+04
3.500	5.5909E+06	4.2409E+06	1.0268E+04
3.800	4.6644E+06	3.5380E+06	9.1969E+03
4.000	4.1341E+06	3.1358E+06	8.4765E+03
4.300	3.4502E+06	2.6170E+06	7.4295E+03
4.600	2.8801E+06	2.1846E+06	6.4532E+03
4.900	2.4050E+06	1.8242E+06	5.5658E+03
5.033	2.2206E+06	1.6842E+06	5.2028E+03
5.400	1.9460E+06	1.4702E+06	4.3384E+03
5.700	1.7449E+06	1.3182E+06	3.7687E+03
6.000	1.5649E+06	1.1822E+06	3.2929E+03
6.300	1.4037E+06	1.0605E+06	2.8914E+03
6.600	1.2595E+06	9.5144E+05	2.5493E+03
6.900	1.1303E+06	8.5386E+05	2.2554E+03
7.200	1.0147E+06	7.6649E+05	2.0011E+03
7.500	9.1116E+05	6.8829E+05	1.7797E+03
7.800	8.1849E+05	6.1827E+05	1.5859E+03
8.000	7.6217E+05	5.7572E+05	1.4699E+03
8.300	6.8510E+05	5.1749E+05	1.3133E+03
8.367	6.6902E+05	5.0535E+05	1.2809E+03
8.667	6.0980E+05	4.6026E+05	1.1478E+03
8.967	5.5585E+05	4.1954E+05	1.0322E+03
9.300	5.0180E+05	3.7873E+05	9.2048E+02
9.600	4.5784E+05	3.4554E+05	8.3234E+02
9.900	4.1795E+05	3.1543E+05	7.5413E+02
10.200	3.8174E+05	2.8809E+05	6.8442E+02
12.033	2.2279E+05	1.6809E+05	3.8863E+02

19.478	4.5898E+04	3.4543E+04	6.8629E+01
24.000	3.0631E+04	2.3021E+04	4.1852E+01
24.033	3.0576E+04	2.2980E+04	4.1758E+01
96.000	2.1942E+04	1.6477E+04	2.8285E+01
240.000	1.1280E+04	8.4709E+03	1.4542E+01
264.000	4.9222E+03	3.6938E+03	6.5158E+00
480.000	1.8136E+03	1.3619E+03	2.3379E+00
504.000	7.9136E+02	5.9387E+02	1.0476E+00
696.000	3.2577E+02	2.4464E+02	4.1996E-01
720.000	1.4215E+02	1.0668E+02	1.8817E-01

Time (hr)	SR I-131 (Curies)	Condenser I-131 (Curies)	TB I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	1.6372E+00	1.8705E-01	8.6434E-03
0.533	2.9023E+00	3.4492E-01	1.1240E-02
0.533	2.9057E+00	3.4537E-01	1.1247E-02
0.900	8.3976E+00	1.1111E+00	2.4142E-02
1.200	1.5276E+01	2.1838E+00	3.4337E-02
1.500	2.3296E+01	3.6509E+00	4.3457E-02
1.800	3.1796E+01	5.5038E+00	5.1616E-02
2.000	3.7507E+01	6.9496E+00	5.6572E-02
2.033	3.8444E+01	7.2042E+00	5.7355E-02
2.033	3.8454E+01	7.2067E+00	5.6880E-02
2.400	4.5856E+01	8.8887E+00	2.7510E-02
2.500	4.6630E+01	9.3299E+00	2.5928E-02
2.800	4.6720E+01	1.0630E+01	2.1720E-02
3.000	4.5465E+01	1.1480E+01	1.9312E-02
3.300	4.2412E+01	1.2732E+01	1.6206E-02
3.500	3.9924E+01	1.3553E+01	1.4428E-02
3.800	3.5903E+01	1.4768E+01	1.2135E-02
4.000	3.3182E+01	1.5567E+01	1.0823E-02
4.300	2.9212E+01	1.6754E+01	9.1298E-03
4.600	2.5498E+01	1.7926E+01	7.7189E-03
4.900	2.2115E+01	1.9086E+01	6.5428E-03
5.033	2.0730E+01	1.9596E+01	6.0861E-03
5.400	1.7410E+01	2.0998E+01	5.4059E-03
5.700	1.5222E+01	2.2136E+01	4.9077E-03
6.000	1.3396E+01	2.3267E+01	4.4616E-03
6.300	1.1856E+01	2.4393E+01	4.0622E-03
6.600	1.0545E+01	2.5513E+01	3.7046E-03
6.900	9.4182E+00	2.6628E+01	3.3843E-03
7.200	8.4437E+00	2.7738E+01	3.0976E-03
7.500	7.5955E+00	2.8843E+01	2.8408E-03
7.800	6.8532E+00	2.9943E+01	2.6109E-03
8.000	6.4091E+00	3.0674E+01	2.4711E-03
8.300	5.8093E+00	3.1767E+01	2.2797E-03
8.367	5.6853E+00	3.2011E+01	2.2398E-03
8.667	5.1746E+00	3.3099E+01	2.0926E-03
8.967	4.7309E+00	3.4183E+01	1.9584E-03
9.300	4.3026E+00	3.5382E+01	1.8240E-03

9.600	3.9646E+00	3.6458E+01	1.7145E-03
9.900	3.6646E+00	3.7531E+01	1.6151E-03
10.200	3.3973E+00	3.8600E+01	1.5249E-03
12.033	2.2615E+00	4.5060E+01	1.1274E-03
19.478	1.0143E+00	7.0152E+01	6.7293E-04
24.000	8.9667E-01	8.4564E+01	6.2508E-04
24.033	8.9621E-01	8.4667E+01	6.2487E-04
96.000	6.3641E-01	2.4516E+02	4.6500E-04
240.000	3.2718E-01	3.2600E+02	2.5720E-04
264.000	5.2753E+00	3.1494E+02	1.2789E-04
480.000	5.2602E-02	1.7574E+02	5.2535E-05
504.000	8.4813E-01	1.6231E+02	3.0688E-05
696.000	9.4490E-03	8.0792E+01	1.3901E-05
720.000	1.5235E-01	7.3727E+01	9.5546E-06

Time (hr)	Dummy I-131 (Curies)	CR I-131 (Curies)	Environment I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	9.9385E+00	3.2486E-06	8.5619E+00
0.533	1.7893E+01	7.6424E-06	2.1405E+01
0.533	1.7915E+01	7.6560E-06	2.1446E+01
0.900	5.6126E+01	3.2342E-05	1.0540E+02
1.200	1.0896E+02	7.0847E-05	2.5622E+02
1.500	1.7918E+02	1.2561E-04	5.0387E+02
1.800	2.6493E+02	1.9281E-04	8.5850E+02
2.000	3.2991E+02	2.4230E-04	1.1561E+03
2.033	3.4119E+02	2.3485E-04	1.2100E+03
2.033	3.4131E+02	2.3478E-04	1.2105E+03
2.400	4.1010E+02	1.8566E-04	1.8841E+03
2.500	4.2614E+02	1.7899E-04	2.0829E+03
2.800	4.6892E+02	1.6607E-04	2.6873E+03
3.000	4.9349E+02	1.5997E-04	3.0837E+03
3.300	5.2528E+02	1.5115E-04	3.6510E+03
3.500	5.4355E+02	1.4472E-04	4.0047E+03
3.800	5.6720E+02	3.9907E-02	4.4934E+03
4.000	5.8079E+02	5.3650E-02	4.7900E+03
4.300	5.9840E+02	3.0178E-02	5.1917E+03
4.600	6.1317E+02	1.6989E-02	5.5438E+03
4.900	6.2556E+02	9.5753E-03	5.8501E+03
5.033	6.3040E+02	7.4302E-03	5.9725E+03
5.400	6.4246E+02	3.6994E-03	6.2720E+03
5.700	6.5121E+02	2.1005E-03	6.4817E+03
6.000	6.5909E+02	1.1997E-03	6.6657E+03
6.300	6.6618E+02	6.9134E-04	6.8281E+03
6.600	6.7257E+02	4.0385E-04	6.9722E+03
6.900	6.7833E+02	2.4069E-04	7.1006E+03
7.200	6.8353E+02	1.4759E-04	7.2155E+03
7.500	6.8823E+02	9.4029E-05	7.3187E+03
7.800	6.9247E+02	6.2845E-05	7.4117E+03
8.000	6.9507E+02	4.9511E-05	7.4686E+03
8.300	6.9867E+02	3.3436E-05	7.5610E+03

8.367	6.9942E+02	3.0861E-05	7.5804E+03
8.667	7.0263E+02	2.2331E-05	7.6624E+03
8.967	7.0558E+02	1.7101E-05	7.7372E+03
9.300	7.0857E+02	1.3492E-05	7.8129E+03
9.600	7.1104E+02	1.1377E-05	7.8752E+03
9.900	7.1332E+02	9.8907E-06	7.9326E+03
10.200	7.1542E+02	8.7898E-06	7.9856E+03
12.033	7.2528E+02	5.2859E-06	8.2378E+03
19.478	7.4298E+02	2.0057E-06	8.7390E+03
24.000	7.4863E+02	1.7116E-06	8.9326E+03
24.033	7.4867E+02	1.6365E-06	8.9339E+03
96.000	7.8505E+02	3.4931E-07	1.1381E+04
240.000	7.0067E+02	3.0256E-08	1.4396E+04
264.000	6.7456E+02	4.7235E-07	2.2852E+04
480.000	3.8304E+02	4.8644E-09	2.3736E+04
504.000	3.5797E+02	7.5942E-08	2.5095E+04
696.000	1.9653E+02	8.7380E-10	2.5227E+04
720.000	1.8207E+02	1.3641E-08	2.5472E+04

##
Cumulative Dose Summary
##

	Control Room		EAB		LPZ	
Time	Thyroid	TEDE	Thyroid	TEDE	Thyroid	TEDE
(hr)	(rem)	(rem)	(rem)	(rem)	(rem)	(rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.400	1.0440E-04	4.0500E-06	5.4609E-03	2.6313E-04	5.1855E-03	2.4986E-04
0.533	3.3454E-04	1.2971E-05	1.3633E-02	6.5444E-04	1.2945E-02	6.2145E-04
0.533	3.3535E-04	1.3003E-05	1.3659E-02	6.5569E-04	1.2970E-02	6.2263E-04
0.900	2.5070E-03	9.8213E-05	6.7055E-02	3.3161E-03	6.3674E-02	3.1489E-03
1.200	7.3878E-03	3.0133E-04	1.6343E-01	8.7090E-03	1.5519E-01	8.2699E-03
1.500	1.6837E-02	7.1804E-04	3.2204E-01	1.8196E-02	3.0580E-01	1.7278E-02
1.800	3.2264E-02	1.4272E-03	5.4919E-01	3.2283E-02	5.2150E-01	3.0655E-02
2.000	4.6371E-02	2.0916E-03	7.3969E-01	4.4312E-02	7.0240E-01	4.2078E-02
2.033	4.8924E-02	2.2128E-03	7.7410E-01	4.6494E-02	7.1902E-01	4.3132E-02
2.033	4.8949E-02	2.2140E-03	7.7445E-01	4.6516E-02	7.1919E-01	4.3143E-02
2.400	7.3444E-02	3.3844E-03	1.2048E+00	7.4097E-02	9.2712E-01	5.6470E-02
2.500	7.9340E-02	3.6688E-03	1.3315E+00	8.2296E-02	9.8837E-01	6.0431E-02
2.800	9.6001E-02	4.4785E-03	8.9293E+00	5.7763E-01	1.1743E+00	7.2551E-02
3.000	1.0651E-01	4.9935E-03	1.3901E+01	9.0509E-01	1.2959E+00	8.0564E-02
3.300	1.2153E-01	5.7345E-03	1.4260E+01	9.2903E-01	1.4695E+00	9.2130E-02
3.500	1.3103E-01	6.2057E-03	1.4483E+01	9.4412E-01	1.5775E+00	9.9418E-02
3.800	2.2578E+00	1.1297E-01	1.4791E+01	9.6520E-01	4.8378E+00	3.2263E-01
4.000	5.2796E+00	2.6481E-01	1.4978E+01	9.7817E-01	6.8120E+00	4.5998E-01
4.300	9.1941E+00	4.6159E-01	1.5230E+01	9.9600E-01	6.9337E+00	4.6860E-01
4.600	1.1390E+01	5.7198E-01	1.5450E+01	1.0120E+00	7.0400E+00	4.7631E-01
4.900	1.2623E+01	6.3398E-01	1.5641E+01	1.0262E+00	7.1323E+00	4.8317E-01
5.033	1.2980E+01	6.5191E-01	1.5717E+01	1.0319E+00	7.1690E+00	4.8596E-01
5.400	1.3601E+01	6.8314E-01	1.5902E+01	1.0464E+00	7.2587E+00	4.9296E-01
5.700	1.3868E+01	6.9659E-01	1.6032E+01	1.0569E+00	7.3214E+00	4.9801E-01

```
  6.000 1.4020E+01 7.0422E-01 1.6145E+01 1.0663E+00 7.3761E+00 5.0255E-01
  6.300 1.4106E+01 7.0859E-01 1.6245E+01 1.0748E+00 7.4243E+00 5.0666E-01
  6.600 1.4157E+01 7.1112E-01 1.6333E+01 1.0825E+00 7.4670E+00 5.1040E-01
  6.900 1.4186E+01 7.1260E-01 1.6412E+01 1.0896E+00 7.5049E+00 5.1381E-01
  7.200 1.4204E+01 7.1350E-01 1.6482E+01 1.0960E+00 7.5387E+00 5.1693E-01
  7.500 1.4215E+01 7.1405E-01 1.6544E+01 1.1020E+00 7.5689E+00 5.1979E-01
  7.800 1.4222E+01 7.1441E-01 1.6600E+01 1.1074E+00 7.5961E+00 5.2244E-01
  8.000 1.4225E+01 7.1459E-01 1.6635E+01 1.1108E+00 7.6127E+00 5.2408E-01
  8.300 1.4229E+01 7.1478E-01 1.6664E+01 1.1149E+00 7.6226E+00 5.2548E-01
  8.367 1.4230E+01 7.1481E-01 1.6670E+01 1.1158E+00 7.6247E+00 5.2578E-01
  8.667 1.4232E+01 7.1493E-01 1.6695E+01 1.1195E+00 7.6334E+00 5.2707E-01
  8.967 1.4234E+01 7.1503E-01 1.6718E+01 1.1230E+00 7.6414E+00 5.2828E-01
  9.300 1.4235E+01 7.1510E-01 1.6741E+01 1.1267E+00 7.6494E+00 5.2953E-01
  9.600 1.4237E+01 7.1516E-01 1.6760E+01 1.1297E+00 7.6560E+00 5.3059E-01
  9.900 1.4238E+01 7.1521E-01 1.6778E+01 1.1326E+00 7.6620E+00 5.3159E-01
 10.200 1.4238E+01 7.1526E-01 1.6794E+01 1.1354E+00 7.6676E+00 5.3254E-01
 12.033 1.4242E+01 7.1544E-01 1.6870E+01 1.1494E+00 7.6938E+00 5.3735E-01
 19.478 1.4249E+01 7.1575E-01 1.7016E+01 1.1826E+00 7.7441E+00 5.4879E-01
 24.000 1.4251E+01 7.1583E-01 1.7070E+01 1.1949E+00 7.7627E+00 5.5304E-01
 24.033 1.4251E+01 7.1583E-01 1.7070E+01 1.1950E+00 7.7627E+00 5.5305E-01
 96.000 1.4255E+01 7.1599E-01 1.7853E+01 1.2971E+00 7.8922E+00 5.6997E-01
240.000 1.4256E+01 7.1601E-01 1.8754E+01 1.3939E+00 7.9443E+00 5.7556E-01
264.000 1.4258E+01 7.1607E-01 2.1266E+01 1.6355E+00 8.0895E+00 5.8953E-01
480.000 1.4258E+01 7.1607E-01 2.1528E+01 1.6582E+00 8.1047E+00 5.9084E-01
504.000 1.4258E+01 7.1608E-01 2.1932E+01 1.6886E+00 8.1281E+00 5.9260E-01
696.000 1.4258E+01 7.1608E-01 2.1972E+01 1.6915E+00 8.1304E+00 5.9276E-01
720.000 1.4258E+01 7.1609E-01 2.2044E+01 1.6963E+00 8.1346E+00 5.9304E-01

##########################################################################
              Worst Two-Hour Doses
##########################################################################

EAB
  Time  Whole Body  Thyroid    TEDE
  (hr)   (rem)      (rem)     (rem)
   2.0  2.3818E-01  1.4238E+01  9.3386E-01
```

StackTop_ESF.o0 (Fumigation X/Q for EAB between 2.5 and 3 hours) (Excerpts)

##

I-131 Summary

##

Time (hr)	SP I-131 (Curies)	RB I-131 (Curies)	SR I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	7.8768E+06	7.1854E+01	1.6811E+00
0.533	1.0735E+07	1.2749E+02	3.0850E+00
0.900	2.2868E+07	3.7146E+02	9.2677E+00
1.200	3.3546E+07	6.7639E+02	1.7141E+01
1.500	4.4198E+07	1.0474E+03	2.6805E+01
1.800	5.4823E+07	1.4651E+03	3.7732E+01
2.000	6.1891E+07	1.7624E+03	4.5528E+01
2.033	6.3068E+07	1.8131E+03	4.6860E+01
2.400	6.5328E+07	2.3073E+03	6.0130E+01
2.500	6.5297E+07	2.4106E+03	6.2927E+01
2.800	6.5205E+07	2.6576E+03	6.9619E+01
3.000	6.5143E+07	2.7805E+03	7.2947E+01
3.300	6.5051E+07	2.9184E+03	7.6686E+01
3.500	6.4989E+07	2.9867E+03	7.8536E+01
3.800	6.4897E+07	3.0628E+03	8.0602E+01
4.000	6.4836E+07	3.1002E+03	8.1615E+01
4.300	6.4744E+07	3.1413E+03	8.2733E+01
4.600	6.4652E+07	3.1693E+03	8.3492E+01
4.900	6.4560E+07	3.1878E+03	8.3997E+01
5.200	6.4469E+07	3.1997E+03	8.4322E+01
5.500	6.4377E+07	3.2068E+03	8.4518E+01
5.800	6.4286E+07	3.2105E+03	8.4622E+01
6.100	6.4195E+07	3.2119E+03	8.4662E+01
6.400	6.4104E+07	3.2115E+03	8.4655E+01
6.700	6.4013E+07	3.2099E+03	8.4616E+01
7.000	6.3922E+07	3.2075E+03	8.4553E+01
7.300	6.3832E+07	3.2045E+03	8.4474E+01
7.600	6.3741E+07	3.2010E+03	8.4383E+01
7.900	6.3651E+07	3.1972E+03	8.4284E+01
8.000	6.3621E+07	3.1959E+03	8.4250E+01
8.300	6.3531E+07	3.1918E+03	8.4143E+01
8.600	6.3440E+07	3.1877E+03	8.4033E+01
8.900	6.3350E+07	3.1834E+03	8.3921E+01
9.200	6.3261E+07	3.1790E+03	8.3807E+01
9.500	6.3171E+07	3.1747E+03	8.3691E+01
9.800	6.3081E+07	3.1703E+03	8.3575E+01
10.100	6.2992E+07	3.1658E+03	8.3458E+01
10.400	6.2903E+07	3.1614E+03	8.3341E+01
24.000	5.8984E+07	2.9645E+03	7.8152E+01
96.000	4.1961E+07	2.1089E+03	5.5596E+01
720.000	2.1933E+06	1.1024E+02	2.9061E+00

Time (hr)	CR I-131 (Curies)	Environment I-131 (Curies)	Dummy I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	3.2697E-06	8.5995E+00	3.4754E-03
0.533	7.9114E-06	2.2074E+01	8.9196E-03
0.900	3.5179E-05	1.1385E+02	4.5990E-02
1.200	7.8432E-05	2.8169E+02	1.1376E-01
1.500	1.4170E-04	5.6317E+02	2.2738E-01
1.800	2.2272E-04	9.7776E+02	3.9465E-01
2.000	2.8502E-04	1.3351E+03	5.3877E-01
2.033	2.7647E-04	1.4012E+03	5.6543E-01
2.400	2.2470E-04	2.2494E+03	9.0740E-01
2.500	2.1973E-04	2.5138E+03	1.0139E+00
2.800	2.1670E-04	3.3701E+03	1.3588E+00
3.000	2.2021E-04	3.9829E+03	1.6055E+00
3.300	2.2859E-04	4.9481E+03	1.9938E+00
3.500	2.3467E-04	5.6150E+03	2.2619E+00
3.800	8.4274E-02	6.6409E+03	2.6740E+00
4.000	1.1975E-01	7.3377E+03	2.9536E+00
4.300	6.7379E-02	8.3968E+03	3.3784E+00
4.600	3.7962E-02	9.4679E+03	3.8075E+00
4.900	2.1439E-02	1.0547E+04	4.2395E+00
5.200	1.2160E-02	1.1631E+04	4.6731E+00
5.500	6.9478E-03	1.2719E+04	5.1075E+00
5.800	4.0206E-03	1.3809E+04	5.5423E+00
6.100	2.3765E-03	1.4899E+04	5.9769E+00
6.400	1.4531E-03	1.5990E+04	6.4112E+00
6.700	9.3440E-04	1.7080E+04	6.8449E+00
7.000	6.4298E-04	1.8170E+04	7.2778E+00
7.300	4.7919E-04	1.9259E+04	7.7099E+00
7.600	3.8708E-04	2.0347E+04	8.1411E+00
7.900	3.3520E-04	2.1433E+04	8.5714E+00
8.000	3.2354E-04	2.1795E+04	8.7146E+00
8.300	2.4810E-04	2.2880E+04	9.1435E+00
8.600	2.0565E-04	2.3963E+04	9.5713E+00
8.900	1.8171E-04	2.5045E+04	9.9982E+00
9.200	1.6818E-04	2.6125E+04	1.0424E+01
9.500	1.6049E-04	2.7204E+04	1.0849E+01
9.800	1.5607E-04	2.8282E+04	1.1272E+01
10.100	1.5350E-04	2.9358E+04	1.1695E+01
10.400	1.5197E-04	3.0432E+04	1.2117E+01
24.000	1.4092E-04	7.7513E+04	3.0135E+01
96.000	2.9048E-05	2.8198E+05	9.5688E+01
720.000	2.5582E-07	7.5961E+05	5.6015E+01

##

Cumulative Dose Summary

##

Time (hr)	Control Room Thyroid (rem)	Control Room TEDE (rem)	EAB Thyroid (rem)	EAB TEDE (rem)	LPZ Thyroid (rem)	LPZ TEDE (rem)

0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.400	1.0324E-04	3.2848E-06	5.4505E-03	1.9634E-04	5.1756E-03	1.8644E-04
0.533	3.3806E-04	1.0746E-05	1.3969E-02	5.0069E-04	1.3265E-02	4.7544E-04
0.900	2.6474E-03	8.3984E-05	7.1786E-02	2.5465E-03	6.8167E-02	2.4181E-03
1.200	7.9406E-03	2.5155E-04	1.7709E-01	6.2446E-03	1.6816E-01	5.9297E-03
1.500	1.8303E-02	5.7913E-04	3.5303E-01	1.2390E-02	3.3523E-01	1.1765E-02
1.800	3.5505E-02	1.1223E-03	6.1123E-01	2.1369E-02	5.8041E-01	2.0291E-02
2.000	5.1518E-02	1.6274E-03	8.3310E-01	2.9061E-02	7.9109E-01	2.7596E-02
2.033	5.4468E-02	1.7204E-03	8.7408E-01	3.0479E-02	8.1089E-01	2.8281E-02
2.400	8.2789E-02	2.6129E-03	1.3988E+00	4.8613E-02	1.0644E+00	3.7043E-02
2.500	8.9763E-02	2.8325E-03	1.5619E+00	5.4236E-02	1.1432E+00	3.9761E-02
2.800	1.1017E-01	3.4746E-03	1.1972E+01	4.1238E-01	1.3979E+00	4.8524E-02
3.000	1.2380E-01	3.9033E-03	1.9401E+01	6.6731E-01	1.5797E+00	5.4761E-02
3.300	1.4475E-01	4.5618E-03	1.9992E+01	6.8754E-01	1.8653E+00	6.4537E-02
3.500	1.5914E-01	5.0138E-03	2.0399E+01	7.0145E-01	2.0620E+00	7.1258E-02
3.800	4.3961E+00	1.3804E-01	2.1023E+01	7.2275E-01	8.6768E+00	2.9677E-01
4.000	1.0748E+01	3.3739E-01	2.1447E+01	7.3715E-01	1.3158E+01	4.4927E-01
4.300	1.9193E+01	6.0228E-01	2.2088E+01	7.5895E-01	1.3468E+01	4.5981E-01
4.600	2.3933E+01	7.5085E-01	2.2735E+01	7.8089E-01	1.3781E+01	4.7041E-01
4.900	2.6598E+01	8.3434E-01	2.3385E+01	8.0289E-01	1.4095E+01	4.8104E-01
5.200	2.8101E+01	8.8141E-01	2.4036E+01	8.2491E-01	1.4409E+01	4.9168E-01
5.500	2.8954E+01	9.0809E-01	2.4687E+01	8.4689E-01	1.4724E+01	5.0230E-01
5.800	2.9442E+01	9.2337E-01	2.5338E+01	8.6883E-01	1.5038E+01	5.1290E-01
6.100	2.9726E+01	9.3225E-01	2.5987E+01	8.9070E-01	1.5352E+01	5.2347E-01
6.400	2.9896E+01	9.3756E-01	2.6635E+01	9.1248E-01	1.5665E+01	5.3399E-01
6.700	3.0002E+01	9.4087E-01	2.7280E+01	9.3418E-01	1.5977E+01	5.4448E-01
7.000	3.0072E+01	9.4306E-01	2.7924E+01	9.5579E-01	1.6288E+01	5.5492E-01
7.300	3.0122E+01	9.4461E-01	2.8565E+01	9.7730E-01	1.6597E+01	5.6531E-01
7.600	3.0160E+01	9.4581E-01	2.9204E+01	9.9872E-01	1.6906E+01	5.7566E-01
7.900	3.0192E+01	9.4681E-01	2.9840E+01	1.0200E+00	1.7214E+01	5.8596E-01
8.000	3.0202E+01	9.4712E-01	3.0052E+01	1.0271E+00	1.7316E+01	5.8938E-01
8.300	3.0227E+01	9.4790E-01	3.0378E+01	1.0387E+00	1.7428E+01	5.9339E-01
8.600	3.0247E+01	9.4853E-01	3.0702E+01	1.0503E+00	1.7540E+01	5.9737E-01
8.900	3.0264E+01	9.4906E-01	3.1026E+01	1.0618E+00	1.7651E+01	6.0134E-01
9.200	3.0280E+01	9.4954E-01	3.1348E+01	1.0733E+00	1.7762E+01	6.0529E-01
9.500	3.0294E+01	9.4999E-01	3.1668E+01	1.0847E+00	1.7873E+01	6.0921E-01
9.800	3.0308E+01	9.5042E-01	3.1988E+01	1.0960E+00	1.7983E+01	6.1312E-01
10.100	3.0322E+01	9.5085E-01	3.2307E+01	1.1073E+00	1.8093E+01	6.1701E-01
10.400	3.0335E+01	9.5126E-01	3.2624E+01	1.1185E+00	1.8202E+01	6.2088E-01
24.000	3.0890E+01	9.6846E-01	4.5986E+01	1.5802E+00	2.2806E+01	7.7993E-01
96.000	3.1270E+01	9.8009E-01	1.1125E+02	3.6421E+00	3.3610E+01	1.1213E+00
720.000	3.1362E+01	9.8289E-01	2.5341E+02	8.0280E+00	4.1830E+01	1.3748E+00

##

Worst Two-Hour Doses

##

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
2.5	6.3438E-02	2.0958E+01	7.1934E-01

Appendix I4 –Fumigation Spreadsheet (including RADTRAD Runs I2' and I5')

Control Room Dose Accumulation Rate (Dose/Unit Time)

Time (hr)	StackTop Run I2' CR TEDE	Run I2' Delta CR TEDE	StackTop ESF Run I5' CR TEDE	Run I5' Delta CR TEDE	Total Delta CR TEDE
0.1	1.39E-06	1.39E-06	1.08E-06	1.08E-06	2.46E-06
0.2	4.91E-05	4.77E-05	3.88E-05	3.77E-05	8.54E-05
0.3	2.90E-04	2.40E-04	2.32E-04	1.93E-04	4.33E-04
0.4	9.77E-04	6.87E-04	7.92E-04	5.61E-04	1.25E-03
0.5	2.43E-03	1.45E-03	2.00E-03	1.21E-03	2.66E-03
D 0.6	4.98E-03	2.55E-03	4.15E-03	2.16E-03	4.71E-03
0.7	9.05E-03	4.07E-03	7.65E-03	3.50E-03	7.56E-03
0.8	1.51E-02	6.03E-03	1.29E-02	5.21E-03	1.12E-02
0.9	2.37E-02	8.61E-03	2.03E-02	7.39E-03	1.60E-02
1	3.56E-02	1.19E-02	3.03E-02	1.01E-02	2.20E-02
1.1	5.17E-02	1.61E-02	4.36E-02	1.33E-02	2.93E-02
1.2	7.27E-02	2.10E-02	6.07E-02	1.70E-02	3.80E-02
1.3	9.94E-02	2.67E-02	8.20E-02	2.13E-02	4.81E-02
1.4	1.33E-01	3.33E-02	1.08E-01	2.62E-02	5.94E-02
1.5	1.73E-01	4.05E-02	1.40E-01	3.15E-02	7.20E-02
1.6	2.22E-01	4.84E-02	1.77E-01	3.73E-02	8.57E-02
1.7	2.78E-01	5.68E-02	2.20E-01	4.35E-02	1.00E-01
1.8	3.44E-01	6.58E-02	2.71E-01	5.02E-02	1.16E-01
1.9	4.19E-01	7.52E-02	3.28E-01	5.72E-02	1.32E-01
2	5.04E-01	8.50E-02	3.92E-01	6.46E-02	1.50E-01
2.1	5.99E-01	9.50E-02	4.65E-01	7.23E-02	1.67E-01
2.2	7.05E-01	1.05E-01	5.45E-01	8.03E-02	1.86E-01
2.3	8.20E-01	1.16E-01	6.33E-01	8.85E-02	2.04E-01
2.4	9.45E-01	1.25E-01	7.30E-01	9.66E-02	2.22E-01
2.5	1.08E+00	1.34E-01	8.35E-01	1.05E-01	2.39E-01
2.6	1.22E+00	1.42E-01	9.47E-01	1.12E-01	2.54E-01
2.7	1.37E+00	1.49E-01	1.07E+00	1.20E-01	2.69E-01
2.8	1.52E+00	1.54E-01	1.19E+00	1.27E-01	2.81E-01
2.9	1.68E+00	1.59E-01	1.33E+00	1.33E-01	2.92E-01
3	1.85E+00	1.62E-01	1.47E+00	1.39E-01	3.02E-01
3.1	2.01E+00	1.65E-01	1.61E+00	1.45E-01	3.09E-01
3.2	2.18E+00	1.66E-01	1.76E+00	1.50E-01	3.16E-01

Time (hr)	StackTop Run I2' CR TEDE	Run I2' Delta CR TEDE	StackTop ESF Run I5' CR TEDE	Run I5' Delta CR TEDE	Total Delta CR TEDE
3.3	2.34E+00	1.66E-01	1.92E+00	1.55E-01	3.21E-01
3.4	2.51E+00	1.66E-01	2.07E+00	1.59E-01	3.25E-01
3.5	2.67E+00	1.64E-01	2.24E+00	1.63E-01	3.27E-01
3.6	2.84E+00	1.63E-01	2.40E+00	1.67E-01	3.29E-01
3.7	3.00E+00	1.60E-01	2.57E+00	1.70E-01	3.30E-01
3.8	3.15E+00	1.57E-01	2.75E+00	1.73E-01	3.30E-01
3.9	3.31E+00	1.54E-01	2.92E+00	1.75E-01	3.29E-01
4	3.46E+00	1.50E-01	3.10E+00	1.77E-01	3.28E-01
4.1	3.60E+00	1.46E-01	3.28E+00	1.80E-01	3.26E-01
4.2	3.75E+00	1.42E-01	3.46E+00	1.81E-01	3.23E-01
4.3	3.88E+00	1.38E-01	3.64E+00	1.83E-01	3.21E-01
4.4	4.02E+00	1.33E-01	3.83E+00	1.84E-01	3.18E-01
4.5	4.14E+00	1.29E-01	4.01E+00	1.86E-01	3.14E-01
4.6	4.27E+00	1.24E-01	4.20E+00	1.87E-01	3.11E-01
4.7	4.39E+00	1.20E-01	4.39E+00	1.88E-01	3.07E-01
4.8	4.50E+00	1.15E-01	4.57E+00	1.88E-01	3.03E-01
4.9	4.61E+00	1.10E-01	4.76E+00	1.89E-01	2.99E-01
5	4.72E+00	1.06E-01	4.95E+00	1.90E-01	2.96E-01
5.1	4.82E+00	1.02E-01	5.14E+00	1.90E-01	2.92E-01
5.2	4.92E+00	9.71E-02	5.33E+00	1.91E-01	2.88E-01
5.3	5.01E+00	9.30E-02	5.53E+00	1.91E-01	2.84E-01
5.4	5.10E+00	8.88E-02	5.72E+00	1.91E-01	2.80E-01
5.5	5.19E+00	8.50E-02	5.91E+00	1.92E-01	2.77E-01
5.6	5.27E+00	8.12E-02	6.10E+00	1.92E-01	2.73E-01
5.7	5.34E+00	7.76E-02	6.29E+00	1.92E-01	2.70E-01
5.8	5.42E+00	7.42E-02	6.48E+00	1.92E-01	2.66E-01
5.9	5.49E+00	7.09E-02	6.68E+00	1.92E-01	2.63E-01
6	5.56E+00	6.78E-02	6.87E+00	1.92E-01	2.60E-01
6.1	5.62E+00	6.49E-02	7.06E+00	1.92E-01	2.57E-01
6.2	5.68E+00	6.20E-02	7.25E+00	1.92E-01	2.54E-01
6.3	5.74E+00	5.94E-02	7.44E+00	1.92E-01	2.51E-01
6.4	5.80E+00	5.69E-02	7.64E+00	1.92E-01	2.49E-01
6.5	5.85E+00	5.45E-02	7.83E+00	1.92E-01	2.46E-01
6.6	5.91E+00	5.22E-02	8.02E+00	1.91E-01	2.44E-01
6.7	5.96E+00	5.00E-02	8.21E+00	1.91E-01	2.41E-01
6.8	6.00E+00	4.80E-02	8.40E+00	1.91E-01	2.39E-01

Time (hr)	StackTop Run I2' CR TEDE	Run I2' Delta CR TEDE	StackTop ESF Run I5' CR TEDE	Run I5' Delta CR TEDE	Total Delta CR TEDE
6.9	6.05E+00	4.61E-02	8.59E+00	1.91E-01	2.37E-01
7	6.10E+00	4.42E-02	8.78E+00	1.91E-01	2.35E-01
7.1	6.14E+00	4.24E-02	8.97E+00	1.91E-01	2.33E-01
7.2	6.18E+00	4.08E-02	9.16E+00	1.90E-01	2.31E-01
7.3	6.22E+00	3.92E-02	9.35E+00	1.90E-01	2.29E-01
7.4	6.26E+00	3.77E-02	9.54E+00	1.90E-01	2.28E-01
7.5	6.29E+00	3.63E-02	9.73E+00	1.90E-01	2.26E-01
7.6	6.33E+00	3.49E-02	9.92E+00	1.90E-01	2.24E-01
7.7	6.36E+00	3.35E-02	1.01E+01	1.89E-01	2.23E-01
7.8	6.39E+00	3.24E-02	1.03E+01	1.89E-01	2.21E-01
7.9	6.42E+00	3.11E-02	1.05E+01	1.89E-01	2.20E-01
8	6.45E+00	3.00E-02	1.07E+01	1.88E-01	2.18E-01

StackTopFinal'.o0 (Excerpts) (Run I2')

##
I-131 Summary
##

Time (hr)	DW I-131 (Curies)	Torus I-131 (Curies)	RB I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	3.4444E+06	0.0000E+00	4.7988E+02
0.533	4.4756E+06	0.0000E+00	8.2208E+02
0.533	4.4786E+06	0.0000E+00	8.2300E+02
0.900	9.6135E+06	0.0000E+00	2.3165E+03
1.200	1.3665E+07	0.0000E+00	4.1451E+03
1.500	1.7283E+07	0.0000E+00	6.2544E+03
1.800	2.0512E+07	0.0000E+00	8.4764E+03
2.000	2.2469E+07	0.0000E+00	9.9642E+03
2.033	2.2778E+07	0.0000E+00	1.0208E+04
2.033	2.2443E+07	3.3287E+05	1.0210E+04
2.400	1.0878E+07	8.2512E+06	1.2020E+04
2.700	9.0707E+06	6.8805E+06	1.2234E+04
3.000	7.5646E+06	5.7380E+06	1.1774E+04
3.300	6.3094E+06	4.7859E+06	1.0937E+04
3.500	5.5909E+06	4.2409E+06	1.0268E+04
3.800	4.6644E+06	3.5380E+06	9.1969E+03
4.000	4.1341E+06	3.1358E+06	8.4765E+03
4.300	3.4502E+06	2.6170E+06	7.4295E+03
4.600	2.8801E+06	2.1846E+06	6.4532E+03
4.900	2.4050E+06	1.8242E+06	5.5658E+03
5.033	2.2206E+06	1.6842E+06	5.2028E+03
5.400	1.9460E+06	1.4702E+06	4.3384E+03
5.700	1.7449E+06	1.3182E+06	3.7687E+03
6.000	1.5649E+06	1.1822E+06	3.2929E+03
6.300	1.4037E+06	1.0605E+06	2.8914E+03
6.600	1.2595E+06	9.5144E+05	2.5493E+03
6.900	1.1303E+06	8.5386E+05	2.2554E+03
7.200	1.0147E+06	7.6649E+05	2.0011E+03
7.500	9.1116E+05	6.8829E+05	1.7797E+03
7.800	8.1849E+05	6.1827E+05	1.5859E+03
8.000	7.6217E+05	5.7572E+05	1.4699E+03
8.300	6.8510E+05	5.1749E+05	1.3133E+03
8.367	6.6902E+05	5.0535E+05	1.2809E+03
8.667	6.0980E+05	4.6026E+05	1.1478E+03
8.967	5.5585E+05	4.1954E+05	1.0322E+03
9.300	5.0180E+05	3.7873E+05	9.2048E+02
9.600	4.5784E+05	3.4554E+05	8.3234E+02
9.900	4.1795E+05	3.1543E+05	7.5413E+02
10.200	3.8174E+05	2.8809E+05	6.8442E+02
12.033	2.2279E+05	1.6809E+05	3.8863E+02
19.478	4.5898E+04	3.4543E+04	6.8629E+01

24.000	3.0631E+04	2.3021E+04	4.1852E+01
24.033	3.0576E+04	2.2980E+04	4.1758E+01
96.000	2.1942E+04	1.6477E+04	2.8285E+01
240.000	1.1280E+04	8.4709E+03	1.4542E+01
264.000	4.9222E+03	3.6938E+03	6.5158E+00
480.000	1.8136E+03	1.3619E+03	2.3379E+00
504.000	7.9136E+02	5.9387E+02	1.0476E+00
696.000	3.2577E+02	2.4464E+02	4.1996E-01
720.000	1.4215E+02	1.0668E+02	1.8817E-01

Time (hr)	SR I-131 (Curies)	Condenser I-131 (Curies)	TB I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	1.6372E+00	1.8705E-01	8.6434E-03
0.533	2.9023E+00	3.4492E-01	1.1240E-02
0.533	2.9057E+00	3.4537E-01	1.1247E-02
0.900	8.3976E+00	1.1111E+00	2.4142E-02
1.200	1.5276E+01	2.1838E+00	3.4337E-02
1.500	2.3296E+01	3.6509E+00	4.3457E-02
1.800	3.1796E+01	5.5038E+00	5.1616E-02
2.000	3.7507E+01	6.9496E+00	5.6572E-02
2.033	3.8444E+01	7.2042E+00	5.7355E-02
2.033	3.8454E+01	7.2067E+00	5.6880E-02
2.400	4.5856E+01	8.8887E+00	2.7510E-02
2.700	4.7002E+01	1.0200E+01	2.3039E-02
3.000	4.5465E+01	1.1480E+01	1.9312E-02
3.300	4.2412E+01	1.2732E+01	1.6206E-02
3.500	3.9924E+01	1.3553E+01	1.4428E-02
3.800	3.5903E+01	1.4768E+01	1.2135E-02
4.000	3.3182E+01	1.5567E+01	1.0823E-02
4.300	2.9212E+01	1.6754E+01	9.1298E-03
4.600	2.5498E+01	1.7926E+01	7.7189E-03
4.900	2.2115E+01	1.9086E+01	6.5428E-03
5.033	2.0730E+01	1.9596E+01	6.0861E-03
5.400	1.7410E+01	2.0998E+01	5.4059E-03
5.700	1.5222E+01	2.2136E+01	4.9077E-03
6.000	1.3396E+01	2.3267E+01	4.4616E-03
6.300	1.1856E+01	2.4393E+01	4.0622E-03
6.600	1.0545E+01	2.5513E+01	3.7046E-03
6.900	9.4182E+00	2.6628E+01	3.3843E-03
7.200	8.4437E+00	2.7738E+01	3.0976E-03
7.500	7.5955E+00	2.8843E+01	2.8408E-03
7.800	6.8532E+00	2.9943E+01	2.6109E-03
8.000	6.4091E+00	3.0674E+01	2.4711E-03
8.300	5.8093E+00	3.1767E+01	2.2797E-03
8.367	5.6853E+00	3.2011E+01	2.2398E-03
8.667	5.1746E+00	3.3099E+01	2.0926E-03
8.967	4.7309E+00	3.4183E+01	1.9584E-03
9.300	4.3026E+00	3.5382E+01	1.8240E-03
9.600	3.9646E+00	3.6458E+01	1.7145E-03
9.900	3.6646E+00	3.7531E+01	1.6151E-03

10.200	3.3973E+00	3.8600E+01	1.5249E-03
12.033	2.2615E+00	4.5060E+01	1.1274E-03
19.478	1.0143E+00	7.0152E+01	6.7293E-04
24.000	8.9667E-01	8.4564E+01	6.2508E-04
24.033	8.9621E-01	8.4667E+01	6.2487E-04
96.000	6.3641E-01	2.4516E+02	4.6500E-04
240.000	3.2718E-01	3.2600E+02	2.5720E-04
264.000	5.2753E+00	3.1494E+02	1.2789E-04
480.000	5.2602E-02	1.7574E+02	5.2535E-05
504.000	8.4813E-01	1.6231E+02	3.0688E-05
696.000	9.4490E-03	8.0792E+01	1.3901E-05
720.000	1.5235E-01	7.3727E+01	9.5546E-06

Time (hr)	Dummy I-131 (Curies)	CR I-131 (Curies)	Environment I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	9.9385E+00	7.8335E-04	8.5619E+00
0.533	1.7893E+01	1.8429E-03	2.1405E+01
0.533	1.7915E+01	1.8461E-03	2.1446E+01
0.900	5.6126E+01	7.7988E-03	1.0540E+02
1.200	1.0896E+02	1.7084E-02	2.5622E+02
1.500	1.7918E+02	3.0288E-02	5.0387E+02
1.800	2.6493E+02	4.6492E-02	8.5850E+02
2.000	3.2991E+02	5.8427E-02	1.1561E+03
2.033	3.4119E+02	6.0457E-02	1.2100E+03
2.033	3.4131E+02	6.0478E-02	1.2105E+03
2.400	4.1010E+02	8.2513E-02	1.8841E+03
2.700	4.5549E+02	9.5702E-02	2.4859E+03
3.000	4.9349E+02	1.0265E-01	3.0837E+03
3.300	5.2528E+02	1.0396E-01	3.6510E+03
3.500	5.4355E+02	1.0237E-01	4.0047E+03
3.800	5.6720E+02	9.7328E-02	4.4934E+03
4.000	5.8079E+02	9.2740E-02	4.7900E+03
4.300	5.9840E+02	8.4797E-02	5.1917E+03
4.600	6.1317E+02	7.6285E-02	5.5438E+03
4.900	6.2556E+02	6.7772E-02	5.8501E+03
5.033	6.3040E+02	6.4100E-02	5.9725E+03
5.400	6.4246E+02	5.4578E-02	6.2720E+03
5.700	6.5121E+02	4.7729E-02	6.4817E+03
6.000	6.5909E+02	4.1790E-02	6.6657E+03
6.300	6.6618E+02	3.6698E-02	6.8281E+03
6.600	6.7257E+02	3.2349E-02	6.9722E+03
6.900	6.7833E+02	2.8633E-02	7.1006E+03
7.200	6.8353E+02	2.5447E-02	7.2155E+03
7.500	6.8823E+02	2.2704E-02	7.3187E+03
7.800	6.9247E+02	2.0331E-02	7.4117E+03
8.000	6.9507E+02	1.8924E-02	7.4686E+03
8.300	6.9867E+02	1.8160E-02	7.5610E+03
8.367	6.9942E+02	1.7928E-02	7.5804E+03
8.667	7.0263E+02	1.6759E-02	7.6624E+03
8.967	7.0558E+02	1.5515E-02	7.7372E+03

9.300	7.0857E+02	1.4172E-02	7.8129E+03
9.600	7.1104E+02	1.3045E-02	7.8752E+03
9.900	7.1332E+02	1.2013E-02	7.9326E+03
10.200	7.1542E+02	1.1077E-02	7.9856E+03
12.033	7.2528E+02	7.0553E-03	8.2378E+03
19.478	7.4298E+02	2.6849E-03	8.7390E+03
24.000	7.4863E+02	2.2911E-03	8.9326E+03
24.033	7.4867E+02	2.2896E-03	8.9339E+03
96.000	7.8505E+02	1.6137E-03	1.1381E+04
240.000	7.0067E+02	8.2961E-04	1.4396E+04
264.000	6.7456E+02	1.2952E-02	2.2852E+04
480.000	3.8304E+02	1.3338E-04	2.3736E+04
504.000	3.5797E+02	2.0823E-03	2.5095E+04
696.000	1.9653E+02	2.3959E-05	2.5227E+04
720.000	1.8207E+02	3.7404E-04	2.5472E+04

###

Cumulative Dose Summary

###

Time (hr)	Control Room Thyroid (rem)	Control Room TEDE (rem)	EAB Thyroid (rem)	EAB TEDE (rem)	LPZ Thyroid (rem)	LPZ TEDE (rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.400	2.5174E-02	9.7660E-04	5.4609E-03	2.6313E-04	5.1855E-03	2.4986E-04
0.533	8.0668E-02	3.1279E-03	1.3633E-02	6.5444E-04	1.2945E-02	6.2145E-04
0.533	8.0865E-02	3.1355E-03	1.3659E-02	6.5569E-04	1.2970E-02	6.2263E-04
0.900	6.0452E-01	2.3683E-02	6.7055E-02	3.3161E-03	6.3674E-02	3.1489E-03
1.200	1.7815E+00	7.2660E-02	1.6343E-01	8.7090E-03	1.5519E-01	8.2699E-03
1.500	4.0599E+00	1.7314E-01	3.2204E-01	1.8196E-02	3.0580E-01	1.7278E-02
1.800	7.7799E+00	3.4415E-01	5.4919E-01	3.2283E-02	5.2150E-01	3.0655E-02
2.000	1.1182E+01	5.0436E-01	7.3969E-01	4.4312E-02	7.0240E-01	4.2078E-02
2.033	1.1818E+01	5.3459E-01	7.7410E-01	4.6494E-02	7.1902E-01	4.3132E-02
2.033	1.1824E+01	5.3489E-01	7.7445E-01	4.6516E-02	7.1919E-01	4.3143E-02
2.400	2.0349E+01	9.4546E-01	1.2048E+00	7.4097E-02	9.2712E-01	5.6470E-02
2.700	2.9041E+01	1.3704E+00	1.5882E+00	9.8998E-02	1.1124E+00	6.8502E-02
3.000	3.8688E+01	1.8460E+00	1.9680E+00	1.2396E-01	1.2959E+00	8.0564E-02
3.300	4.8700E+01	2.3425E+00	2.3273E+00	1.4790E-01	1.4695E+00	9.2130E-02
3.500	5.5333E+01	2.6726E+00	2.5508E+00	1.6298E-01	1.5775E+00	9.9418E-02
3.800	6.4949E+01	3.1526E+00	8.6315E+00	5.7929E-01	4.8378E+00	3.2263E-01
4.000	7.1026E+01	3.4568E+00	1.2314E+01	8.3546E-01	6.8120E+00	4.5998E-01
4.300	7.9522E+01	3.8829E+00	1.2565E+01	8.5329E-01	6.9337E+00	4.6860E-01
4.600	8.7204E+01	4.2691E+00	1.2785E+01	8.6924E-01	7.0400E+00	4.7631E-01
4.900	9.4051E+01	4.6139E+00	1.2976E+01	8.8346E-01	7.1323E+00	4.8317E-01
5.033	9.6824E+01	4.7538E+00	1.3052E+01	8.8924E-01	7.1690E+00	4.8596E-01
5.400	1.0368E+02	5.1002E+00	1.3238E+01	9.0371E-01	7.2587E+00	4.9296E-01
5.700	1.0850E+02	5.3440E+00	1.3368E+01	9.1416E-01	7.3214E+00	4.9801E-01
6.000	1.1271E+02	5.5569E+00	1.3481E+01	9.2356E-01	7.3761E+00	5.0255E-01
6.300	1.1638E+02	5.7432E+00	1.3581E+01	9.3207E-01	7.4243E+00	5.0666E-01
6.600	1.1960E+02	5.9068E+00	1.3669E+01	9.3980E-01	7.4670E+00	5.1040E-01
6.900	1.2244E+02	6.0509E+00	1.3747E+01	9.4686E-01	7.5049E+00	5.1381E-01

7.200	1.2495E+02	6.1783E+00	1.3817E+01	9.5332E-01	7.5387E+00	5.1693E-01
7.500	1.2718E+02	6.2915E+00	1.3880E+01	9.5925E-01	7.5689E+00	5.1979E-01
7.800	1.2917E+02	6.3923E+00	1.3936E+01	9.6471E-01	7.5961E+00	5.2244E-01
8.000	1.3037E+02	6.4534E+00	1.3971E+01	9.6812E-01	7.6127E+00	5.2408E-01
8.300	1.3208E+02	6.5405E+00	1.3999E+01	9.7219E-01	7.6226E+00	5.2548E-01
8.367	1.3245E+02	6.5595E+00	1.4005E+01	9.7306E-01	7.6247E+00	5.2578E-01
8.667	1.3404E+02	6.6412E+00	1.4031E+01	9.7680E-01	7.6334E+00	5.2707E-01
8.967	1.3552E+02	6.7172E+00	1.4054E+01	9.8030E-01	7.6414E+00	5.2828E-01
9.300	1.3703E+02	6.7946E+00	1.4077E+01	9.8394E-01	7.6494E+00	5.2953E-01
9.600	1.3826E+02	6.8582E+00	1.4096E+01	9.8702E-01	7.6560E+00	5.3059E-01
9.900	1.3940E+02	6.9166E+00	1.4114E+01	9.8992E-01	7.6620E+00	5.3159E-01
10.200	1.4044E+02	6.9701E+00	1.4130E+01	9.9266E-01	7.6676E+00	5.3254E-01
12.033	1.4530E+02	7.2153E+00	1.4206E+01	1.0066E+00	7.6938E+00	5.3735E-01
19.478	1.5409E+02	7.6205E+00	1.4352E+01	1.0398E+00	7.7441E+00	5.4879E-01
24.000	1.5713E+02	7.7383E+00	1.4406E+01	1.0522E+00	7.7627E+00	5.5304E-01
24.033	1.5715E+02	7.7387E+00	1.4406E+01	1.0522E+00	7.7627E+00	5.5305E-01
96.000	1.7757E+02	8.4581E+00	1.5189E+01	1.1544E+00	7.8922E+00	5.6997E-01
240.000	1.9324E+02	9.0044E+00	1.6089E+01	1.2512E+00	7.9443E+00	5.7556E-01
264.000	2.3591E+02	1.0475E+01	1.8601E+01	1.4928E+00	8.0895E+00	5.8953E-01
480.000	2.4124E+02	1.0664E+01	1.8864E+01	1.5155E+00	8.1047E+00	5.9084E-01
504.000	2.4810E+02	1.0911E+01	1.9268E+01	1.5459E+00	8.1281E+00	5.9260E-01
696.000	2.4891E+02	1.0942E+01	1.9307E+01	1.5487E+00	8.1304E+00	5.9276E-01
720.000	2.5014E+02	1.0992E+01	1.9380E+01	1.5536E+00	8.1346E+00	5.9304E-01

###
Worst Two-Hour Doses
###

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
2.0	2.2248E-01	1.1574E+01	7.9114E-01

StackTop ESF'.o0 (Excerpts) (Run I5')

##
I-131 Summary
##

Time (hr)	SP I-131 (Curies)	RB I-131 (Curies)	SR I-131 (Curies)
0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	7.8768E+06	7.1854E+01	1.6811E+00
0.533	1.0735E+07	1.2749E+02	3.0850E+00
0.900	2.2868E+07	3.7146E+02	9.2677E+00
1.200	3.3546E+07	6.7639E+02	1.7141E+01
1.500	4.4198E+07	1.0474E+03	2.6805E+01
1.800	5.4823E+07	1.4651E+03	3.7732E+01
2.000	6.1891E+07	1.7624E+03	4.5528E+01
2.033	6.3068E+07	1.8131E+03	4.6860E+01
2.400	6.5328E+07	2.3073E+03	6.0130E+01
2.700	6.5236E+07	2.5846E+03	6.7641E+01
3.000	6.5143E+07	2.7805E+03	7.2947E+01
3.300	6.5051E+07	2.9184E+03	7.6686E+01
3.500	6.4989E+07	2.9867E+03	7.8536E+01
3.800	6.4897E+07	3.0628E+03	8.0602E+01
4.000	6.4836E+07	3.1002E+03	8.1615E+01
4.300	6.4744E+07	3.1413E+03	8.2733E+01
4.600	6.4652E+07	3.1693E+03	8.3492E+01
4.900	6.4560E+07	3.1878E+03	8.3997E+01
5.200	6.4469E+07	3.1997E+03	8.4322E+01
5.500	6.4377E+07	3.2068E+03	8.4518E+01
5.800	6.4286E+07	3.2105E+03	8.4622E+01
6.100	6.4195E+07	3.2119E+03	8.4662E+01
6.400	6.4104E+07	3.2115E+03	8.4655E+01
6.700	6.4013E+07	3.2099E+03	8.4616E+01
7.000	6.3922E+07	3.2075E+03	8.4553E+01
7.300	6.3832E+07	3.2045E+03	8.4474E+01
7.600	6.3741E+07	3.2010E+03	8.4383E+01
7.900	6.3651E+07	3.1972E+03	8.4284E+01
8.000	6.3621E+07	3.1959E+03	8.4250E+01
8.300	6.3531E+07	3.1918E+03	8.4143E+01
8.600	6.3440E+07	3.1877E+03	8.4033E+01
8.900	6.3350E+07	3.1834E+03	8.3921E+01
9.200	6.3261E+07	3.1790E+03	8.3807E+01
9.500	6.3171E+07	3.1747E+03	8.3691E+01
9.800	6.3081E+07	3.1703E+03	8.3575E+01
10.100	6.2992E+07	3.1658E+03	8.3458E+01
10.400	6.2903E+07	3.1614E+03	8.3341E+01
24.000	5.8984E+07	2.9645E+03	7.8152E+01
96.000	4.1961E+07	2.1089E+03	5.5596E+01
720.000	2.1933E+06	1.1024E+02	2.9061E+00

Time (hr)	CR I-131 (Curies)	Environment I-131 (Curies)	Dummy I-131 (Curies)

0.000	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00
0.400	7.8844E-04	8.5995E+00	3.4754E-03
0.533	1.9077E-03	2.2074E+01	8.9196E-03
0.900	8.4830E-03	1.1385E+02	4.5990E-02
1.200	1.8913E-02	2.8169E+02	1.1376E-01
1.500	3.4169E-02	5.6317E+02	2.2738E-01
1.800	5.3706E-02	9.7776E+02	3.9465E-01
2.000	6.8729E-02	1.3351E+03	5.3877E-01
2.033	7.1368E-02	1.4012E+03	5.6543E-01
2.400	1.0182E-01	2.2494E+03	9.0740E-01
2.700	1.2522E-01	3.0753E+03	1.2401E+00
3.000	1.4495E-01	3.9829E+03	1.6055E+00
3.300	1.6067E-01	4.9481E+03	1.9938E+00
3.500	1.6911E-01	5.6150E+03	2.2619E+00
3.800	1.7913E-01	6.6409E+03	2.6740E+00
4.000	1.8433E-01	7.3377E+03	2.9536E+00
4.300	1.9035E-01	8.3968E+03	3.3784E+00
4.600	1.9469E-01	9.4679E+03	3.8075E+00
4.900	1.9778E-01	1.0547E+04	4.2395E+00
5.200	1.9994E-01	1.1631E+04	4.6731E+00
5.500	2.0141E-01	1.2719E+04	5.1075E+00
5.800	2.0239E-01	1.3809E+04	5.5423E+00
6.100	2.0301E-01	1.4899E+04	5.9769E+00
6.400	2.0338E-01	1.5990E+04	6.4112E+00
6.700	2.0355E-01	1.7080E+04	6.8449E+00
7.000	2.0360E-01	1.8170E+04	7.2778E+00
7.300	2.0354E-01	1.9259E+04	7.7099E+00
7.600	2.0342E-01	2.0347E+04	8.1411E+00
7.900	2.0326E-01	2.1433E+04	8.5714E+00
8.000	2.0319E-01	2.1795E+04	8.7146E+00
8.300	2.0298E-01	2.2880E+04	9.1435E+00
8.600	2.0275E-01	2.3963E+04	9.5713E+00
8.900	2.0250E-01	2.5045E+04	9.9982E+00
9.200	2.0224E-01	2.6125E+04	1.0424E+01
9.500	2.0197E-01	2.7204E+04	1.0849E+01
9.800	2.0170E-01	2.8282E+04	1.1272E+01
10.100	2.0142E-01	2.9358E+04	1.1695E+01
10.400	2.0115E-01	3.0432E+04	1.2117E+01
24.000	1.8863E-01	7.7513E+04	3.0135E+01
96.000	1.3419E-01	2.8198E+05	9.5688E+01
720.000	7.0143E-03	7.5961E+05	5.6015E+01

##

Cumulative Dose Summary

##

	Control Room		EAB		LPZ	
Time	Thyroid	TEDE	Thyroid	TEDE	Thyroid	TEDE
(hr)	(rem)	(rem)	(rem)	(rem)	(rem)	(rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.033	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.400	2.4895E-02	7.9207E-04	5.4505E-03	1.9634E-04	5.1756E-03	1.8644E-04

0.533	8.1519E-02	2.5912E-03	1.3969E-02	5.0069E-04	1.3265E-02	4.7544E-04
0.900	6.3839E-01	2.0252E-02	7.1786E-02	2.5465E-03	6.8167E-02	2.4181E-03
1.200	1.9147E+00	6.0658E-02	1.7709E-01	6.2446E-03	1.6816E-01	5.9297E-03
1.500	4.4135E+00	1.3965E-01	3.5303E-01	1.2390E-02	3.3523E-01	1.1765E-02
1.800	8.5614E+00	2.7061E-01	6.1123E-01	2.1369E-02	5.8041E-01	2.0291E-02
2.000	1.2423E+01	3.9242E-01	8.3310E-01	2.9061E-02	7.9109E-01	2.7596E-02
2.033	1.3159E+01	4.1563E-01	8.7408E-01	3.0479E-02	8.1089E-01	2.8281E-02
2.400	2.3139E+01	7.3013E-01	1.3988E+00	4.8613E-02	1.0644E+00	3.7043E-02
2.700	3.3836E+01	1.0669E+00	1.9077E+00	6.6142E-02	1.3104E+00	4.5513E-02
3.000	4.6525E+01	1.4660E+00	2.4652E+00	8.5281E-02	1.5797E+00	5.4761E-02
3.300	6.0827E+01	1.9156E+00	3.0562E+00	1.0551E-01	1.8653E+00	6.4537E-02
3.500	7.1075E+01	2.2375E+00	3.4634E+00	1.1942E-01	2.0620E+00	7.1258E-02
3.800	8.7275E+01	2.7462E+00	1.5800E+01	5.4003E-01	8.6768E+00	2.9677E-01
4.000	9.8507E+01	3.0986E+00	2.4158E+01	8.2445E-01	1.3158E+01	4.4927E-01
4.300	1.1584E+02	3.6422E+00	2.4800E+01	8.4625E-01	1.3468E+01	4.5981E-01
4.600	1.3359E+02	4.1988E+00	2.5447E+01	8.6819E-01	1.3781E+01	4.7041E-01
4.900	1.5163E+02	4.7639E+00	2.6097E+01	8.9019E-01	1.4095E+01	4.8104E-01
5.200	1.6986E+02	5.3347E+00	2.6748E+01	9.1221E-01	1.4409E+01	4.9168E-01
5.500	1.8819E+02	5.9086E+00	2.7399E+01	9.3419E-01	1.4724E+01	5.0230E-01
5.800	2.0659E+02	6.4841E+00	2.8049E+01	9.5613E-01	1.5038E+01	5.1290E-01
6.100	2.2500E+02	7.0601E+00	2.8699E+01	9.7800E-01	1.5352E+01	5.2347E-01
6.400	2.4341E+02	7.6355E+00	2.9346E+01	9.9978E-01	1.5665E+01	5.3399E-01
6.700	2.6180E+02	8.2100E+00	2.9992E+01	1.0215E+00	1.5977E+01	5.4448E-01
7.000	2.8014E+02	8.7830E+00	3.0635E+01	1.0431E+00	1.6288E+01	5.5492E-01
7.300	2.9843E+02	9.3542E+00	3.1276E+01	1.0646E+00	1.6597E+01	5.6531E-01
7.600	3.1667E+02	9.9235E+00	3.1915E+01	1.0860E+00	1.6906E+01	5.7566E-01
7.900	3.3485E+02	1.0491E+01	3.2552E+01	1.1073E+00	1.7214E+01	5.8596E-01
8.000	3.4090E+02	1.0679E+01	3.2763E+01	1.1144E+00	1.7316E+01	5.8938E-01
8.300	3.5899E+02	1.1244E+01	3.3089E+01	1.1260E+00	1.7428E+01	5.9339E-01
8.600	3.7703E+02	1.1806E+01	3.3414E+01	1.1376E+00	1.7540E+01	5.9737E-01
8.900	3.9499E+02	1.2366E+01	3.3737E+01	1.1491E+00	1.7651E+01	6.0134E-01
9.200	4.1289E+02	1.2924E+01	3.4059E+01	1.1606E+00	1.7762E+01	6.0529E-01
9.500	4.3072E+02	1.3479E+01	3.4380E+01	1.1720E+00	1.7873E+01	6.0921E-01
9.800	4.4849E+02	1.4033E+01	3.4700E+01	1.1833E+00	1.7983E+01	6.1312E-01
10.100	4.6619E+02	1.4584E+01	3.5018E+01	1.1946E+00	1.8093E+01	6.1701E-01
10.400	4.8383E+02	1.5133E+01	3.5335E+01	1.2058E+00	1.8202E+01	6.2088E-01
24.000	1.2266E+03	3.8148E+01	4.8697E+01	1.6675E+00	2.2806E+01	7.7993E-01
96.000	2.9302E+03	9.0330E+01	1.1396E+02	3.7294E+00	3.3610E+01	1.1213E+00
720.000	5.4041E+03	1.6570E+02	2.5613E+02	8.1153E+00	4.1830E+01	1.3748E+00

##
Worst Two-Hour Doses
##

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
3.5	6.7129E-02	2.3935E+01	8.1477E-01

Appendix I5 –STARDOSE LIBFILE1

libfile1.inp

n_isotopes 76 n_isotope_groups 11

Kr83m	N_Gas	NONE	NONE	3.43E+03	1.04E-04	0	4.20E-06		0	0	0	0	0	0	0
	0	0	0												
Kr85m	N_Gas	NONE	NONE	7.33E+03	4.39E-05	0	0.03069	0	0	0.05	0	0.22	0	0	0
	0	0													
Kr85	N_Gas	NONE	NONE	3.60E+02	2.04E-09	0	0.00048	0	0	0.05	0	0.22	0	0	0
	0	0													
Kr87	N_Gas	NONE	NONE	1.45E+04	1.52E-04	0	0.14626	0	0	0.34	0	1.48	0	0	0
	0	0													
Kr88	N_Gas	NONE	NONE	2.01E+04	6.88E-05	0	0.3708	0	0	0.08	0	0.35	0	0	0
	0	0													
Kr89	N_Gas	NONE	NONE	2.52E+04	3.63E-03	0	0.303	0	0	0.35	0	1.52	0	0	0
	0	0													
Xe131m	N_Gas	NONE	NONE	3.54E+02	6.68E-07	0	0.00152	0	0	0.02	0	0.04	0	0	0
	0	0													
Xe133m	N_Gas	NONE	NONE	1.73E+03	3.49E-06	0	0.00554	0	0	0.03	0	0.13	0	0	0
	0	0													
Xe133	N_Gas	I133Part	NONE	5.50E+04	1.52E-06	0	0.00625	0	0	0.01	0	0.04	0	0	0
	0	0													
Xe135m	N_Gas	NONE	NONE	1.14E+04	7.40E-04	0	0.07756	0	0	0.02	0	0.09	0	0	0
	0	0													
Xe135	N_Gas	I135Part	NONE	1.97E+04	2.09E-05	0	0.0482	0	0	0.06	0	0.26	0	0	0
	0	0													
Xe137	N_Gas	NONE	NONE	5.02E+04	2.96E-03	0	0.0283	0	0	0.46	0	2	0	0	0
	0	0													

Xe138	N_Gas	NONE	NONE	4.76E+04	6.80E-04	0	0.19776	0	0	0.15	0	0.65	0	0	0	0	0
I131Org	Org_I	NONE	NONE	2.67E+04	9.96E-07	1080400	0.0559	0	0	0.03	32893	0.13	0	0	0	0	0
I132Org	Org_I	NONE	NONE	3.89E+04	8.27E-05	6438	0.355	0	0	0.11	381.1	0.48	0	0	0	0	0
I133Org	Org_I	NONE	NONE	5.53E+04	9.22E-06	179820	0.0911	0	0	0.09	5846	0.39	0	0	0	0	0
I134Org	Org_I	NONE	NONE	6.14E+04	2.23E-04	1065.6	0.411	0	0	0.14	131.35	0.61	0	0	0	0	0
I135Org	Org_I	NONE	NONE	5.25E+04	2.86E-05	31302	0.249	0	0	0.08	1228.4	0.35	0	0	0	0	0
I131Elem	Elm_I	NONE	NONE	2.67E+04	9.96E-07	1080400	0.0559	0	0	0.03	32893	0.13	0	0	0	0	0
I132Elem	Elm_I	NONE	NONE	3.89E+04	8.27E-05	6438	0.355	0	0	0.11	381.1	0.48	0	0	0	0	0
I133Elem	Elm_I	NONE	NONE	5.53E+04	9.22E-06	179820	0.0911	0	0	0.09	5846	0.39	0	0	0	0	0
I134Elem	Elm_I	NONE	NONE	6.14E+04	2.23E-04	1065.6	0.411	0	0	0.14	131.35	0.61	0	0	0	0	0
I135Elem	Elm_I	NONE	NONE	5.25E+04	2.86E-05	31302	0.249	0	0	0.08	1228.4	0.35	0	0	0	0	0
I131Part	Prt_I	Te131m	NONE	2.67E+04	9.96E-07	1080400	0.0559	0	0	0.03	32893	0.13	0	0	0	0	0
I132Part	Prt_I	Te132	NONE	3.89E+04	8.27E-05	6438	0.355	0	0	0.11	381.1	0.48	0	0	0	0	0

I133Part	Prt_I	NONE	Xe133	5.53E+04	9.22E-06	179820	0.0911	0	0	0.09	5846	0.39	0	0	0	0	0
I134Part	Prt_I	NONE	NONE	6.14E+04	2.23E-04	1065.6	0.411	0	0	0.14	131.35	0.61	0	0	0	0	0
I135Part	Prt_I	NONE	Xe135	5.25E+04	2.86E-05	31302	0.249	0	0	0.08	1228.4	0.35	0	0	0	0	0
Rb86	CsGrp	NONE	NONE	6.37E+01	4.29E-07	4921	0	0	0	0	6623	0	0	0	0	0	0
Cs134	CsGrp	NONE	NONE	5.70E+03	9.55E-09	41070	0	0	0	0	46250	0	0	0	0	0	0
Cs136	CsGrp	NONE	NONE	1.94E+03	6.16E-07	6401	0	0	0	0	7326	0	0	0	0	0	0
Cs137	CsGrp	NONE	Ba137m	4.04E+03	7.30E-10	29341	0	0	0	0	31931	0	0	0	0	0	0
Sb127	TeGrp	NONE	Te127	2.80E+03	2.07E-06	227.55	0	0	0	0	6031	0	0	0	0	0	0
Sb129	TeGrp	NONE	Te129	8.46E+03	4.42E-05	35.964	0	0	0	0	643.8	0	0	0	0	0	0
Te127m	TeGrp	NONE	NONE	3.72E+02	7.64E-08	357.42	0	0	0	0	21497	0	0	0	0	0	0
Te127	TeGrp	Sb127	NONE	2.77E+03	2.06E-05	6.808	0	0	0	0	318.2	0	0	0	0	0	0
Te129m	TeGrp	NONE	NONE	1.62E+03	2.36E-07	577.2	0	0	0	0	23939	0	0	0	0	0	0
Te129	TeGrp	Sb129	NONE	8.33E+03	1.57E-04	1.8833	0	0	0	0	77.33	0	0	0	0	0	0

Te131m	TeGrp	NONE	I131Part	5.16E+03	6.42E-06	133570	0	0	0	0	6401	0	0	0	0
	0	0													
Te132	TeGrp	NONE	I132Part	3.83E+04	2.51E-06	232360	0	0	0	0	9435	0	0	0	0
	0	0													
Ba137m	BaGrp	Cs137	NONE	3.83E+03	4.53E-03	0	0	0	0	0	0	0	0	0	0
	0	0													
Ba139	BaGrp	NONE	NONE	4.93E+04	1.39E-04	8.88	0	0	0	0	171.68	0	0	0	0
	0	0													
Ba140	BaGrp	NONE	La140	4.91E+04	6.27E-07	947.2	0	0	0	0	3737	0	0	0	0
	0	0													
Mo99	NMtls	NONE	Tc99m	5.09E+04	2.87E-06	56.24	0	0	0	0	3959	0	0	0	0
	0	0													
Tc99m	NMtls	Mo99	NONE	4.45E+04	3.18E-05	185.37	0	0	0	0	32.56	0	0	0	0
	0	0													
Ru103	NMtls	NONE	NONE	4.09E+04	2.03E-07	950.9	0	0	0	0	8954	0	0	0	0
	0	0													
Ru105	NMtls	NONE	Rh105	2.71E+04	4.22E-05	15.355	0	0	0	0	455.1	0	0	0	0
	0	0													
Ru106	NMtls	NONE	NONE	1.49E+04	2.20E-08	6364	0	0	0	0	477300	0	0	0	0
	0	0													
Rh105	NMtls	Ru105	NONE	2.56E+04	5.40E-06	10.656	0	0	0	0	954.6	0	0	0	0
	0	0													
Y90	LaGrp	Sr90	NONE	3.28E+03	2.99E-06	1.9129	0	0	0	0	8436	0	0	0	0
	0	0													
Y91	LaGrp	Sr91	NONE	3.58E+04	1.38E-07	31.45	0	0	0	0	48840	0	0	0	0
	0	0													

Y92	LaGrp	Sr92	NONE	3.70E+04	5.35E-05	3.885	0	0	0	0	780.7	0	0	0	0
	0	0													
Y93	LaGrp	NONE	NONE	4.15E+04	1.91E-05	3.4262	0	0	0	0	2153.4	0	0	0	0
	0	0													
Zr95	LaGrp	NONE	Nb95	4.88E+04	1.27E-07	4292	0	0	0	0	23347	0	0	0	0
	0	0													
Zr97	LaGrp	NONE	NONE	4.95E+04	1.13E-05	85.47	0	0	0	0	4329	0	0	0	0
	0	0													
Nb95	LaGrp	Zr95	NONE	4.90E+04	2.29E-07	1324.6	0	0	0	0	5809	0	0	0	0
	0	0													
La140	LaGrp	Ba140	NONE	5.23E+04	4.77E-06	254.19	0	0	0	0	4847	0	0	0	0
	0	0													
La141	LaGrp	NONE	Ce141	4.50E+04	4.94E-05	9.065	0	0	0	0	562.4	0	0	0	0
	0	0													
La142	LaGrp	NONE	NONE	4.40E+04	1.26E-04	18.167	0	0	0	0	203.5	0	0	0	0
	0	0													
Pr143	LaGrp	Ce143	NONE	4.11E+04	5.85E-07	6.20E-06		0	0	0	0	8103	0	0	0
	0	0	0												
Nd147	LaGrp	NONE	NONE	1.81E+04	7.10E-07	67.34	0	0	0	0	6845	0	0	0	0
	0	0													
Am241	LaGrp	NONE	NONE	5.45E+00	4.80E-11	5920	0	0	0	0	4.40E+08		0	0	0
	0	0	0												
Cm242	LaGrp	NONE	NONE	1.23E+03	4.94E-08	3481.7	0	0	0	0	1.70E+07		0	0	0
	0	0	0												
Cm244	LaGrp	NONE	NONE	5.70E+01	1.25E-09	3737	0	0	0	0	2.50E+08		0	0	0
	0	0	0												

Ce141	CeGrp	La141	NONE	4.54E+04	2.51E-07	94.35	0	0	0	0	8954	0	0	0	0
	0	0													
Ce143	CeGrp	NONE	Pr143	4.25E+04	6.03E-06	23.051	0	0	0	0	3389.2	0	0	0	0
	0	0													
Ce144	CeGrp	NONE	NONE	3.81E+04	2.77E-08	1080.4	0	0	0	0	373700	0	0	0	0
	0	0													
Np239	CeGrp	NONE	NONE	5.20E+05	3.44E-06	28.194	0	0	0	0	2508.6	0	0	0	0
	0	0													
Pu238	CeGrp	NONE	NONE	2.81E+02	2.40E-10	3559.4	0	0	0	0	3.90E+08		0	0	0
	0	0	0												
Pu239	CeGrp	NONE	NONE	1.23E+01	9.00E-13	3341.1	0	0	0	0	4.30E+08		0	0	0
	0	0	0												
Pu240	CeGrp	NONE	NONE	1.73E+01	3.30E-12	3348.5	0	0	0	0	4.30E+08		0	0	0
	0	0	0												
Pu241	CeGrp	NONE	NONE	4.45E+03	1.67E-09	45.88	0	0	0	0	82510000		0	0	0
	0	0													
Sr89	SrGrp	NONE	NONE	2.79E+04	1.59E-07	1539.2	0	0	0	0	6512	0	0	0	0
	0	0													
Sr90	SrGrp	NONE	Y90	3.17E+03	8.00E-10	9768	0	0	0	0	239390	0	0	0	0
	0	0													
Sr91	SrGrp	NONE	Y91	3.49E+04	2.01E-05	150.96	0	0	0	0	932.4	0	0	0	0
	0	0													
Sr92	SrGrp	NONE	Y92	3.68E+04	7.29E-05	81.03	0	0	0	0	629	0	0	0	0
	0	0													

Appendix I6 –STARDOSE Input Files

StackBase.dat

edit_time
0 2.0333 2 4 8 24 96 720
end_edit_time

participating_isotopes
Kr83m Kr85m Kr85 Kr87 Kr88 Kr89
Xe131m Xe133m Xe133 Xe135m Xe135 Xe137 Xe138
I131Org I131Elem I131Part
I132Org I132Elem I132Part
I133Org I133Elem I133Part
I134Org I134Elem I134Part
I135Org I135Elem I135Part
Rb86 Cs134 Cs136 Cs137
Sb127 Sb129 Te127m Te127 Te129m Te129 Te131m Te132
Ba137m Ba139 Ba140
Mo99 Tc99m Ru103 Ru105 Ru106 Rh105
Y90 Y91 Y92 Y93 Zr95 Zr97 Nb95
La140 La141 La142 Pr143 Nd147 Am241 Cm242 Cm244
Ce141 Ce143 Ce144 Np239 Pu238 Pu239 Pu240 Pu241
Sr89 Sr90 Sr91 Sr92
end_participating_isotopes

core
thermal_power 4031
elemental_iodine_frac 0.0485
organic_iodine_frac 0.0015
particulate_iodine_frac 0.95
release_frac
to_control_volume DW
Time N_Gas I_Grp CsGrp TeGrp BaGrp NMtls CeGrp LaGrp SrGrp
0.0333 0 0 0 0 0 0 0 0 0
0.5333 0.1 0.1 0.1 0 0 0 0 0 0
2.0333 0.63 0.166 0.133 0.033 0.013 0.0017 0.00033 0.00013 0.013
720 0 0 0 0 0 0 0 0 0
end_to_control_volume
end_release_frac
end_core

control_volume
obj_type OBJ_CV
name DW
air_volume 1.59e+005
water_volume 0
surface_area 1
has_recirc_filter false
removal_rate_to_surface
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
0.033 0 0 0 0 0 0
0.533 0 0.75 0 0.75 0.75 0.75
2.033 0 0.37 0 0.37 0.37 0.37

5.033 0 1.06 0 1.06 1.06 1.06
8.367 0 0.64 0 0.64 0.64 0.64
12.033 0 0.56 0 0.56 0.56 0.56
19.478 0 0.53 0 0.53 0.53 0.53
24.033 0 0.51 0 0.51 0.51 0.51
720 0 0 0 0 0 0
end_removal_rate_to_surface
frac_4_daughter_resusp_from_surface
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0 0 0
end_frac_4_daughter_resusp_from_surface
end_control_volume

control_volume
obj_type OBJ_CV
name WW
air_volume 1.194e+005
water_volume 1.215e+005
surface_area 0
has_recirc_filter false
end_control_volume
control_volume
obj_type OBJ_CV
name RB
air_volume 1.311e+006
water_volume 0
surface_area 0
has_recirc_filter false
end_control_volume

control_volume
obj_type OBJ_CV
name SR
air_volume 3.456e+004
water_volume 0
surface_area 0
has_recirc_filter false
end_control_volume
control_volume

obj_type OBJ_CV
name MC
air_volume 1.224e+005
water_volume 0
surface_area 0
has_recirc_filter false
end_control_volume
control_volume

control_volume
obj_type OBJ_CV
name Dummy
air_volume 1.0e+006

```
water_volume 0
surface_area 0
has_recirc_filter false
end_control_volume

control_volume
obj_type OBJ_CR
name Control_Room
air_volume 2.1e+005
water_volume 0
surface_area 0
has_recirc_filter false
breathing_rate
Time (hr) Value (cfm)
720 0.00035
end_breathing_rate
occupancy_factor
Time (hr) Value (frac)
24 1
96 0.6
720 0.4
end_occupancy_factor
end_control_volume

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream CORE
downstream DW
has_filter false
flow_rate
Time (hr) Value (cfm)
720 1
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream DW
downstream WW
has_filter false
flow_rate
Time (hr) Value (cfm)
2.033 0
720 119400
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream WW
```

downstream DW
has_filter false
flow_rate
Time (hr) Value (cfm)
2.033 0
720 119400
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream DW
downstream RB
has_filter false
flow_rate
Time (hr) Value (cfm)
720 2.208
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream WW
downstream RB
has_filter false
flow_rate
Time (hr) Value (cfm)
720 1.658
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream RB
downstream SR
has_filter true
flow_rate
Time (hr) Value (cfm)
720 24750
end_flow_rate
filter_efficiency
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0.9 0.9 0.9
end_filter_efficiency
frac_4_daughter_resusp
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 1 1 0 0 0 0
end_frac_4_daughter_resusp
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream WW
downstream SR
has_filter true
flow_rate
Time (hr) Value (cfm)
240 0
264 139
480 0
504 139
696 0
720 139
end_flow_rate
filter_efficiency
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0.9 0.9 0.9
end_filter_efficiency
frac_4_daughter_resusp
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0 0 0
end_frac_4_daughter_resusp
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream WW
downstream Dummy
has_filter false
flow_rate
Time (hr) Value (cfm)
8 0
720 0.167
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream SR
downstream environment
has_filter false
flow_rate
Time (hr) Value (cfm)
720 20
end_flow_rate
X_over_Q_4_ctrl_room
Time (hr) Value (s/m*3)
2 0.0002
8 0.000128
24 0.0000572

96 0.0000405
720 0.0000309
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time (hr) Value (s/m*3)
1 0
3 0.000262
24 0
96 0
720 0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time (hr) Value (s/m*3)
2 0.000131
8 0.0000661
24 0.0000469
96 0.0000223
720 0.00000796
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream SR
downstream Dummy
has_filter false
flow_rate
Time (hr) Value (cfm)
720 24740.
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream DW
downstream MC
has_filter true
flow_rate
Time (hr) Value (cfm)
720 0.3625
end_flow_rate
filter_efficiency
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0.997 0 0.9997 0.9997 0.9997
end_filter_efficiency
frac_4_daughter_resusp
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0 0 0
end_frac_4_daughter_resusp
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream DW
downstream Dummy
has_filter true
flow_rate
Time (hr) Value (cfm)
720 0.3788
end_flow_rate
filter_efficiency
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0.253 0 0.929 0.929 0.929
end_filter_efficiency
frac_4_daughter_resusp
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0 0 0
end_frac_4_daughter_resusp
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream MC
downstream Dummy
has_filter false
flow_rate
Time (hr) Value (cfm)
720 1.11
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream Control_Room
downstream environment
has_filter false
flow_rate
Time (hr) Value (cfm)
720 6717
end_flow_rate
X_over_Q_4_ctrl_room
Time (hr) Value (s/m*3)
720 0
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time (hr) Value (s/m*3)
720 0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time (hr) Value (s/m*3)
720 0

end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream environment
downstream Control_Room
has_filter false
flow_rate
Time (hr) Value (cfm)
720 6717
end_flow_rate
end_junction

environment
breathing_rate_sb
Time (hr) Value (cfm)
8 0.00035
24 0.00018
720 0.00023
end_breathing_rate_sb
breathing_rate_lpz
Time (hr) Value (frac)
8 0.00035
24 0.00018
720 0.00023
end_breathing_rate_lpz
end_environment

StackTop.dat (Fumigation X/Q for CR and LPZ between 3.5 and 4 hrs, and for EAB between 2.5 and 3 hours)

```
edit_time
0 2.0333 2 4 8 24 96 720
end_edit_time

participating_isotopes
Kr83m Kr85m Kr85 Kr87 Kr88 Kr89
Xe131m Xe133m Xe133 Xe135m Xe135 Xe137 Xe138
I131Org I131Elem I131Part
I132Org I132Elem I132Part
I133Org I133Elem I133Part
I134Org I134Elem I134Part
I135Org I135Elem I135Part
Rb86 Cs134 Cs136 Cs137
Sb127 Sb129 Te127m Te127 Te129m Te129 Te131m Te132
Ba137m Ba139 Ba140
Mo99 Tc99m Ru103 Ru105 Ru106 Rh105
Y90 Y91 Y92 Y93 Zr95 Zr97 Nb95
La140 La141 La142 Pr143 Nd147 Am241 Cm242 Cm244
Ce141 Ce143 Ce144 Np239 Pu238 Pu239 Pu240 Pu241
Sr89 Sr90 Sr91 Sr92
end_participating_isotopes

core
thermal_power 4031
elemental_iodine_frac 0.0485
organic_iodine_frac 0.0015
particulate_iodine_frac 0.95
release_frac
to_control_volume DW
Time N_Gas I_Grp CsGrp TeGrp BaGrp NMtls CeGrp LaGrp SrGrp
0.0333 0 0 0 0 0 0 0 0 0
0.5333 0.1 0.1 0.1 0 0 0 0 0 0
2.0333 0.63 0.166 0.133 0.033 0.013 0.0017 0.00033 0.00013 0.013
720 0 0 0 0 0 0 0 0 0
end_to_control_volume
end_release_frac
end_core

control_volume
obj_type OBJ_CV
name DW
air_volume 1.59e+005
water_volume 0
surface_area 1
has_recirc_filter false
removal_rate_to_surface
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
0.033 0 0 0 0 0 0
0.533 0 0.75 0 0.75 0.75 0.75
2.033 0 0.37 0 0.37 0.37 0.37
5.033 0 1.06 0 1.06 1.06 1.06
8.367 0 0.64 0 0.64 0.64 0.64
```

12.033 0 0.56 0 0.56 0.56 0.56
19.478 0 0.53 0 0.53 0.53 0.53
24.033 0 0.51 0 0.51 0.51 0.51
720 0 0 0 0 0 0
end_removal_rate_to_surface
frac_4_daughter_resusp_from_surface
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0 0 0
end_frac_4_daughter_resusp_from_surface
end_control_volume

control_volume
obj_type OBJ_CV
name WW
air_volume 1.194e+005
water_volume 1.215e+005
surface_area 0
has_recirc_filter false
end_control_volume

control_volume
obj_type OBJ_CV
name RB
air_volume 1.311e+006
water_volume 0
surface_area 0
has_recirc_filter false
end_control_volume

control_volume
obj_type OBJ_CV
name SR
air_volume 3.456e+004
water_volume 0
surface_area 0
has_recirc_filter false
end_control_volume
control_volume

obj_type OBJ_CV
name MC
air_volume 1.224e+005
water_volume 0
surface_area 0
has_recirc_filter false
end_control_volume
control_volume

control_volume
obj_type OBJ_CV
name Dummy
air_volume 1.0e+006
water_volume 0

surface_area 0
has_recirc_filter false
end_control_volume

control_volume
obj_type OBJ_CR
name Control_Room
air_volume 2.1e+005
water_volume 0
surface_area 0
has_recirc_filter false
breathing_rate
Time (hr) Value (cfm)
720 0.00035
end_breathing_rate
occupancy_factor
Time (hr) Value (frac)
24 1
96 0.6
720 0.4
end_occupancy_factor
end_control_volume

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream CORE
downstream DW
has_filter false
flow_rate
Time (hr) Value (cfm)
720 1
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream DW
downstream WW
has_filter false
flow_rate
Time (hr) Value (cfm)
2.033 0
720 119400
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream WW
downstream DW

has_filter false
flow_rate
Time (hr) Value (cfm)
2.033 0
720 119400
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream DW
downstream RB
has_filter false
flow_rate
Time (hr) Value (cfm)
720 2.208
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream WW
downstream RB
has_filter false
flow_rate
Time (hr) Value (cfm)
720 1.658
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream RB
downstream SR
has_filter true
flow_rate
Time (hr) Value (cfm)
720 24750
end_flow_rate
filter_efficiency
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0.9 0.9 0.9
end_filter_efficiency
frac_4_daughter_resusp
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 1 1 0 0 0 0
end_frac_4_daughter_resusp
end_junction

junction

junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream WW
downstream SR
has_filter true
flow_rate
Time (hr) Value (cfm)
240 0
264 139
480 0
504 139
696 0
720 139
end_flow_rate
filter_efficiency
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0.9 0.9 0.9
end_filter_efficiency
frac_4_daughter_resusp
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0 0 0
end_frac_4_daughter_resusp
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream WW
downstream environment
has_filter false
flow_rate
Time (hr) Value (cfm)
8 0
720 0.167
end_flow_rate
X_over_Q_4_ctrl_room
Time (hr) Value (s/m*3)
2 0.000000141
3.5 0.000000045
4 0.000034
8 0.000000045
24 0.0000000254
96 0.00000000736
720 0.00000000124
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time (hr) Value (s/m*3)
1 0
2.5 0.00000119
3 0.0000235
24 0
96 0
720 0

end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time (hr) Value (s/m*3)
2 0.00000113
3.5 0.000000575
4 0.0000126
8 0.000000575
24 0.00000041
96 0.000000197
720 0.0000000688
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream SR
downstream Dummy
has_filter false
flow_rate
Time (hr) Value (cfm)
720 20
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream SR
downstream environment
has_filter false
flow_rate
Time (hr) Value (cfm)
720 24740.
end_flow_rate
X_over_Q_4_ctrl_room
Time (hr) Value (s/m*3)
2 0.000000141
3.5 0.000000045
4 0.000034
8 0.000000045
24 0.0000000254
96 0.00000000736
720 0.00000000124
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time (hr) Value (s/m*3)
1 0
2.5 0.00000119
3 0.0000235
24 0
96 0
720 0

end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time (hr) Value (s/m*3)
2 0.00000113
3.5 0.000000575
4 0.0000126
8 0.000000575
24 0.00000041
96 0.000000197
720 0.0000000688
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream DW
downstream MC
has_filter true
flow_rate
Time (hr) Value (cfm)
720 0.3625
end_flow_rate
filter_efficiency
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0.997 0 0.9997 0.9997 0.9997
end_filter_efficiency
frac_4_daughter_resusp
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0 0 0
end_frac_4_daughter_resusp
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream DW
downstream Dummy
has_filter true
flow_rate
Time (hr) Value (cfm)
720 0.3788
end_flow_rate
filter_efficiency
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0.253 0 0.929 0.929 0.929
end_filter_efficiency
frac_4_daughter_resusp
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0 0 0
end_frac_4_daughter_resusp
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream MC
downstream Dummy
has_filter false
flow_rate
Time (hr) Value (cfm)
720 1.11
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream Control_Room
downstream environment
has_filter false
flow_rate
Time (hr) Value (cfm)
720 6717
end_flow_rate
X_over_Q_4_ctrl_room
Time (hr) Value (s/m*3)
720 0
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time (hr) Value (s/m*3)
720 0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time (hr) Value (s/m*3)
720 0
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream environment
downstream Control_Room
has_filter false
flow_rate
Time (hr) Value (cfm)
720 6717
end_flow_rate
end_junction

environment
breathing_rate_sb
Time (hr) Value (cfm)
8 0.00035
24 0.00018

720 0.00023
end_breathing_rate_sb
breathing_rate_lpz
Time (hr) Value (frac)
8 0.00035
24 0.00018
720 0.00023
end_breathing_rate_lpz
end_environment

TBRoof.dat

```
edit_time
0 2.0333 2 4 8 24 96 720
end_edit_time

participating_isotopes
Kr83m Kr85m Kr85 Kr87 Kr88 Kr89
Xe131m Xe133m Xe133 Xe135m Xe135 Xe137 Xe138
I131Org I131Elem I131Part
I132Org I132Elem I132Part
I133Org I133Elem I133Part
I134Org I134Elem I134Part
I135Org I135Elem I135Part
Rb86 Cs134 Cs136 Cs137
Sb127 Sb129 Te127m Te127 Te129m Te129 Te131m Te132
Ba137m Ba139 Ba140
Mo99 Tc99m Ru103 Ru105 Ru106 Rh105
Y90 Y91 Y92 Y93 Zr95 Zr97 Nb95
La140 La141 La142 Pr143 Nd147 Am241 Cm242 Cm244
Ce141 Ce143 Ce144 Np239 Pu238 Pu239 Pu240 Pu241
Sr89 Sr90 Sr91 Sr92
end_participating_isotopes

core
thermal_power 4031
elemental_iodine_frac 0.0485
organic_iodine_frac 0.0015
particulate_iodine_frac 0.95
release_frac
to_control_volume DW
Time N_Gas I_Grp CsGrp TeGrp BaGrp NMtls CeGrp LaGrp SrGrp
0.0333 0 0 0 0 0 0 0 0 0
0.5333 0.1 0.1 0.1 0 0 0 0 0 0
2.0333 0.63 0.166 0.133 0.033 0.013 0.0017 0.00033 0.00013 0.013
720 0 0 0 0 0 0 0 0 0
end_to_control_volume
end_release_frac
end_core

control_volume
obj_type OBJ_CV
name DW
air_volume 1.59e+005
water_volume 0
surface_area 1
has_recirc_filter false
removal_rate_to_surface
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
0.033 0 0 0 0 0 0
0.533 0 0.75 0 0.75 0.75 0.75
2.033 0 0.37 0 0.37 0.37 0.37
5.033 0 1.06 0 1.06 1.06 1.06
```

8.367 0 0.64 0 0.64 0.64 0.64
12.033 0 0.56 0 0.56 0.56 0.56
19.478 0 0.53 0 0.53 0.53 0.53
24.033 0 0.51 0 0.51 0.51 0.51
720 0 0 0 0 0 0
end_removal_rate_to_surface
frac_4_daughter_resusp_from_surface
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0 0 0
end_frac_4_daughter_resusp_from_surface
end_control_volume

control_volume
obj_type OBJ_CV
name WW
air_volume 1.194e+005
water_volume 1.215e+005
surface_area 0
has_recirc_filter false
end_control_volume
control_volume
obj_type OBJ_CV
name RB
air_volume 1.311e+006
water_volume 0
surface_area 0
has_recirc_filter false
end_control_volume

control_volume
obj_type OBJ_CV
name SR
air_volume 3.456e+004
water_volume 0
surface_area 0
has_recirc_filter false
end_control_volume
control_volume

obj_type OBJ_CV
name MC
air_volume 1.224e+005
water_volume 0
surface_area 0
has_recirc_filter false
end_control_volume
control_volume

control_volume
obj_type OBJ_CV
name Dummy
air_volume 1.0e+006
water_volume 0

surface_area 0
has_recirc_filter false
end_control_volume

control_volume
obj_type OBJ_CR
name Control_Room
air_volume 2.1e+005
water_volume 0
surface_area 0
has_recirc_filter false
breathing_rate
Time (hr) Value (cfm)
720 0.00035
end_breathing_rate
occupancy_factor
Time (hr) Value (frac)
24 1
96 0.6
720 0.4
end_occupancy_factor
end_control_volume

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream CORE
downstream DW
has_filter false
flow_rate
Time (hr) Value (cfm)
720 1
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream DW
downstream WW
has_filter false
flow_rate
Time (hr) Value (cfm)
2.033 0
720 119400
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream WW
downstream DW

has_filter false
flow_rate
Time (hr) Value (cfm)
2.033 0
720 119400
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream DW
downstream RB
has_filter false
flow_rate
Time (hr) Value (cfm)
720 2.208
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream WW
downstream RB
has_filter false
flow_rate
Time (hr) Value (cfm)
720 1.658
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream RB
downstream SR
has_filter true
flow_rate
Time (hr) Value (cfm)
720 24750
end_flow_rate
filter_efficiency
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0.9 0.9 0.9
end_filter_efficiency
frac_4_daughter_resusp
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 1 1 0 0 0 0
end_frac_4_daughter_resusp
end_junction

junction

junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream WW
downstream SR
has_filter true
flow_rate
Time (hr) Value (cfm)
240 0
264 139
480 0
504 139
696 0
720 139
end_flow_rate
filter_efficiency
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0.9 0.9 0.9
end_filter_efficiency
frac_4_daughter_resusp
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0 0 0
end_frac_4_daughter_resusp
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream WW
downstream Dummy
has_filter false
flow_rate
Time (hr) Value (cfm)
8 0
720 0.167
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream SR
downstream Dummy
has_filter false
flow_rate
Time (hr) Value (cfm)
720 10.
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream SR

downstream Dummy
has_filter false
flow_rate
Time (hr) Value (cfm)
720 24740.
end_flow_rate
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream DW
downstream MC
has_filter true
flow_rate
Time (hr) Value (cfm)
720 0.3625
end_flow_rate
filter_efficiency
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0.9970 0 0.9997 0.9997 0.9997
end_filter_efficiency
frac_4_daughter_resusp
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0 0 0
end_frac_4_daughter_resusp
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream DW
downstream environment
has_filter true
flow_rate
Time (hr) Value (cfm)
720 0.3788
end_flow_rate
filter_efficiency
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0.253 0 0.929 0.929 0.929
end_filter_efficiency
frac_4_daughter_resusp
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0 0 0 0 0
end_frac_4_daughter_resusp
X_over_Q_4_ctrl_room
Time (hr) Value (s/m*3)
2 0.000322
8 0.000277
24 0.000131
96 0.0000791
720 0.0000610

end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time (hr) Value (s/m*3)
1.0 0
3.0 0.000262
24 0
96 0
720 0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time (hr) Value (s/m*3)
2 0.000131
8 0.0000661
24 0.0000469
96 0.0000223
720 0.00000796
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream MC
downstream environment
has_filter false
flow_rate
Time (hr) Value (cfm)
720 1.11
end_flow_rate
X_over_Q_4_ctrl_room
Time (hr) Value (s/m*3)
2 0.000322
8 0.000277
24 0.000131
96 0.0000791
720 0.0000610
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time (hr) Value (s/m*3)
1.0 0
3.0 0.000262
24 0
96 0
720 0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time (hr) Value (s/m*3)
2 0.000131
8 0.0000661
24 0.0000469
96 0.0000223
720 0.00000796
end_X_over_Q_4_low_population_zone

```
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream Control_Room
downstream environment
has_filter false
flow_rate
Time (hr) Value (cfm)
720 6717
end_flow_rate
X_over_Q_4_ctrl_room
Time (hr) Value (s/m*3)
720 0
end_X_over_Q_4_ctrl_room
X_over_Q_4_site_boundary
Time (hr) Value (s/m*3)
720 0
end_X_over_Q_4_site_boundary
X_over_Q_4_low_population_zone
Time (hr) Value (s/m*3)
720 0
end_X_over_Q_4_low_population_zone
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream environment
downstream Control_Room
has_filter false
flow_rate
Time (hr) Value (cfm)
720 6717
end_flow_rate
end_junction

environment
breathing_rate_sb
Time (hr) Value (cfm)
8 0.00035
24 0.00018
720 0.00023
end_breathing_rate_sb
breathing_rate_lpz
Time (hr) Value (frac)
8 0.00035
24 0.00018
720 0.00023
end_breathing_rate_lpz
end_environment
```

Appendix I7 –STARDOSE Output Files

StackBase.out (Excerpts)

edit time 720.000000
Control_Room

	thyroid	wbody	skin	CEDE
Total dose:	5.42E-001	7.64E-004	1.53E-002	2.33E-002
Noble gas	0.00E+000	7.24E-004	1.49E-002	0.00E+000
Org iodine	9.43E-002	2.02E-006	2.10E-005	2.89E-003
Elem iodine	1.46E-001	1.25E-005	1.10E-004	4.57E-003
Part iodine	2.87E-001	2.58E-005	2.24E-004	8.97E-003
Cesium	2.44E-003	0.00E+000	0.00E+000	2.72E-003
Tellurium	1.17E-002	0.00E+000	0.00E+000	5.67E-004
Barium	2.33E-005	0.00E+000	0.00E+000	9.26E-005
Noble metal	9.61E-006	0.00E+000	0.00E+000	5.12E-004
Lanthanides	1.90E-006	0.00E+000	0.00E+000	2.24E-004
Cerium	7.92E-007	0.00E+000	0.00E+000	2.26E-003
Strontinum	4.00E-005	0.00E+000	0.00E+000	4.95E-004

environment

	thyroid	wbody	skin	CEDE
EAB dose:	3.46E-001	5.27E-003	3.48E-003	1.56E-002
LPZ dose:	2.89E-001	9.65E-003	1.07E-002	1.25E-002

StackTop.out (Excerpts)

edit time 720.000000
Control_Room

	thyroid	wbody	skin	CEDE
Total dose:	1.40E+001	1.31E-002	1.67E-001	6.39E-001
Noble gas	0.00E+000	1.20E-002	1.57E-001	0.00E+000
Org iodine	3.46E-001	2.56E-005	2.35E-004	1.08E-002
Elem iodine	4.46E+000	3.41E-004	3.11E-003	1.39E-001
Part iodine	8.74E+000	7.18E-004	6.38E-003	2.73E-001
Cesium	7.26E-002	0.00E+000	0.00E+000	8.10E-002
Tellurium	3.85E-001	0.00E+000	0.00E+000	1.86E-002
Barium	7.61E-004	0.00E+000	0.00E+000	3.02E-003
Noble metal	3.12E-004	0.00E+000	0.00E+000	1.66E-002
Lanthanides	5.97E-005	0.00E+000	0.00E+000	7.22E-003
Cerium	2.58E-005	0.00E+000	0.00E+000	7.34E-002
Strontinum	1.30E-003	0.00E+000	0.00E+000	1.60E-002

environment

	thyroid	wbody	skin	CEDE
EAB dose:	1.94E+000	2.96E-002	1.95E-002	8.75E-002
LPZ dose:	7.98E+000	1.98E-001	1.80E-001	3.57E-001

TBRoof.out (Excerpts)

edit time 720.000000
Control_Room

	thyroid	wbody	skin	CEDE
Total dose:	1.27E+002	2.29E-001	3.84E+000	5.48E+000
Noble gas	0.00E+000	2.17E-001	3.74E+000	0.00E+000
Org iodine	1.66E+001	5.69E-004	5.71E-003	5.10E-001
Elem iodine	3.74E+001	3.81E-003	3.20E-002	1.17E+000
Part iodine	6.96E+001	7.34E-003	6.11E-002	2.18E+000
Cesium	5.80E-001	0.00E+000	0.00E+000	6.46E-001
Tellurium	2.80E+000	0.00E+000	0.00E+000	1.35E-001
Barium	5.50E-003	0.00E+000	0.00E+000	2.19E-002
Noble metal	2.25E-003	0.00E+000	0.00E+000	1.20E-001
Lanthanides	4.12E-004	0.00E+000	0.00E+000	5.15E-002
Cerium	1.86E-004	0.00E+000	0.00E+000	5.29E-001
Strontinum	9.45E-003	0.00E+000	0.00E+000	1.16E-001

environment

	thyroid	wbody	skin	CEDE
EAB dose:	6.09E+001	1.45E+000	9.78E-001	2.75E+000
LPZ dose:	4.02E+001	1.50E+000	1.38E+000	1.75E+000

Appendix I8 – Table 1 Max 2-hour EAB TEDE Spreadsheet
(Fumigation X/Q for EAB between 3.5 and 4 hours)

	Accumulative Doses From RADTRAD Results					2-Hour EAB TEDE From Accumulative Doses					
Time Hour	StackBase Release Run 1	StackTop Release Run 2	TBRoof Release Run 3	StackBase ESF Release Run 4	StackTop ESF Release Run 5	StackBase Release Run 1	StackTop Release Run 2	TBRoof Release Run 3	StackBase ESF Release Run 4	StackTop ESF Release Run 5	Total 2HR EAB TEDE rem
0.1	1.73E-07	9.74E-07	2.50E-03	1.23E-07	6.91E-07	1.73E-07	9.74E-07	2.50E-03	1.23E-07	6.91E-07	2.51E-03
0.2	3.98E-06	2.23E-05	1.53E-02	2.87E-06	1.61E-05	3.98E-06	2.23E-05	1.53E-02	2.87E-06	1.61E-05	1.53E-02
0.3	1.77E-05	9.96E-05	3.82E-02	1.30E-05	7.31E-05	1.77E-05	9.96E-05	3.82E-02	1.30E-05	7.31E-05	3.84E-02
0.4	4.68E-05	2.63E-04	7.03E-02	3.49E-05	1.96E-04	4.68E-05	2.63E-04	7.03E-02	3.49E-05	1.96E-04	7.08E-02
0.5	9.56E-05	5.37E-04	1.11E-01	7.25E-05	4.08E-04	9.56E-05	5.37E-04	1.11E-01	7.25E-05	4.08E-04	1.12E-01
0.6	1.67E-04	9.39E-04	1.60E-01	1.29E-04	7.25E-04	1.67E-04	9.39E-04	1.60E-01	1.29E-04	7.25E-04	1.62E-01
0.7	2.66E-04	1.49E-03	2.27E-01	2.08E-04	1.17E-03	2.66E-04	1.49E-03	2.27E-01	2.08E-04	1.17E-03	2.30E-01
0.8	4.03E-04	2.26E-03	3.22E-01	3.14E-04	1.77E-03	4.03E-04	2.26E-03	3.22E-01	3.14E-04	1.77E-03	3.26E-01
0.9	5.90E-04	3.32E-03	4.42E-01	4.53E-04	2.55E-03	5.90E-04	3.32E-03	4.42E-01	4.53E-04	2.55E-03	4.49E-01
1	8.38E-04	4.71E-03	5.87E-01	6.29E-04	3.54E-03	8.38E-04	4.71E-03	5.87E-01	6.29E-04	3.54E-03	5.96E-01
1.1	1.16E-03	6.50E-03	7.55E-01	8.48E-04	4.76E-03	1.16E-03	6.50E-03	7.55E-01	8.48E-04	4.76E-03	7.68E-01
1.2	1.55E-03	8.71E-03	9.46E-01	1.11E-03	6.24E-03	1.55E-03	8.71E-03	9.46E-01	1.11E-03	6.24E-03	9.63E-01
1.3	2.03E-03	1.14E-02	1.16E+00	1.42E-03	8.00E-03	2.03E-03	1.14E-02	1.16E+00	1.42E-03	8.00E-03	1.18E+00
1.4	2.59E-03	1.45E-02	1.39E+00	1.79E-03	1.00E-02	2.59E-03	1.45E-02	1.39E+00	1.79E-03	1.00E-02	1.42E+00
1.5	3.24E-03	1.82E-02	1.64E+00	2.20E-03	1.24E-02	3.24E-03	1.82E-02	1.64E+00	2.20E-03	1.24E-02	1.68E+00
1.6	3.98E-03	2.24E-02	1.91E+00	2.68E-03	1.51E-02	3.98E-03	2.24E-02	1.91E+00	2.68E-03	1.51E-02	1.96E+00
1.7	4.82E-03	2.71E-02	2.20E+00	3.21E-03	1.80E-02	4.82E-03	2.71E-02	2.20E+00	3.21E-03	1.80E-02	2.26E+00
1.8	5.75E-03	3.23E-02	2.51E+00	3.80E-03	2.14E-02	5.75E-03	3.23E-02	2.51E+00	3.80E-03	2.14E-02	2.57E+00
1.9	6.77E-03	3.80E-02	2.83E+00	4.45E-03	2.50E-02	6.77E-03	3.80E-02	2.83E+00	4.45E-03	2.50E-02	2.91E+00
2	7.89E-03	4.43E-02	3.17E+00	5.17E-03	2.91E-02	7.89E-03	4.43E-02	3.17E+00	5.17E-03	2.91E-02	3.26E+00
2.1	9.10E-03	5.11E-02	3.43E+00	5.95E-03	3.34E-02	9.10E-03	5.11E-02	3.43E+00	5.95E-03	3.34E-02	3.53E+00
2.2	1.04E-02	5.84E-02	3.63E+00	6.79E-03	3.82E-02	1.04E-02	5.84E-02	3.62E+00	6.79E-03	3.82E-02	3.73E+00
2.3	1.18E-02	6.61E-02	3.82E+00	7.69E-03	4.32E-02	1.17E-02	6.60E-02	3.78E+00	7.68E-03	4.32E-02	3.91E+00
2.4	1.32E-02	7.41E-02	4.00E+00	8.65E-03	4.86E-02	1.31E-02	7.38E-02	3.93E+00	8.61E-03	4.84E-02	4.07E+00
2.5	1.46E-02	8.23E-02	4.17E+00	9.65E-03	5.42E-02	1.46E-02	8.18E-02	4.06E+00	9.58E-03	5.38E-02	4.22E+00

	Accumulative Doses From RADTRAD Results					2-Hour EAB TEDE From Accumulative Doses					
Time Hour	StackBase Release Run 1	StackTop Release Run 2	TBRoof Release Run 3	StackBase ESF Release Run 4	StackTop ESF Release Run 5	StackBase Release Run 1	StackTop Release Run 2	TBRoof Release Run 3	StackBase ESF Release Run 4	StackTop ESF Release Run 5	Total 2HR EAB TEDE rem
2.6	1.61E-02	9.06E-02	4.33E+00	1.07E-02	6.01E-02	1.60E-02	8.97E-02	4.17E+00	1.06E-02	5.94E-02	4.35E+00
2.7	1.76E-02	9.90E-02	4.48E+00	1.18E-02	6.61E-02	1.74E-02	9.75E-02	4.26E+00	1.16E-02	6.50E-02	4.45E+00
2.8	1.91E-02	1.07E-01	4.63E+00	1.29E-02	7.24E-02	1.87E-02	1.05E-01	4.31E+00	1.26E-02	7.06E-02	4.52E+00
2.9	2.06E-02	1.16E-01	4.77E+00	1.40E-02	7.88E-02	2.00E-02	1.12E-01	4.33E+00	1.36E-02	7.62E-02	4.55E+00
3	2.21E-02	1.24E-01	4.90E+00	1.52E-02	8.53E-02	2.12E-02	1.19E-01	4.32E+00	1.45E-02	8.17E-02	4.55E+00
3.1	2.35E-02	1.32E-01	5.03E+00	1.64E-02	9.19E-02	2.24E-02	1.26E-01	4.28E+00	1.55E-02	8.72E-02	4.53E+00
3.2	2.49E-02	1.40E-01	5.15E+00	1.76E-02	9.87E-02	2.34E-02	1.31E-01	4.21E+00	1.64E-02	9.24E-02	4.47E+00
3.3	2.63E-02	1.48E-01	5.27E+00	1.88E-02	1.06E-01	2.43E-02	1.37E-01	4.11E+00	1.73E-02	9.75E-02	4.39E+00
3.4	2.77E-02	1.56E-01	5.38E+00	2.00E-02	1.12E-01	2.51E-02	1.41E-01	3.99E+00	1.82E-02	1.02E-01	4.28E+00
3.5	2.90E-02	1.63E-01	5.49E+00	2.12E-02	1.19E-01	2.58E-02	1.45E-01	3.84E+00	1.90E-02	1.07E-01	4.14E+00
3.6	3.03E-02	3.06E-01	5.59E+00	2.25E-02	2.59E-01	2.63E-02	2.84E-01	3.67E+00	1.98E-02	2.44E-01	4.25E+00
3.7	3.15E-02	4.45E-01	5.69E+00	2.38E-02	3.99E-01	2.67E-02	4.18E-01	3.48E+00	2.06E-02	3.81E-01	4.33E+00
3.8	3.28E-02	5.79E-01	5.78E+00	2.50E-02	5.40E-01	2.70E-02	5.47E-01	3.27E+00	2.12E-02	5.19E-01	4.38E+00
3.9	3.39E-02	7.10E-01	5.87E+00	2.63E-02	6.82E-01	2.72E-02	6.71E-01	3.04E+00	2.19E-02	6.57E-01	4.41E+00
4	3.51E-02	8.35E-01	5.95E+00	2.76E-02	8.24E-01	2.72E-02	7.91E-01	2.78E+00	2.24E-02	7.95E-01	4.42E+00
4.1	3.62E-02	8.42E-01	6.03E+00	2.89E-02	8.32E-01	2.71E-02	7.91E-01	2.60E+00	2.29E-02	7.98E-01	4.24E+00
4.2	3.72E-02	8.48E-01	6.11E+00	3.02E-02	8.39E-01	2.68E-02	7.89E-01	2.48E+00	2.34E-02	8.01E-01	4.12E+00
4.3	3.82E-02	8.53E-01	6.19E+00	3.15E-02	8.46E-01	2.65E-02	7.87E-01	2.37E+00	2.38E-02	8.03E-01	4.01E+00
4.4	3.92E-02	8.59E-01	6.26E+00	3.28E-02	8.54E-01	2.60E-02	7.85E-01	2.26E+00	2.41E-02	8.05E-01	3.90E+00
4.5	4.02E-02	8.64E-01	6.33E+00	3.41E-02	8.61E-01	2.55E-02	7.82E-01	2.16E+00	2.44E-02	8.07E-01	3.80E+00
4.6	4.11E-02	8.69E-01	6.40E+00	3.54E-02	8.68E-01	2.50E-02	7.79E-01	2.07E+00	2.47E-02	8.08E-01	3.70E+00
4.7	4.20E-02	8.74E-01	6.46E+00	3.67E-02	8.76E-01	2.43E-02	7.75E-01	1.98E+00	2.49E-02	8.09E-01	3.61E+00
4.8	4.28E-02	8.79E-01	6.52E+00	3.80E-02	8.83E-01	2.37E-02	7.72E-01	1.89E+00	2.51E-02	8.10E-01	3.52E+00
4.9	4.36E-02	8.83E-01	6.58E+00	3.93E-02	8.90E-01	2.30E-02	7.68E-01	1.81E+00	2.53E-02	8.11E-01	3.44E+00
5	4.44E-02	8.88E-01	6.64E+00	4.06E-02	8.98E-01	2.23E-02	7.64E-01	1.74E+00	2.54E-02	8.12E-01	3.36E+00
5.1	4.51E-02	8.92E-01	6.70E+00	4.19E-02	9.05E-01	2.16E-02	7.60E-01	1.66E+00	2.56E-02	8.13E-01	3.28E+00

	Accumulative Doses From RADTRAD Results					2-Hour EAB TEDE From Accumulative Doses					
Time Hour	StackBase Release Run 1	StackTop Release Run 2	TBRoof Release Run 3	StackBase ESF Release Run 4	StackTop ESF Release Run 5	StackBase Release Run 1	StackTop Release Run 2	TBRoof Release Run 3	StackBase ESF Release Run 4	StackTop ESF Release Run 5	Total 2HR EAB TEDE rem
5.2	4.59E-02	8.96E-01	6.75E+00	4.32E-02	9.12E-01	2.09E-02	7.56E-01	1.60E+00	2.57E-02	8.14E-01	3.21E+00
5.3	4.66E-02	9.00E-01	6.80E+00	4.45E-02	9.20E-01	2.02E-02	7.52E-01	1.53E+00	2.57E-02	8.14E-01	3.14E+00
5.4	4.72E-02	9.04E-01	6.85E+00	4.58E-02	9.27E-01	1.95E-02	7.48E-01	1.47E+00	2.58E-02	8.14E-01	3.08E+00
5.5	4.79E-02	9.07E-01	6.90E+00	4.71E-02	9.34E-01	1.89E-02	7.44E-01	1.42E+00	2.59E-02	8.15E-01	3.02E+00
5.6	4.85E-02	9.11E-01	6.95E+00	4.84E-02	9.42E-01	1.82E-02	6.05E-01	1.36E+00	2.59E-02	6.83E-01	2.70E+00
5.7	4.91E-02	9.14E-01	7.00E+00	4.97E-02	9.49E-01	1.75E-02	4.69E-01	1.31E+00	2.60E-02	5.50E-01	2.38E+00
5.8	4.97E-02	9.17E-01	7.05E+00	5.10E-02	9.56E-01	1.69E-02	3.38E-01	1.27E+00	2.60E-02	4.16E-01	2.06E+00
5.9	5.02E-02	9.21E-01	7.09E+00	5.23E-02	9.63E-01	1.63E-02	2.11E-01	1.22E+00	2.60E-02	2.82E-01	1.76E+00
6	5.08E-02	9.24E-01	7.13E+00	5.36E-02	9.71E-01	1.57E-02	8.81E-02	1.18E+00	2.60E-02	1.46E-01	1.46E+00
6.1	5.13E-02	9.26E-01	7.18E+00	5.49E-02	9.78E-01	1.51E-02	8.49E-02	1.14E+00	2.60E-02	1.46E-01	1.42E+00
6.2	5.18E-02	9.29E-01	7.22E+00	5.62E-02	9.85E-01	1.46E-02	8.18E-02	1.11E+00	2.60E-02	1.46E-01	1.38E+00
6.3	5.23E-02	9.32E-01	7.26E+00	5.75E-02	9.93E-01	1.40E-02	7.88E-02	1.07E+00	2.60E-02	1.46E-01	1.34E+00
6.4	5.27E-02	9.35E-01	7.30E+00	5.88E-02	1.00E+00	1.35E-02	7.59E-02	1.04E+00	2.60E-02	1.46E-01	1.30E+00
6.5	5.32E-02	9.37E-01	7.34E+00	6.01E-02	1.01E+00	1.30E-02	7.32E-02	1.01E+00	2.60E-02	1.46E-01	1.27E+00
6.6	5.36E-02	9.40E-01	7.38E+00	6.14E-02	1.01E+00	1.26E-02	7.06E-02	9.80E-01	2.60E-02	1.46E-01	1.24E+00
6.7	5.41E-02	9.42E-01	7.41E+00	6.27E-02	1.02E+00	1.21E-02	6.80E-02	9.53E-01	2.60E-02	1.46E-01	1.21E+00
6.8	5.45E-02	9.45E-01	7.45E+00	6.39E-02	1.03E+00	1.17E-02	6.57E-02	9.27E-01	2.59E-02	1.46E-01	1.18E+00
6.9	5.49E-02	9.47E-01	7.49E+00	6.52E-02	1.04E+00	1.13E-02	6.34E-02	9.03E-01	2.59E-02	1.46E-01	1.15E+00
7	5.53E-02	9.49E-01	7.52E+00	6.65E-02	1.04E+00	1.09E-02	6.12E-02	8.80E-01	2.59E-02	1.46E-01	1.12E+00
7.1	5.57E-02	9.51E-01	7.55E+00	6.78E-02	1.05E+00	1.05E-02	5.92E-02	8.59E-01	2.59E-02	1.45E-01	1.10E+00
7.2	5.60E-02	9.53E-01	7.59E+00	6.91E-02	1.06E+00	1.02E-02	5.72E-02	8.38E-01	2.58E-02	1.45E-01	1.08E+00
7.3	5.64E-02	9.55E-01	7.62E+00	7.03E-02	1.06E+00	9.86E-03	5.54E-02	8.17E-01	2.58E-02	1.45E-01	1.05E+00
7.4	5.68E-02	9.57E-01	7.65E+00	7.16E-02	1.07E+00	9.54E-03	5.36E-02	7.98E-01	2.58E-02	1.45E-01	1.03E+00
7.5	5.71E-02	9.59E-01	7.68E+00	7.29E-02	1.08E+00	9.24E-03	5.19E-02	7.78E-01	2.57E-02	1.45E-01	1.01E+00
7.6	5.74E-02	9.61E-01	7.71E+00	7.41E-02	1.09E+00	8.96E-03	5.03E-02	7.60E-01	2.57E-02	1.44E-01	9.89E-01
7.7	5.78E-02	9.63E-01	7.74E+00	7.54E-02	1.09E+00	8.68E-03	4.88E-02	7.42E-01	2.57E-02	1.44E-01	9.69E-01

	Accumulative Doses From RADTRAD Results					2-Hour EAB TEDE From Accumulative Doses					
Time Hour	StackBase Release Run 1	StackTop Release Run 2	TBRoof Release Run 3	StackBase ESF Release Run 4	StackTop ESF Release Run 5	StackBase Release Run 1	StackTop Release Run 2	TBRoof Release Run 3	StackBase ESF Release Run 4	StackTop ESF Release Run 5	Total 2HR EAB TEDE rem
7.8	5.81E-02	9.65E-01	7.77E+00	7.67E-02	1.10E+00	8.42E-03	4.73E-02	7.25E-01	2.56E-02	1.44E-01	9.50E-01
7.9	5.84E-02	9.66E-01	7.80E+00	7.79E-02	1.11E+00	8.17E-03	4.59E-02	7.08E-01	2.56E-02	1.44E-01	9.31E-01
8	5.87E-02	9.68E-01	7.83E+00	7.92E-02	1.11E+00	7.93E-03	4.46E-02	6.92E-01	2.56E-02	1.44E-01	9.13E-01

Appendix I8 – Table 2 Max 2-hour EAB TEDE Spreadsheet
(Fumigation X/Q for EAB between 2.5 and 3 hours)

	Accumulative Doses From RADTRAD Results					2-Hour EAB TEDE From Accumulative Doses					
Time Hour	StackBase Release Run 1	StackTop Release Run 2	TBRoof Release Run 3	StackBase ESF Release Run 4	StackTop ESF Release Run 5	StackBase Release Run 1	StackTop Release Run 2	TBRoof Release Run 3	StackBase ESF Release Run 4	StackTop ESF Release Run 5	Total 2HR EAB TEDE rem
0.1	1.73E-07	9.74E-07	2.50E-03	1.23E-07	6.91E-07	1.73E-07	9.74E-07	2.50E-03	1.23E-07	6.91E-07	2.51E-03
0.2	3.98E-06	2.23E-05	1.53E-02	2.87E-06	1.61E-05	3.98E-06	2.23E-05	1.53E-02	2.87E-06	1.61E-05	1.53E-02
0.3	1.77E-05	9.96E-05	3.82E-02	1.30E-05	7.31E-05	1.77E-05	9.96E-05	3.82E-02	1.30E-05	7.31E-05	3.84E-02
0.4	4.68E-05	2.63E-04	7.03E-02	3.49E-05	1.96E-04	4.68E-05	2.63E-04	7.03E-02	3.49E-05	1.96E-04	7.08E-02
0.5	9.56E-05	5.37E-04	1.11E-01	7.25E-05	4.08E-04	9.56E-05	5.37E-04	1.11E-01	7.25E-05	4.08E-04	1.12E-01
0.6	1.67E-04	9.39E-04	1.60E-01	1.29E-04	7.25E-04	1.67E-04	9.39E-04	1.60E-01	1.29E-04	7.25E-04	1.62E-01
0.7	2.66E-04	1.49E-03	2.27E-01	2.08E-04	1.17E-03	2.66E-04	1.49E-03	2.27E-01	2.08E-04	1.17E-03	2.30E-01
0.8	4.03E-04	2.26E-03	3.22E-01	3.14E-04	1.77E-03	4.03E-04	2.26E-03	3.22E-01	3.14E-04	1.77E-03	3.26E-01
0.9	5.90E-04	3.32E-03	4.42E-01	4.53E-04	2.55E-03	5.90E-04	3.32E-03	4.42E-01	4.53E-04	2.55E-03	4.49E-01
1	8.38E-04	4.71E-03	5.87E-01	6.29E-04	3.54E-03	8.38E-04	4.71E-03	5.87E-01	6.29E-04	3.54E-03	5.96E-01
1.1	1.16E-03	6.50E-03	7.55E-01	8.48E-04	4.76E-03	1.16E-03	6.50E-03	7.55E-01	8.48E-04	4.76E-03	7.68E-01
1.2	1.55E-03	8.71E-03	9.46E-01	1.11E-03	6.24E-03	1.55E-03	8.71E-03	9.46E-01	1.11E-03	6.24E-03	9.63E-01
1.3	2.03E-03	1.14E-02	1.16E+00	1.42E-03	8.00E-03	2.03E-03	1.14E-02	1.16E+00	1.42E-03	8.00E-03	1.18E+00
1.4	2.59E-03	1.45E-02	1.39E+00	1.79E-03	1.00E-02	2.59E-03	1.45E-02	1.39E+00	1.79E-03	1.00E-02	1.42E+00
1.5	3.24E-03	1.82E-02	1.64E+00	2.20E-03	1.24E-02	3.24E-03	1.82E-02	1.64E+00	2.20E-03	1.24E-02	1.68E+00
1.6	3.98E-03	2.24E-02	1.91E+00	2.68E-03	1.51E-02	3.98E-03	2.24E-02	1.91E+00	2.68E-03	1.51E-02	1.96E+00
1.7	4.82E-03	2.71E-02	2.20E+00	3.21E-03	1.80E-02	4.82E-03	2.71E-02	2.20E+00	3.21E-03	1.80E-02	2.26E+00
1.8	5.75E-03	3.23E-02	2.51E+00	3.80E-03	2.14E-02	5.75E-03	3.23E-02	2.51E+00	3.80E-03	2.14E-02	2.57E+00
1.9	6.77E-03	3.80E-02	2.83E+00	4.45E-03	2.50E-02	6.77E-03	3.80E-02	2.83E+00	4.45E-03	2.50E-02	2.91E+00
2	7.89E-03	4.43E-02	3.17E+00	5.17E-03	2.91E-02	7.89E-03	4.43E-02	3.17E+00	5.17E-03	2.91E-02	3.26E+00
2.1	9.10E-03	5.11E-02	3.43E+00	5.95E-03	3.34E-02	9.10E-03	5.11E-02	3.43E+00	5.95E-03	3.34E-02	3.53E+00
2.2	1.04E-02	5.84E-02	3.63E+00	6.79E-03	3.82E-02	1.04E-02	5.84E-02	3.62E+00	6.79E-03	3.82E-02	3.73E+00
2.3	1.18E-02	6.61E-02	3.82E+00	7.69E-03	4.32E-02	1.17E-02	6.60E-02	3.78E+00	7.68E-03	4.32E-02	3.91E+00
2.4	1.32E-02	7.41E-02	4.00E+00	8.65E-03	4.86E-02	1.31E-02	7.38E-02	3.93E+00	8.61E-03	4.84E-02	4.07E+00
2.5	1.46E-02	8.23E-02	4.17E+00	9.65E-03	5.42E-02	1.46E-02	8.18E-02	4.06E+00	9.58E-03	5.38E-02	4.22E+00

2.6	1.61E-02	2.47E-01	4.33E+00	1.07E-02	1.70E-01	1.60E-02	2.46E-01	4.17E+00	1.06E-02	1.69E-01	4.61E+00
2.7	1.76E-02	4.12E-01	4.48E+00	1.18E-02	2.89E-01	1.74E-02	4.11E-01	4.26E+00	1.16E-02	2.88E-01	4.98E+00
2.8	1.91E-02	5.78E-01	4.63E+00	1.29E-02	4.12E-01	1.87E-02	5.75E-01	4.31E+00	1.26E-02	4.11E-01	5.33E+00
2.9	2.06E-02	7.42E-01	4.77E+00	1.40E-02	5.38E-01	2.00E-02	7.39E-01	4.33E+00	1.36E-02	5.36E-01	5.64E+00
3	2.21E-02	9.05E-01	4.90E+00	1.52E-02	6.67E-01	2.12E-02	9.00E-01	4.32E+00	1.45E-02	6.64E-01	5.92E+00
3.1	2.35E-02	9.13E-01	5.03E+00	1.64E-02	6.74E-01	2.24E-02	9.07E-01	4.28E+00	1.55E-02	6.69E-01	5.89E+00
3.2	2.49E-02	9.21E-01	5.15E+00	1.76E-02	6.81E-01	2.34E-02	9.13E-01	4.21E+00	1.64E-02	6.74E-01	5.83E+00
3.3	2.63E-02	9.29E-01	5.27E+00	1.88E-02	6.88E-01	2.43E-02	9.18E-01	4.11E+00	1.73E-02	6.80E-01	5.75E+00
3.4	2.77E-02	9.37E-01	5.38E+00	2.00E-02	6.94E-01	2.51E-02	9.22E-01	3.99E+00	1.82E-02	6.84E-01	5.64E+00
3.5	2.90E-02	9.44E-01	5.49E+00	2.12E-02	7.01E-01	2.58E-02	9.26E-01	3.84E+00	1.90E-02	6.89E-01	5.50E+00
3.6	3.03E-02	9.51E-01	5.59E+00	2.25E-02	7.09E-01	2.63E-02	9.29E-01	3.67E+00	1.98E-02	6.93E-01	5.34E+00
3.7	3.15E-02	9.58E-01	5.69E+00	2.38E-02	7.16E-01	2.67E-02	9.31E-01	3.48E+00	2.06E-02	6.98E-01	5.16E+00
3.8	3.28E-02	9.65E-01	5.78E+00	2.50E-02	7.23E-01	2.70E-02	9.33E-01	3.27E+00	2.12E-02	7.01E-01	4.95E+00
3.9	3.39E-02	9.72E-01	5.87E+00	2.63E-02	7.30E-01	2.72E-02	9.34E-01	3.04E+00	2.19E-02	7.05E-01	4.72E+00
4	0.035069	9.78E-01	5.95E+00	2.76E-02	7.37E-01	2.72E-02	9.34E-01	2.78E+00	2.24E-02	7.08E-01	4.47E+00
4.1	3.62E-02	9.84E-01	6.03E+00	2.89E-02	7.44E-01	2.71E-02	9.33E-01	2.60E+00	2.29E-02	7.11E-01	4.29E+00
4.2	3.72E-02	9.90E-01	6.11E+00	3.02E-02	7.52E-01	2.68E-02	9.32E-01	2.48E+00	2.34E-02	7.13E-01	4.18E+00
4.3	3.82E-02	9.96E-01	6.19E+00	3.15E-02	7.59E-01	2.65E-02	9.30E-01	2.37E+00	2.38E-02	7.16E-01	4.06E+00
4.4	3.92E-02	1.00E+00	6.26E+00	3.28E-02	7.66E-01	2.60E-02	9.27E-01	2.26E+00	2.41E-02	7.18E-01	3.96E+00
4.5	4.02E-02	1.01E+00	6.33E+00	3.41E-02	7.74E-01	2.55E-02	9.25E-01	2.16E+00	2.44E-02	7.19E-01	3.86E+00
4.6	4.11E-02	1.01E+00	6.40E+00	3.54E-02	7.81E-01	2.50E-02	7.65E-01	2.07E+00	2.47E-02	6.11E-01	3.49E+00
4.7	4.20E-02	1.02E+00	6.46E+00	3.67E-02	7.88E-01	2.43E-02	6.05E-01	1.98E+00	2.49E-02	4.99E-01	3.13E+00
4.8	4.28E-02	1.02E+00	6.52E+00	3.80E-02	7.96E-01	2.37E-02	4.44E-01	1.89E+00	2.51E-02	3.83E-01	2.77E+00
4.9	4.36E-02	1.03E+00	6.58E+00	3.93E-02	8.03E-01	2.30E-02	2.84E-01	1.81E+00	2.53E-02	2.64E-01	2.41E+00
5	4.44E-02	1.03E+00	6.64E+00	4.06E-02	8.10E-01	2.23E-02	1.25E-01	1.74E+00	2.54E-02	1.43E-01	2.05E+00
5.1	4.51E-02	1.03E+00	6.70E+00	4.19E-02	8.18E-01	2.16E-02	1.21E-01	1.66E+00	2.56E-02	1.44E-01	1.98E+00
5.2	4.59E-02	1.04E+00	6.75E+00	4.32E-02	8.25E-01	2.09E-02	1.18E-01	1.60E+00	2.57E-02	1.44E-01	1.90E+00
5.3	4.66E-02	1.04E+00	6.80E+00	4.45E-02	8.32E-01	2.02E-02	1.14E-01	1.53E+00	2.57E-02	1.45E-01	1.84E+00
5.4	4.72E-02	1.05E+00	6.85E+00	4.58E-02	8.40E-01	1.95E-02	1.10E-01	1.47E+00	2.58E-02	1.45E-01	1.77E+00
5.5	4.79E-02	1.05E+00	6.90E+00	4.71E-02	8.47E-01	1.89E-02	1.06E-01	1.42E+00	2.59E-02	1.45E-01	1.71E+00

5.6	4.85E-02	1.05E+00	6.95E+00	4.84E-02	8.54E-01	1.82E-02	1.02E-01	1.36E+00	2.59E-02	1.46E-01	1.66E+00
5.7	4.91E-02	1.06E+00	7.00E+00	4.97E-02	8.62E-01	1.75E-02	9.85E-02	1.31E+00	2.60E-02	1.46E-01	1.60E+00
5.8	4.97E-02	1.06E+00	7.05E+00	5.10E-02	8.69E-01	1.69E-02	9.49E-02	1.27E+00	2.60E-02	1.46E-01	1.55E+00
5.9	5.02E-02	1.06E+00	7.09E+00	5.23E-02	8.76E-01	1.63E-02	9.14E-02	1.22E+00	2.60E-02	1.46E-01	1.50E+00
6	5.08E-02	1.07E+00	7.13E+00	5.36E-02	8.83E-01	1.57E-02	8.81E-02	1.18E+00	2.60E-02	1.46E-01	1.46E+00
6.1	5.13E-02	1.07E+00	7.18E+00	5.49E-02	8.91E-01	1.51E-02	8.49E-02	1.14E+00	2.60E-02	1.46E-01	1.42E+00
6.2	5.18E-02	1.07E+00	7.22E+00	5.62E-02	8.98E-01	1.46E-02	8.17E-02	1.11E+00	2.60E-02	1.46E-01	1.38E+00
6.3	5.23E-02	1.07E+00	7.26E+00	5.75E-02	9.05E-01	1.40E-02	7.88E-02	1.07E+00	2.60E-02	1.46E-01	1.34E+00
6.4	5.27E-02	1.08E+00	7.30E+00	5.88E-02	9.12E-01	1.35E-02	7.59E-02	1.04E+00	2.60E-02	1.46E-01	1.30E+00
6.5	5.32E-02	1.08E+00	7.34E+00	6.01E-02	9.20E-01	1.30E-02	7.32E-02	1.01E+00	2.60E-02	1.46E-01	1.27E+00
6.6	5.36E-02	1.08E+00	7.38E+00	6.14E-02	9.27E-01	1.26E-02	7.05E-02	9.80E-01	2.60E-02	1.46E-01	1.24E+00
6.7	5.41E-02	1.08E+00	7.41E+00	6.27E-02	9.34E-01	1.21E-02	6.80E-02	9.53E-01	2.60E-02	1.46E-01	1.21E+00
6.8	5.45E-02	1.09E+00	7.45E+00	6.39E-02	9.41E-01	1.17E-02	6.57E-02	9.27E-01	2.59E-02	1.46E-01	1.18E+00
6.9	5.49E-02	1.09E+00	7.49E+00	6.52E-02	9.49E-01	1.13E-02	6.34E-02	9.03E-01	2.59E-02	1.46E-01	1.15E+00
7	5.53E-02	1.09E+00	7.52E+00	6.65E-02	9.56E-01	1.09E-02	6.13E-02	8.80E-01	2.59E-02	1.46E-01	1.12E+00
7.1	5.57E-02	1.09E+00	7.55E+00	6.78E-02	9.63E-01	1.05E-02	5.92E-02	8.59E-01	2.59E-02	1.45E-01	1.10E+00
7.2	5.60E-02	1.10E+00	7.59E+00	6.91E-02	9.70E-01	1.02E-02	5.72E-02	8.38E-01	2.58E-02	1.45E-01	1.08E+00
7.3	5.64E-02	1.10E+00	7.62E+00	7.03E-02	9.77E-01	9.86E-03	5.54E-02	8.17E-01	2.58E-02	1.45E-01	1.05E+00
7.4	5.68E-02	1.10E+00	7.65E+00	7.16E-02	9.84E-01	9.54E-03	5.36E-02	7.98E-01	2.58E-02	1.45E-01	1.03E+00
7.5	5.71E-02	1.10E+00	7.68E+00	7.29E-02	9.92E-01	9.24E-03	5.20E-02	7.78E-01	2.57E-02	1.45E-01	1.01E+00
7.6	5.74E-02	1.10E+00	7.71E+00	7.41E-02	9.99E-01	8.96E-03	5.03E-02	7.60E-01	2.57E-02	1.45E-01	9.89E-01
7.7	5.78E-02	1.11E+00	7.74E+00	7.54E-02	1.01E+00	8.68E-03	4.88E-02	7.42E-01	2.57E-02	1.44E-01	9.69E-01
7.8	5.81E-02	1.11E+00	7.77E+00	7.67E-02	1.01E+00	8.42E-03	4.73E-02	7.25E-01	2.56E-02	1.44E-01	9.50E-01
7.9	5.84E-02	1.11E+00	7.80E+00	7.79E-02	1.02E+00	8.17E-03	4.60E-02	7.08E-01	2.56E-02	1.44E-01	9.31E-01
8	5.87E-02	1.11E+00	7.83E+00	7.92E-02	1.03E+00	7.93E-03	4.45E-02	6.92E-01	2.56E-02	1.44E-01	9.13E-01

ATTACHMENT 8

NDQ0999980016
Parameters Used in Dose Analyses

ORIGINAL

QA Record

NPG CALCULATION COVERSHEET / CTS UPDATE

REV 0 EDMS/RIMS NO.	CTS TYPE:	EDMS TYPE:	EDMS ACCESSION NO (N/A for REV. 0)
R14981211106	Calculation	Calculations (nuclear)	R14 131023 106

Calc Title: Parameters Used in Dose Analyses

	ORG	PLANT	BRANCH	NUMBER	CUR REV	NEW REV
CALC ID	NUC	BFN	NTB	NDQ0999980016	007	008

CTS UPDATE ONLY ☐ (Verifier and Approval Signatures Not Required)	NO CTS CHANGES ☐ (For calc revision, CTS has been reviewed and no CTS changes required)

UNITS (check one)	SYSTEMS	UNIDS
☒ 0 ☐, 1 ☐, 2 ☐, 3 ☐	999	N/A

DCN,EDC,N/A	APPLICABLE DESIGN DOCUMENT(S)	CLASSIFICATION
N/A	N/A	E

QUALITY RELATED?	SAFETY RELATED? (If yes, QR = yes)	UNVERIFIED ASSUMPTION	SPECIAL REQUIREMENTS AND/OR LIMITING CONDITIONS?	DESIGN OUTPUT ATTACHMENT?	SAR/TS and/or ISFSI SAR/CoC AFFECTED
Yes ☒ No ☐	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒

CALCULATION NUMBER REQUESTOR	PREPARING DISCIPLINE	VERIFICATION METHOD	NEW METHOD OF ANALYSIS
Name: PHONE:	N	Design Review	☐ Yes ☒ No

PREPARER (PRINT NAME AND SIGN)	DATE	CHECKER (PRINT NAME AND SIGN)	DATE
Jun Li as directed by [signature]	10-17-13	Dave Leaver By direction [signature]	10-17-13
VERIFIER (PRINT NAME AND SIGN)	DATE	APPROVAL (PRINT NAME AND SIGN)	DATE
Dave Leaver By direction [signature]	10-17-13	Kevin L. Groom / [signature]	10/22/2013

STATEMENT OF PROBLEM/ABSTRACT

This calculation provides a single document which contains the various input data for BFN dose analyses. Often, parameters may change which are incorporated in one calculation, but not in other similar calculations. This calculation is an attempt to locate the most important and widely referenced data in one location to provide easy access to the information and so that successor calculations may be more easily identified. Revision 6 (Appendix A) provides updated and supplemental input for the application of the Regulatory Guide 1.183 Alternative Source Term (AST).

R008: Appendix B was developed to support Appendix I of NDQ0031920075, Revision 22.

MICROFICHE/EFICHE Yes ☐ No ☒ FICHE NUMBER(S)

NPG CALCULATION COVERSHEET / CTS UPDATE

Page 2

CALC ID	ORG	PLANT	BRANCH	NUMBER	REV
	NUC	BFN	NTB	NDQ0999980016	008

BLDG	ROOM	ELEV	COORD/AZIM	FIRM
NA	NA	NA	NA	WorleyParsons

CATEGORIES

KEY NOUNS (A-add, D-delete)

ACTION (A/D)	KEY NOUN	A/D	KEY NOUN

CROSS-REFERENCES (A-add, C-change, D-delete)

ACTION (A/C/D)	XREF CODE	XREF PLANT	XREF TYPE	XREF NUMBER	XREF REV
A	P	BFN	CALCULATION	NDQ099920010019	3

CTS ONLY UPDATES:
Following are required only when making keyword/cross reference CTS updates and page 1 of form NEDP-2-1 is not included:

PREPARER (PRINT NAME AND SIGN)	DATE	CHECKER (PRINT NAME AND SIGN)	DATE
PREPARER PHONE NO.	EDMS ACCESSION NO. R14 131023 106		

TVAN CALCULATION RECORD OF REVISION	
CALCULATION IDENTIFIER ND-Q0999-980016	
Title	**Parameters Used in Dose Analyses**
Revision No.	DESCRIPTION OF REVISION
0	Initial Issue
1	Revision 1 was performed to fix minor typographical errors and add additional volume data. The changes do not invalidate revision 0, therefore calculations utilizing revision 0 do not need to be revised. Pages changed: 1-5, 10, 15, 17 R1: 17 total pages
2	Revision 2 was performed to add a new case of 200 scfh/valve, 400 maximum MSIV leakage (this is an equivalent of 100 scfh/valve average). Pages changed: 1-3, 13, 14 Pages deleted: none Pages added: none R2:17 total pages
3	Revision 3 was performed to change the 200 scfh/valve (400 max) MSIV leakage to 168 scfh maximum. This is performed as part of corrective action of Corp. PER 99-000069-000. Also, the control room top of stack X/Q values were changed (no longer ARCON96 methodology). This is part of corrective action of BFN PER 00-000813-000. Pages changed: 1-3, 11, 13, 14, 16 Pages added: none Pages deleted: none R3: 17 total pages
4	Revision 4 updates the computer code listing. Also, justification is given for using the same source terms for GE14 and GE11 fuel types (for the same power level). The calculation classification forms were deleted, and all pages were renumbered. Only actual text changes are marked with revision bars. Due to the nature of this revision, no successors will be impacted. R4: 16 total pages pages added: all pages deleted: all pages changed: all The SAR was reviewed by Glenn Henry and no SAR change is required.
5	Revision 5 is issued to add the justification for using the same source term for ATRIUM-10 fuel (for Unit 3, cycle 12). The justification is contained in FANP Document "BFN Unit 3 Cycle 12 FHA and Core-Wide Activity Release Evaluation," (TAG:03:145) December 22, 2003 (added as Reference 61). Pages added: 1a, 2a, 3a, and 17 Pages revised and replaced: 5 and 9 Pages deleted: none Total pages = 20 FSAR and Technical Specification review will be conducted by EDC 60038A.
6	Revision 6 provides Regulatory Guide 1.183 Alternative Source Term input and extends the applicability of the calculation to Unit 1. It also updates the revision for Reference 41. R6: 30 total pages (including 2a, 2b, 2c) Pages added: thirteen (2b, 2c, 17 – 27) Pages deleted: three (1a, 3a, and 5; i.e., TVA Calculation Verification Form) Pages changed: six (1-4, including 2a, and 15) Pages renumbered: all after page 4 (due to deletion of TVA Calculation Verification Form) The SAR was reviewed by W B Crouch and no SAR change is required.

NPG CALCULATION RECORD OF REVISION	
CALCULATION IDENTIFIER NDQ0999980016	
Title	Parameters Used in Dose Analyses
Revision No.	DESCRIPTION OF REVISION
007	This Revision captures the most recent input parameter changes from the LOCA and Control Rod Drop Accidents. A *review of the ,FSAR Technical Specifications, ISFSI SAR and ISFSI CoC was performed by* Wai Law *and found* not to be affected. Pages added: 3a Pages deleted: 2a, 2b and 2c Pages revised: none Pages replaced: 1, 1a, 10, 12, 20, 25, 26 and 27. Total pages: 28
008	Appendix B was developed to support NDQ099920010019, Revision 3 and Appendix I of NDQ0031920075, Revision 22. NDQ099920010019, Revision 3 calculates ex-containment steam line and main condenser flows and removal coefficients based on reduced MSIV leak rates and a reduced main condenser flow area fraction, and Appendix I of NDQ0031920075, Revision 22 calculates control room and offsite doses based on the NDQ099920010019, Revision 3 steam line and main condenser flows and removal coefficients. 10-18-13 SAR and ISFSI SAR have been reviewed by Thomas R Hefner and this revision of the calculation does not impact the SAR or the ISFSI SAR. Tech Specs and ISFSI CoC have been reviewed and determined not to be impacted. Successor Calculations impacted by this revision MDQ0001870126 Evaluation of MSSRV Inlet Piping And MS Drain Line Piping Size NDQ0000890013 Post-LOCA Main Control Room Gamma Dose From Secondary Containment and Core Spray Piping NDQ0031890035 Dose During A Mission On Outside The Main Control Room NDQ0031920075 Control Room And Offsite Doses Due To A LOCA NDQ0031920117 Control Room Emergency Ventilation System (CREVS) Filter Dose NDQ0043900029 Post Accident Sampling System Doses Pages added: Appendix B page B-1 Pages deleted: None Pages revised: None Pages replaced: 1, 2, 3a, 4, 5 Total pages: 29

NPG CALCULATION TABLE OF CONTENTS

Calculation Identifier: NDQ0999980016	Revision:	008

TABLE OF CONTENTS

NPG COMPUTER INPUT FILE
STORAGE INFORMATION SHEET

Document NDQ0999980016	Rev. 008	Plant: BFN	

Subject:

Parameters Used in Dose Analyses

☐ Electronic storage of the input files for this calculation is not required. Comments:

☒ Input files for this calculation have been stored electronically and sufficient identifying information is provided below for each input file. (Any retrieved file requires re-verification of its contents before use.)

The Word files utilized in revision 008 are permanently stored in FILEKEEPER file # 322641

☐ Microfiche/eFiche

TVAN COMPUTER OUTPUT
MICROFICHE INFORMATION SHEET

Document ND-Q0999-980016	Rev. 006	Plant: BFN	

Subject:
Parameters Used in Dose Analyses

Microfiche Number	Description
	There are no computer runs associated with this calculation.

Purpose

The purpose of this calculation is to provide a single document which contains the various input data for BFN dose analyses. This will provide some indication of which calculations may be affected by any change of these parameters.

Introduction

Often, parameters may change which are incorporated in one calculation, but not in other similar calculations. This calculation is an attempt to locate the most important and widely referenced data in one location to provide easy access to the information and so that successor calculations may be more easily identified.

Assumptions

There are no assumptions in this calculation

Special Requirements/Limiting Conditions

There are no special requirements or limiting conditions in this calculation.

Design Input Data

Radiation Computer Codes

The following are the QA computer codes used by TVA for BFN:

Computer Code STPISOTP R1, code I.D. 262342 (ref.1)
Computer Code STP R6, code I.D. 262165 (ref.2)
Computer Code QADISOTP R1, code I.D. 262343 (ref.3)
Computer Code QAD-P5Z R6, code I.D. 262361 (ref.4)
Computer Code PARINT R1, code I.D. 262350 (ref.5)
Computer Code PATH R1, code I.D. 262374 (ref.6)
Computer Code COROD R6, code I.D. 262347 (ref.7)
Computer Code FENCDOSE R4,code I.D. 262358 (ref.8)
Computer Code ITS 2.1 R2, code I.D. 262448 (ref.9)
Computer Code PLATEOUT R1, code I.D. 262408 (ref.10)
Computer Code BETAISOT R1, code I.D. 262464 (ref.11)

TVA

Calculation No. ND-Q0999-980016	Rev: 006	Plant: BFN	Page: 8 of 27
Subject: Parameters Used in Dose Analyses		Prepared:	Date:
		Checked:	Date:

Source Terms

The following is a listing of the end of life core inventory of the critical isotopes for BFN for 1400 EFPD (24 month fuel cycle), 4.1 weight % U-235 enrichment, 3458 MWt, GE11 fuel as determined by the computer code ORIGEN. The information was transmitted to TVA by GE (reference 13). The transmittal contains information for other enrichments, additional burnup cases, and various decay times. This inventory needs to be multiplied by 1.02 for control room and offsite analyses. This is to account for 102% power per Regulatory Guide 1.49 (ref.12). While the isotope inventories are not exactly a linear function of power, this small increase will not result in significant error since the short half lives of the isotopes used for the control room and offsite doses (iodines and noble gasses) will be in equilibrium at the end of cycle (ref.54). Section 11.6 of GE-NE-L12-00889-00-01P (ref.60), for the same power level, the differences in source terms in GE-11 and GE-14 fuel types are insignificant. Therefore, one may use the following source terms, for 3458 MWt, for GE11 or GE14 fuel. An evaluation by Framatome (ref. 61) concludes that, since the ATRIUM-10 fuel is between the GE13 and GE14 in weight and enrichment and the core wide burnup for Unit 3 Cycle 12 is limited to be less than 1400 EFPD, the GE source term information is applicable to the initial cycle (U3C12) with ATRIUM-10 fuel. The following is the source term information needed for design basis radiological dose analyses:

	Curies		Curies		Curies
Kr-83m	1.127E7	Rb-88	6.413E7	Sn-130	3.343E7
Kr-85m	2.351E7	Rb-89	8.204E7	Sb-127	1.044E7
Kr-85	1.359E6	Rb-90m	1.881E7	Sb-129	3.073E7
Kr-87	4.481E7	Rb-90	7.933E7	Sb-130m	4.431E7
Kr-88	6.303E7	Rb-91	9.946E7	Sb-130	9.976E6
Kr-89	7.653E7	Se-84	1.866E7	Sb-133	5.356E7
Kr-90	7.554E7	Sr-89	8.475E7	Te-125m	3.902E5
Xe-131m	1.050E6	Sr-90	1.085E7	Te-127m	1.389E6
Xe-133m	5.956E6	Sr-91	1.069E8	Te-127	1.036E7
Xe-133	1.847E8	Sr-92	1.166E8	Te-129m	4.502E6
Xe-135m	3.761E7	Sr-93	1.331E8	Te-129	3.024E7
Xe-135	6.610E7	Sr-94	1.260E8	Te-131m	1.367E7
Xe-137	1.655E8	Y-90	1.122E7	Te-131	8.327E7
Xe-138	1.552E8	Y-91m	6.206E7	Te-132	1.333E8
Xe-139	1.210E8	Y-91	1.100E8	Te-133m	6.830E7
Xe-140	7.878E7	Y-92	1.171E8	Te-133	1.116E8
		Y-93	1.366E8	Te-134	1.549E8
I-130	3.735E6	Y-94	1.383E8	Ba-137m	1.424E7
I-131	9.378E7	Y-95	1.494E8	Ba-139	1.686E8
I-132	1.355E8	Y-96	1.422E8	Ba-140	1.629E8
I-133	1.898E8	Zr-95	1.542E8	Ba-141	1.529E8
I-134	2.081E8	Zr-97	1.554E8	Ba-142	1.445E8
I-135	1.778E8	Nb-95	1.549E8	La-140	1.713E8
I-136m	4.945E7	Nb-97m	1.474E8	La-141	1.536E8
		Nb-97	1.568E8	La-142	1.480E8
Br-83	1.124E7	Mo-99	1.767E8	La-143	1.407E8
Br-84m	7.088E5	Tc-99m	1.547E8	Ce-141	1.546E8
Br-84	1.934E7	Tc-99	1.901E3	Ce-143	1.417E8
Br-85	2.319E7	Tc-101	1.597E8	Ce-144	1.278E8
Br-87	3.776E7	Ru-103	1.484E8	Ce-145	9.671E7
Cs-134	2.508E7	Ru-105	1.040E8	Pr-143	1.375E8
Cs-135	8.679E1	Ru-106	6.096E7	Pr-144	1.285E8
Cs-136	7.868E6	Ru-107	6.022E7	Pr-145	9.675E7
Cs-137	1.503E7	Rh-103m	1.337E8		
Cs-138	1.723E8	Rh-105m	2.911E7		
Cs-139	1.632E8	Rh-105	9.791E7		
Cs-140	1.470E8	Rh-106	6.519E7		
Cs-141	1.090E8	Rh-107	6.052E7		

X/Q Values

The following are the control room and offsite dispersion coefficients (X/Q) for BFN. All units are in sec/m^3:

EAB (0-2 hr, 1465 m, ref. 32):

Fumigation Top of Stack Release: 2.35E-5 (for 0-30 min release only)
Top of Stack Release: 1.19E-6
Bottom of Stack Release: 2.62E-4
Building Releases: 2.62E-4 (this value is for the Turbine Building, however is valid for all building releases due to the methodology of determining the X/Q value)

LPZ (3200m, ref.32):

	0-2 hr	2-8 hr	8-24 hr	1-4 day	4-30 day
Fumigation Top of Stack:	1.26E-5 (0-30 min only)				
Top of Stack Release:	1.13E-6	5.75E-7	4.10E-7	1.97E-7	6.88E-8
Bottom of Stack Release:	1.31E-4	6.61E-5	4.69E-5	2.23E-5	7.96E-6
Building Releases:	1.31E-4	6.61E-5	4.69E-5	2.23E-5	7.96E-6

Control Room (ref.47,49,50)

The control room X/Q values were developed using the ARCON96 code (except for top of stack and top of stack fumigation). Note that these values <u>do not</u> include the factor of 2 allowed by the Standard Review Plan section 6.4 (ref.56, page 6.4-10). Since the intakes are on opposite side of the building, and the makeup flow is equally distributed from each intake, the dilution due to the other intake in effect will reduce the dose by a factor of 2. See reference 47 (section report "Technical Approach to Determine X/Q Values Under Simultaneous Contamination of Browns Ferry CREVS Intakes 1 and 3") for more discussion on the applicability of the factor of 2.

	Unit 1 (West)	Unit 3 (East)	
Top of Stack Release (ref.59):			
0-30 min:	3.40E-5	3.02E-5	(fumigation conditions, ref.50)
30 min - 2 hr:	9.08E-13	1.41E-7	(non-fumigation, ref.59)
2 hr - 8 hr:	3.41E-13	4.50E-8	
8 hr - 1 day:	2.09E-13	2.54E-8	
1 day - 4 day:	7.21E-14	7.36E-9	
4 day - 30 day:	1.57E-14	1.24E-9	
Base of Stack Release (ref.49):			
0-30 min:	2.00E-4	8.60E-5	
30 min - 2 hr:	2.00E-4	8.60E-5	
2 hr - 8 hr:	1.28E-4	6.46E-5	
8 hr - 1 day:	5.72E-5	2.80E-5	
1 day - 4 day:	4.05E-5	2.00E-5	
4 day - 30 day:	3.09E-5	1.53E-5	
Turbine Building Roof Ventilators Release (ref.49):			
0 - 2 hr:	1.20E-4	2.17E-4	
2 hr - 8 hr:	9.96E-5	1.64E-4	
8 hr - 1 day:	4.85E-5	7.89E-5	
1 day - 4 day:	3.15E-5	4.33E-5	
4 day - 30 day:	2.02E-5	3.35E-5	

Turbine Building Exhaust Release (ref.51):

	0-2 hr	2-8 hr	8-24 hr	1-4 day	4-30 day
U1 Turbine Bldg Exh. /U1 CREVS	3.22E-4	2.77E-4	1.31E-4	7.91E-5	6.10E-5
U3 Turbine Bldg Exh /U3 CREVS	2.05E-4	1.12E-4	5.45E-5	3.28E-5	2.26E-5
U2 Turbine Bldg Exh /U1 CREVS	1.53E-4	1.32E-4	6.39E-5	3.90E-5	2.80E-5

Refueling Vent Releases (ref.51):

	0-2 hr	2-8 hr	8-24 hr	1-4 day	4-30 day
U1 Refuel Floor Vent/U1 CREVS	4.60E-4	3.51E-4	1.57E-4	1.12E-4	7.90E-5
U3 Refuel Floor Vent/U3 CREVS	3.99E-4	2.74E-4	1.28E-4	8.47E-5	5.90E-5
U2 Refuel Floor Vent/U3 CREVS	1.46E-4	8.65E-5	3.75E-5	2.56E-5	1.78E-5

Reactor Building Vent Releases (ref.51):

	0-2 hr	2-8 hr	8-24 hr	1-4 day	4-30 day
U1 Reactor Bldg Vent/U1 CREVS	3.97E-4	3.27E-4	1.47E-4	9.57E-5	7.14E-5
U3 Reactor Bldg Vent/U3 CREVS	3.00E-4	1.66E-4	8.11E-5	5.18E-5	3.51E-5
U2 Reactor Bldg Vent/U3 CREVS	1.11E-4	6.56E-5	2.80E-5	1.91E-5	1.35E-5

Pertinent Flow/Leakage Rates

SGTS exhaust Flow: 24,750 cfm. This value is for 3 SGTS trains running and was determined based on test data. The 2 SGTS trains case will result in a slower release rate, and therefore allows more holdup and associated decay. Also, any radioisotopes released later in the accident will have more favorable X/Q values. The use of 3 SGTS trains is therefore conservative. The value of 24,750 is based on reference 40 value of 22,500 + 10%. The test data indicated the value is actually between 22,500 cfm and 22,000 cfm. The 22,500 cfm value is chosen for conservatism.

Hardened Wetwell Valve (HWWV) Leakage: 10 scfh, ref. 24. Note: The HWWV valves are periodically tested via the Appendix J test program to determine their leakage at pressures typical of the peak pressure following a LOCA. Reference 24 states that the maximum leakage for these valves is 10scfh. The leakage of the valves start at the beginning of the accident. However, the lines are 14" sch 30 (ID-13.25", ref.26) and are over 500 feet long (ref.33), therefore the travel time from the valves to the stack is (assuming plug flow) $\pi(13.25''/12\text{in/ft})^2 * 500\text{ft}/(4 * 10\text{cfh}) = 47.88$ hr. A delay of 8 hours for the start of the leakage is acceptable.

Base of Stack Leakage: 10 scfm, ref. 17.
20 cfm for AST LOCA & AST CRDA per Refs. A-42 & A-45 | R007

Control Room Makeup Flow Rate: 3000 cfm, ref.22a, 22b
0 cfm for AST LOCA & AST CRDA per Refs. A-42 & A-45 | R007

Control Room Unfiltered Inleakage: 3717 cfm, ref. 30
6717 cfm for AST LOCA & AST CRDA per Refs. A-42 & A-45 | R007

Containment Atmospheric Dilution (CAD) System Flow Rate: 139 cfm for 24 hrs at 10 days, 20 days, 29 days, ref.19,20. Note: the last time period is actually 30 days, but for conservatism and to include in the 30 day time period of interest, use 29 days.

MSIV leakage = 11.5 scfh/valve under testing conditions of 25 psig, ref.28,29. An additional case of 168 scfh total is also determined.

CALCULATE THE MSIV LEAK RATE

Use the Darcy equation for compressible flow (Crane TP-410 equation 3-20, ref.55)

$$q'_h = 24700\frac{Y}{S_g}d^2\sqrt{\frac{\Delta P\rho}{K}}$$

where

q'_h = leak rate [cfh]
Y= net expansion factor for compressible flow through orifices, nozzles, or pipe
S_g= specific gravity of a gas relative to air
d= internal diameter of pipe [inches]
P= pressure [psia]
ρ= density of fluid, lbs per cuft
K= resistance coefficient

Assume constant leak characteristics:

$$q'_h = 24700\frac{Y}{S_g}\frac{d^2}{\sqrt{K}}\sqrt{\Delta P\rho}$$

For maximum leak flow, Y=1.0 and for air S_g = 1.0

$$q'_h = 24700\frac{d^2}{\sqrt{K}}\sqrt{\Delta P\rho}$$

For two conditions, 1 and 2:

$$q'_1 = 24700\frac{d_1^2}{\sqrt{K_1}}\sqrt{\Delta P_1\rho_1}$$

$$q'_2 = 24700\frac{d_2^2}{\sqrt{K_2}}\sqrt{\Delta P_2\rho_2}$$

Assuming constant leak path characteristics :

$$\frac{d_1^2}{\sqrt{K_1}} = \frac{d_2^2}{\sqrt{K_2}}$$

Then:

$$q'_2 = q'_1\frac{\sqrt{\Delta P_2\rho_2}}{\sqrt{\Delta P_1\rho_1}}$$

Calculate the air densities assuming ideal gas law:

$$\rho = \frac{144P}{RT}$$

where

R= Individual gas constant = 55.2 for nitrogen (Crane page A-8)

The MSIV leakage is therefore calculated as:

$$q'_2 = q'_1\left[\frac{\sqrt{\Delta P_2\rho_2}}{\sqrt{\Delta P_1\rho_1}}\right]$$

Using the following conditions based on the Technical Specification SR 3.6.1.3.10, ref.28, one can then calculate the time dependent leak during the LOCA

T.S. condition:
P = 25 psig = 39.696 psia
T = 68□F
q' = 11.5 scfh (standard conditions are defined as 68□F and 1 atm, ANSI/ANS-56.8-1994, ref.57)
  = 11.5 scfh*(14.696 psi)/(25psig+14.696 psi) ** (alternate case of 168 scfh total was determined)
  = 4.257 cfh at the above Technical Specification condition of P=25 psig and T=68□F

** P_1V_1=nRT_1 for constant mass (nR=constant)

$$P_1V_1/T_1=P_2V_2/T_2$$

or $$V_2= P_1V_1T_2/(P_2T_2) = P_1V_1/P_2 \quad \text{for } T_1=T_2$$

The following time dependent pressures and temperatures are taken from ref.44:

Tech Spec condition:

P psig	psia	T-F	T-R	R	density	q' cfh	q' scfh
25	39.696	68	528	55.2	0.19613	4.257	11.5 or 100 scfh(average)

Leak at various times

Time-day	time-hr	P psig	P psia	T - F	T - R	Den	11.5 scfh/valve q (=/line)	q*4 (=total)	168 scfh max total q (total)
0.000399	0.009576	36.804	51.5	282.8	742.8	0.18087	4.96	19.84	72.47
0.00051	0.01224	37.404	52.1	283.6	743.6	0.18278	5.03	20.11	73.44
0.000762	0.018288	37.704	52.4	284	744	0.18373	5.06	20.24	73.93
0.000777	0.018648	37.704	52.4	284	744	0.18373	5.06	20.24	73.93
0.003044	0.073056	33.004	47.7	278	738	0.16861	4.54	18.14	66.26
0.006429	0.154296	13.204	27.9	224.7	684.7	0.10630	2.28	9.11	33.28
0.011746	0.281904	8.804	23.5	180	640	0.09579	1.77	7.06	25.79
0.036836	0.884064	9.204	23.9	175.7	635.7	0.09808	1.83	7.31	26.69
0.22228	5.33472	9.804	24.5	177.3	637.3	0.10029	1.91	7.63	27.85
0.46454	11.14896	8.104	22.8	167	627	0.09486	1.69	6.74	24.63
1	24	5.704	20.4	152.3	612.3	0.08691	1.35	5.42	19.78
2	48	4.304	19	140.3	600.3	0.08257	1.15	4.58	16.74
5	120	3.404	18.1	130	590	0.08003	1.00	4.01	14.66
10	240	2.504	17.2	118.6	578.6	0.07755	0.85	3.39	12.38
40	960	2.004	16.7	111.7	571.7	0.07620	0.75	3.01	10.98
60	1440	1.804	16.5	108	568	0.07578	0.71	2.84	10.39
100	2400	1.604	16.3	105.5	565.5	0.07519	0.67	2.67	9.75

]Note: the above MSIV leakage does not include CAD pressurization. This is conservative for the application where the MSIV leakage is used as a removal term only. For applications where the MSIV effluent is of concern, then the CAD must be taken into account.

Turbine Roof Exhaust Rate: 144,000 cfm, ref.16a, 16b, 16c.

Turbine Building Exhaust Rate: 125,000 cfm, ref.16a, 16b, 16c.

ECCS Leakage Into Reactor Building: 5 gpm, ref.25. Note, the reference 25 value is actually 1 gpm, however the 5 gpm is to be used for conservatism and exceeds the SRP 15.6.5 Appendix B, ref.53, requirement of doubling the maximum ECCS operational leakage.

For AST, ECCS Leakage is 20 gpm per Ref. A-42. | R007

Reactor Building Exhaust (normal ventilation): 95,000 cfm, ref.39a, 39b, 39c. Note that the U2 flow is 94,000 cfm. The use of 95,000 cfm for all units is conservative.

Refuel Floor Exhaust (normal ventilation): 45,000 cfm, ref.39 a, 39b, 39c. Of this flow, 20,000 cfm (≅ 18,000 + 10%) is from the spent fuel pit area. Under some conditions (i.e. if the operators align the ductwork), 10,000 cfm (≅ 9,000 + 10%) may come from the area above the core during refueling operation.

Pertinent Volumes

Turbine Building Free Volume: 2,100,000 cuft, ref. 31, Note: this entire volume may be used as the mixing volume for a LOCA since the leakage into the building occurs over several locations and the exhaust vents are spread over the entire length of the Turbine Building. This volume is for the accident unit turbine deck only.

Reactor Building Free Volume: 1.335E6 cuft/unit, ref.38

Refueling Zone Free Volume = 2.949E6 cuft, ref.38

Reactor Building + Refueling Floor Mixing Volume: U2/U3: 1,931,502 cuft, ref.18. Note: Use of this volume is for when the SGTS is in operations since the SGTS takes suction from both the Reactor Building and the Refueling Floor Free Volume. The SGTS intake consists of 70% from Refueling Floor and 30% Reactor Building. If unit 1 is the accident unit, then the mixing volume is 1,311,209 cuft (ref.18, 690917 cuft reactor building + 620292 cuft refuel zone).

Control Room Free Volume: 210,000 cuft (includes U1, U2, and U3). This is based on the dimensions below (see Other Data section) with a factor of 80% included to account for equipment and walls. The value is then rounded. (464.5'*36.83'*15.33')*0.8 = 2.098E5 ≅ 2.1E5 cuft, ref.27a, 27b, 27c, 27d.

Drywell and Torus Free Volume: 283,000 cuft, ref.43.

ECCS water (mixing) volume: 141,260 cuft. This ECCS mixing volume consists of the following sources:

a) Reactor Coolant System volume
b) Torus water volume
c) RHR System volume
d) CS System volume.

The Reactor coolant system volume can be determined from MD-Q0063-920470 (ref.41). Attachment C gives the total weight of water in the vessel, recirculation loops, and RHR system at 70 deg F as 1,200,000 lbs. This converts to:

$(1{,}200{,}000 lb_m \text{ water}) \times (0.016050 ft^3/lb_m \text{ water}) = \underline{19260\ ft^3}$

where 70°F water specific volume is $0.016050 ft^3/lb_m$; reference 42

The torus water volume is determined at the minimum Technical Specification level of -7.25 inches from ND-Q0999-880163, ref.43. Sheet 56 of ref. 43 lists the total volume of the wetwell as 251,000 ft^3 and the air volume as 129,000 ft^3 with the minimum allowable water in the wetwell. This gives a minimum water volume of 122,000 ft^3.

The CS system is minimal with respect to the above volumes and will be neglected. This give a total ECCS mixing volume of:

$$122{,}000\ ft^3 + 19260\ ft^3 = \underline{141{,}260\ ft^3}$$

Stack Room Free Volume: 69120 cuft, ref.23. Note: use 50% (34560 cuft) of this volume for incomplete mixing.

Condenser Free Volume: 136,000 cuft, ref.58

Low Pressure Turbine Free Volume: 51,000 cuft, ref.58

Other Data:

SGTS Charcoal Filter Efficiency: 90% organic and inorganic iodine, ref.34.
CREVS Charcoal Filter Efficiency: 90% organic and inorganic iodine, ref.21.
Control Room Dimensions: 464.5' x 36.83' x 15.33', ref.27a, 27b, 27c, 27d.
Control Room Ceiling Thickness: 2.25' of concrete, ref.27c, 27d
Control Room Occupancy Factors: 100% 0-24 hours, 60% 1-4 days, 40% 4-30 days, ref.46.
FCO-64-9, -10 Damper Closure Time: 10 sec, ref.48a, 48b in conjunction with ref.39
Breathing Rates (ref.52): 0-8 hr: 3.47E-4 m^3/sec
8-24 hr: 1.75E-4 m^3/sec
24 hr-30day: 2.32E-4 m^3/sec

References

1. Computer Code STPISOTP R1, code I.D. 262342
2. Computer Code STP R6, code I.D. 262165
3. Computer Code QADISOTP R1, code I.D. 262343
4. Computer Code QAD-P5Z R6, code I.D. 262361
5. Computer Code PARINT R1, code I.D. 262350
6. Computer Code PATH R1, code I.D. 262374
7. Computer Code COROD R6, code I.D. 262347
8. Computer Code FENCDOSE R4,code I.D. 262358
9. Computer Code ITS 2.1 R2, code I.D. 262448
10. Computer Code PLATEOUT R1, code I.D. 262408
11. Computer Code BETAISOT R1, code I.D. 262464
12. Regulatory Guide 1.49 "Power Levels of Water-Cooled Nuclear Power Plants"
13. Memorandum from Dale E. Porter (GE) to Lee Williams dated March 24 1995 "Revised Source Terms" RIMS# W79 950324002
14. Memorandum from C.E.Cronan (Stone and Webster) to H.Lee Williams dated April 30, 1998 "BROWNS FERRY NUCLEAR STATION RESPONSE TO NRC QUESTIONS ON ATMOSPHERIC DISPERSION FACTORS/CONTROL ROOM HABITABILITY ATMOSPHERIC DISPERSION FACTOR CALCULATIONS" RIMS# R92 980504 963 (not used)
15. ND-Q0031-920066 R1 "Turbine Building Chi/Q Values For Relocated CR Air Intakes" (not used)

16a. BFN drawing 1-47E865-3 R8

16b. BFN drawing 2-47E865-3 R14

16c. BFN drawing 3-47E865-3 R16

17. Test Instruction 0-TI-225, "Stack Backdraft Isolation Damper Leak Rate Testing"
18. MD-Q0065-920473 R1 "Estimated Mixing Volume and SGTS Flow During a Design Basis Accident on Unit 2 With the Equipment Hatches Removed"
19. Significant Conditions Report SCRBFNEEB8510 R2 BFNP Units 1, 2, & 3 RIMS# B22 870327 019
20. Memorandum from R.J. Smith, Project Engineer, to Guy G. Campbell, Plant Manager, dated September 28, 1989, "BFN-Nuclear Engineering (NE) Position Concerning the Use of Containment Atmosphere Dilution (CAD) Following a Loss of Coolant Accident (LOCA)" RIMS# B22 890928 003
21. Browns Ferry Nuclear Plant Units 1, 2, 3 Technical Specifications , "CREV System", Surveillance Requirement 3.7.3.2

22a. BFN drawing 0-47E865-4 R57

22b. BFN drawing 2-47E2865-4 R13.

23. ND-Q0065-920078 R0, "Determine the Free Volume in the SGTS Stack at Elevation 568 ft to 597.5 ft"
24. Test Instruction 0-TI-360, "Containment Leak Rate Program"
25. Memorandum from J.D Shaw to R.J Moll dated June 17, 1998 "Browns Ferry Nuclear Plant (BFN) - Emergency Core Cooling System (ECCS) Leakage" RIMS# R92 980617 916
26. Perry's Chemical Engineers' Handbook, 6th ed.

27a. BFN drawing 0-47E200-16 R7

27b. BFN drawing 0-47E605-1 R20

27c. BFN drawing 3-41N1001 R0

27d. BFN drawing 41N701 RA

28. Browns Ferry Nuclear Plant Units 1, 2, and 3 Technical Specifications, "Containment Systems", Surveillance Requirement 3.6.1.3.10
29. Letter from A.L. Jenkins to J.L. Kamphouse, "Browns Ferry Control Room Dose Calculations in Accordance with the BWROG Radiological Dose Methodology (11.5 scfh per Steam Line) Revision 1" dated August 28, 1992, with attachment "Browns Ferry Nuclear Plant Calculation of LOCA Doses to the Control Room from MSIV Leakage' DRF A00-04146 Section C, Performed by GE Nuclear Energy, August 1992. RIMS# R92 920904 001
30. MD-Q0031-920154 R0, "Evaluation of Habitability Zone Unfiltered Inleakage"

31. Letter from J.R.Rupert to Patrick P. Carier, dated July 8, 1991, "BFNP - Boiling Water Reactor Owner's Group (BWROG) Plant - Specific Radiological Dose Calculation Data Sheets - MSIV Leakage' with attached data sheets RIMS# B22 910708002
32.Memorandum From C.E.Cronan (Stone and Webster) to J.D.McCamy, on June 29, 1998 "Browns Ferry Nuclear Station Response to NRC Questions on Atmospheric Dispersion Factors/Control Room Habitability Atmospheric Dispersion Factor Calculations - Task II.C and II.D" RIMS# R92 980707 937
33. BFN drawing 0-17E401-11 R1
34. Browns Ferry Nuclear Plant Units 1, 2, 3 Technical Specifications, "SGT System" Surveillance Requirement 3.6.4.3.2
35. not used
36. not used
37. not used
38. MD-Q0000-88280 R0 "Reactor Building Free Volumes"
39a. BFN drawing 0-47E865-11 R23
39b. BFN drawing 3-47E865-12 R38
39c. BFN drawing 2-47E2865-12 R32
40. BF PER 98-005696-000 Final Calibration Report
41. MD-Q0063-920470, R3 "Standby Liquid Control System - Boron-10 Requirements"
42. Combustion Engineering Steam Tables, Tenth Printing
43. ND-Q0999-880163, R1 "Calculation of the Volume of the Drywell and the Suppression Pool (Wetwell)"
44. Letter from Dale E. Porter to E. Hartwig dated April 1, 1998, BFSE 98-022 "Final Power Uprate Task Report 4 Primary Containment System Evaluation" RIMS# W79 980401 001, with attachment GE-NE-B13-01866-4
45. BFN drawing 3-47E225-100 R4 (not used)
46. 13th AEC Air Cleaning Conference "Nuclear Power Plant Control Room Ventilation System Design for Meeting General Criterion 19" K.G.Murphy and K.M.Campe
47. Memorandum from C.E.Cronan (Stone and Webster) to Don McCamy dated July 15, 1998 "Browns Ferry Nuclear Station Response to NRC Questions on Atmospheric Dispersion Factors/Control Room Habitability Atmospheric Dispersion & Iodine Deposition Modeling Reports and Proposed Response to NRC Request B.2" RIMS# R92 980724 974
48a. Design Criteria BFN-50-7064B R6 "Reactor Building Ventilation System - Units 2 and 3"
48b. Design Criteria BFN-50-7064C R7 "Secondary Containment"
49.Memorandum From C.E.Cronan (Stone and Webster) to J.D.McCamy, on May 29, 1998 "Browns Ferry Nuclear Station Response to NRC Questions on Atmospheric Dispersion Factors/Control Room Habitability Atmospheric Dispersion Factor Calculations - Task IIB" RIMS# R92 980608 900
50. Memorandum From C.E.Cronan (Stone and Webster) to J.D.McCamy, on April 3, 1998 "Browns Ferry Nuclear Station Response to NRC Questions on Atmospheric Dispersion Factors/Control Room Habitability Atmospheric Dispersion Factor Calculations" RIMS# R92 980414 949
51. Memorandum From C.E.Cronan (Stone and Webster) to J.D.McCamy, on July 31, 1998 "Browns Ferry Nuclear Station Response to NRC Questions on Atmospheric Dispersion Factors/Control Room Habitability Atmospheric Dispersion Factor Calculation to Support Proposed Response to NRC Request B.2" RIMS# R92 980804 982
52. Regulatory Guide 1.3 R2 "Assumptions Used For Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors"
53. NUREG-0800 "Standard Review Plant" section 15.6.5
54. Memorandum from Dale E. Porter (GE) to E. Hartwig dated October 30, 1998, "Transmittal of Radiological Scaling Factors" RIMS# W79 981030 001
55. Crane Technical Paper 410 "Flow of Fluids Through Valves, Fittings, and Pipe"
56. NUREG-0800 "Standard Review Plan" section 6.4
57. ANS/ANSI-56.8-1994 "Containment System Leakage Testing Requirements"
58. Memorandum from J.R.Rupert to Patrick P. Carier on July 8, 1991, "Browns Ferry Nuclear Plant (BFN) - Boiling Water Reactor Owner's Group (BWROG) Plant - Specific Radiological Dose Calculations Data Sheets -MSIV Leakage" RIMS# B22 910708 002
59. Memorandum from C.E.Cronan to Lee Williams dated February 3, 2000 "Browns Ferry Nuclear Station Elevated Release Atmospheric Dispersion Factors Transmittal - Atmospheric Dispersion Factor Calculations" RIMS# R47 000204 002
60. GE-NE-L12-00889-00-01P Revision 0 "GE14 Fuel Design Cycle-Independent Analyses For Browns Ferry Units 2 and 3" RIMS # L32 020208 800

61. FANP Document, "BFN Unit 3 Cycle 12 FHA and Core-Wide Activity Release Evaluations," (TAG:03:145) December 22, 2003. (L32 031222 805)

Appendix A:
Design Data Base for Application of the Revised DBA Source Term at EPU Conditions

Note: this appendix applies to Units 1, 2 and 3. The calculation main body is for Units 2 and 3 only except for certain inputs and references applicable for Unit 1, as well. These are addressed in Section 12 of this appendix.

1. Radionuclide Data

1.1 Core Inventory (Reference A-1)

Isotopes	Ci/MWt t = 0	Ci/MWt t = 24 hr	Isotopes	Ci/MWt t = 0	Ci/MWt t = 24 hr
CO58	1.430E+02	1.416E+02	XE131M	3.544E+02	3.487E+02
CO60	1.425E+02	1.424E+02	TE132	3.629E+04	3.089E+04
KR83M	3.432E+03	1.387E+01	I132	3.885E+04	3.184E+04
KR85	3.601E+02	3.601E+02	I133	5.534E+04	2.559E+04
KR85M	7.329E+03	1.611E+02	XE133	5.504E+04	5.303E+04
RB86	6.372E+01	6.141E+01	XE133M	1.734E+03	1.562E+03
KR87	1.446E+04	3.051E-02	I134	6.141E+04	1.450E-03
KR88	2.009E+04	5.743E+01	CS134	5.703E+03	5.697E+03
KR89	2.521E+04	0.000E+00	I135	5.250E+04	4.189E+03
SR89	2.786E+04	2.748E+04	XE135	1.971E+04	1.429E+04
SR90	3.165E+03	3.165E+03	XE135M	1.135E+04	6.823E+02
Y90	3.283E+03	3.273E+03	CS136	1.941E+03	1.841E+03
SR91	3.487E+04	6.103E+03	XE137	5.023E+04	0.000E+00
Y91	3.583E+04	3.564E+04	CS137	4.037E+03	4.037E+03
SR92	3.677E+04	7.922E+01	BA137M	3.829E+03	3.810E+03
Y92	3.696E+04	1.168E+03	XE138	4.757E+04	1.172E-26
Y93	4.147E+04	8.084E+03	BA139	4.930E+04	4.170E-01
ZR95	4.880E+04	4.822E+04	BA140	4.909E+04	4.644E+04
NB95	4.897E+04	4.897E+04	LA140	5.231E+04	5.079E+04
ZR97	4.953E+04	1.851E+04	LA141	4.498E+04	7.085E+02
MO99	5.088E+04	3.956E+04	CE141	4.535E+04	4.463E+04
TC99M	4.454E+04	3.772E+04	LA142	4.397E+04	1.035E+00
RU103	4.094E+04	4.018E+04	CE143	4.245E+04	2.597E+04
RU105	2.710E+04	6.615E+02	PR143	4.113E+04	4.075E+04
RH105	2.559E+04	1.840E+04	CE144	3.810E+04	3.810E+04
RU106	1.488E+04	1.486E+04	ND147	1.806E+04	1.698E+04
SB127	2.796E+03	2.369E+03	NP239	5.201E+05	3.902E+05
TE127	2.773E+03	2.580E+03	PU238	2.805E+02	2.805E+02
TE127M	3.721E+02	3.719E+02	PU239	1.234E+01	1.238E+01
SB129	8.457E+03	1.952E+02	PU240	1.730E+01	1.730E+01
TE129	8.326E+03	1.236E+03	PU241	4.450E+03	4.448E+03
TE129M	1.615E+03	1.590E+03	AM241	5.449E+00	5.470E+00
TE131M	5.155E+03	2.976E+03	CM242	1.234E+03	1.234E+03
I131	2.669E+04	2.481E+04	CM244	5.697E+01	5.697E+01

1.2 Multiplier for uncertainty in core inventory determination – 1.02 (Reference A-2)

1.3 Number of assemblies in core – 764 assemblies (Reference A-3)

2. Source Terms

LOCA

2.1 Fraction of core inventory, 0 – 120 seconds: (Reference A-2)
No Release

2.2 Fraction of core inventory, 120 – 1920 seconds: (Reference A-2)

Gases
- Xe, Kr – 5% total (0.1/hr over 0.5 hours)
- Elemental I – 5% x 4.85% = 0.243% total (4.9E-3/hr over 0.5 hours)
- Organic I – 5% x 0.15% = 0.0075% total (1.5E-4/hr over 0.5 hours)

Aerosols
- I, Br – 5% x 95% = 4.75% total (0.095/hr over 0.5 hours)
- Cs, Rb – 5% total (0.1/hr over 0.5 hours)

2.3 Fraction of core inventory, 1920 – 7320 seconds: (Reference A-2)

Gases
- Xe, Kr – 95% total (0.63/hr over 1.5 hours)
- Elemental I – 25% x 4.85% = 1.21% total (8.1E-3/hr over 1.5 hours)
- Organic I – 25% x 0.15% = 0.0375% total (2.5E-4/hr over 1.5 hours)

Aerosols
- I, Br – 25% x 95% = 23.75% total (0.158/hr over 1.5 hours)
- Cs, Rb – 20% total (0.133/hr over 1.5 hours)
- Te Group – 5% total (0.033/hr over 1.5 hours)
- Ba, Sr – 2% total (0.013/hr over 1.5 hours)
- Noble Metals – 0.25% total (1.7E-3/hr over 1.5 hours)
- La Group – 0.02% total (1.3E-4/hr over 1.5 hours)
- Ce Group – 0.05% total (3.3E-4/hr over 1.5 hours)

CRDA

2.4 Fraction of Damaged Fuel for CRDA analysis – 0.01794 (850 rods out of a total of 62 rods/assembly x 764 assemblies) (Reference A-4)

2.5 Fraction of Fuel that melts in CRDA – 0.77% of damaged fuel (Reference A-4)

2.6 CRDA Release Fractions (Reference A-2)

Radio-nuclide Group	Release Fraction from Gap to Coolant	Release Fraction from Fuel to Coolant	Activity That Reaches the Condenser	Fraction of Condenser Activity Avail. for Release to Enviro.
Noble Gas	10%	100%	100%	100%
Iodine	10%	50%	10%	10%
Br	5%	30%	1%	1%
Cs, Rb	12%	25%	1%	1%
Te Group	0%	5%	1%	1%
Ba, Sr	0%	2%	1%	1%
Noble Mtls	0%	0.25%	1%	1%
Ce Group	0%	0.05%	1%	1%
La Group	0%	0.02%	1%	1%

2.7 Peaking factor for damaged pins for CRDA analysis – 1.5 (Reference 53)

2.8 Iodine Chemical Forms for CRDA Releases from the Turbine and Condenser (Reference A-2)
Elemental Iodine – 97%
Organic Iodine – 3%

FHA

2.9 Number of rods broken for FHA analysis – 111 rods (References A-5, A-6)

2.10 Number of fuel rods per assembly for FHA analysis – 49 rods (Reference A-5)

2.11 Fraction of fuel pin failure for FHA analysis – 0.00297 (111 / (49 x 764))
(Items 1.3, 2.9 & 2.10)

2.12 FHA Release Fractions* (Reference A-2)

Radio-nuclide Group	Release Fraction from Gap to Coolant
Kr-85	10%
Other NG	5%
I-131	8%
Other Iodines	5%

*Alkali metals ignored because of credit for infinite pool DF permitted by Reference A-2

2.13 Peaking Factor for FHA – 1.5 (Reference 53)

2.14 Iodine Chemical Forms for FHA (in water pool) (Reference A-2)
Elemental Iodine – 99.85%
Organic Iodine – 0.15%

3. Volumes and Volumetric Flowrates

3.1 Volume of Drywell – Min 159,000 ft^3, Max 171,000 ft^3 (Reference A-7)

3.2 Volume of Torus Airspace – Min 119,400 ft^3, Max 129,300 ft^3 (Reference A-7)

3.3 Volume of Suppression Pool – Min 121,500 ft^3, Max 131,400 ft^3 (Reference A-7)

3.4 Volume of Reactor Building (RB) – 1,931,502 ft^3 for Units 2/3; 1, 311,209 ft^3 for Unit 1 (Reference 18)

3.5 Volumetric Flowrate, Drywell to RB – 132.5 cfh (Reference A-8)
This represents 2% of the min DW volume per day (Item 3.1).

3.6 Volumetric Flowrate, Torus to RB – 99.5 cfh (Reference A-8)
This represents 2% of the min torus volume per day (Item 3.2).

3.7 Volumetric Flowrate, Drywell to Main Condenser – 1.30 cfm (78.1 cfh) (Reference A-9)

3.8 Volumetric Flowrate, Condenser to Environment – 3.97 cfm (238.3 cfh) (Reference A-9)

3.9 Combined MSIV Tested Leakrates – 150 scfh total (Reference 28)

3.10 Per Line MSIV Tested Leakrate – 100 scfh (Reference 28)

3.11 Leakage from condenser to TB for CRDA – 1% per day for 24 hours (Reference A-2)

3.12 Mechanical Condenser Vacuum Pump (MVP) flow rate – 1850 cfm at 7" Hg

(References A-10)

3.13 High Pressure Turbine Free Volume – 568.6 ft^3 (Reference 58)

3.14 Condenser Leakage Bypass – 0.5%

(Calculated in Attachment 10 of Reference A-11 based on ratio of Items 7.4 and 7.5)

3.15 Drywell Spray Flow – 12,168 gpm (one loop) (Reference A-12)

3.16 Volumetric Flowrate, Stack Room (SR) to Stack – 24,730 cfm | R007

(Refer to main body of calculation: SGTS Exhaust Flow – Base of Stack Leakage. SGTS serves all units.)

4. Filter Efficiencies, Removal Lambdas, and Decontamination Factors

4.1 Filter Efficiency – SGTS and CREVS filters (References 21 & 34)

For Particulate Iodine, Cesium and other Aerosols – 90%

(however, no credit is taken for CREVS HEPA filtration for LOCA and CRDA AST analysis, Refs. A-42 & A-45) | R007

For Elemental and Organic Iodine – 90% (however, no credit for charcoal filtration taken in AST analysis)

For Noble Gases – 0%

4.2 Delay for CREVS filter credit – 10 minutes (Reference A-13)

4.3 Release Fraction of Radioiodine from ESF leakage – 10% (applied as a filter efficiency) (Reference A-2)

4.4 Steam Lines and Main Condenser Removal Efficiencies

(Reference A-9)

	Removal Efficiency for Aerosol Particles**		Removal Efficiency for Elemental Iodine**	
	T < 1 hour	T > 1 hour	T < 1 hour	T > 1 hour
Steam Line Leakage (Item 3.7)* (Drywell to Main Condenser)	99.87%	94.45%	99.01%	93.10%
MC Bypass (Item 3.14) (Drywell to Environment)	89.33%	32.70%	16.37%	16.37%

* These removal efficiencies applied to a leakage entering the main condenser volume include removal in the condenser downstream.

** The times apply only to cases involving a sprayed drywell. If drywell spray is not credited, then values calculated for T < 1 hour may be used both before and after one hour.

5. Breathing Rates and Occupancy Factors

5.1 Breathing Rates (Reference A-2)

Control Room
0 – 30 days   3.5E-4 m^3/sec
EAB, LPZ, Environment
0 - 8 hours -   3.5E-4 m^3/sec
8 - 24 hours -   1.8E-4 m^3/sec
1 - 30 days -   2.3E-4 m^3/sec

5.2 Control Room Occupancy Factors (Reference A-2)

From t=0 to t=1 day -   1.0
From t=1 to t=4 days -   0.6
From t=4 to t=30 days -   0.4

6. Chemistry Data

6.1 Initial Pool pH – 5.3 (Reference A-14)

6.2 Mass of Chloride-Bearing Cable Insulation in Containment – see table below (Reference A-44)

6.3 Thickness of Jacket – see table below (Reference A-44)

6.4 Mass of SLCS Chemical (enriched Sodium Pentaborate) available for injection (Reference 41)

8.6 lbm/gal at 7% weight of SPB
8.64 lbm/gal at 8% weight of SPB

6.5 Formula of Enriched Sodium Pentaborate - Na_2O-$5B_2O_3$-$10H_2O$ (Reference 41)

6.6 Formula Weight of ESPB – 585.9 lbm/lbm-mole (Reference 41)

6.7 Reactor Coolant Mass Excluding Suppression Pool – 1.226E6 lbm (Reference A-41)

6.8 Enrichment of B-10 in Sodium Pentaborate – 62.9% (Reference A-41)

6.9 Average Cable OD – see table below (Reference A-44)

6.10 Fraction of Cable Covered by Conduit – see table below (Reference A-44)

6.11 Torus Surface Area with Epoxy – 34,014 ft^2 (N/A for Unit 1)* (Reference A-16)

6.12 Drywell Surface Area with Epoxy – 28,780 ft^2 (N/A for Unit 1)* (Reference A-16)

6.13 Year of Most Recent Painting (Unit 3 construction) – 1976 (N/A for Unit 1)* (Reference A-16)

6.14 Fraction of Activity Remaining in Drywell without Sprays – 0.79 (Reference A-17)

6.15 SLC Injectable Volume – 4000 gallons (Reference A-14)

*Because pH margin is less for Units 2/3 than for Unit 1, organic acid production is addressed in pH calculation for Units 2/3 – see Reference A-15.

Table of Cable Characteristics (Reference A-44)

	Unit 1	Unit 2	Unit 3
Hypalon Jacketed Cables:			
Total Footage, ft.	59193	23680	23680
Total Jacket Weight, lbs	3703	868	868
Average Cable OD, in.	0.89	0.89	0.89
Jacket Thickness, mils	72	72	72
% in Conduit, %	30	50	50
% in Tray, %	70	50	50
% in Free Air, %	0	0	0
PVC Jacketed Cables:			
Total Footage, ft.	0	17402	17402
Total Jacket Weight, lbs	N/A	1389	1389
Average Cable OD, in.	N/A	0.89	0.89
Jacket Thickness, mils	N/A	72	72
% in Conduit, %	N/A	30	30
% in Tray, %	N/A	70	70
% in Free Air, %	N/A	0	0
Neoprene Jacketed Cables:			
Total Footage, ft.	16650	16650	16650
Total Jacket Weight, lbs	1492	1492	1492
Average Cable OD, in.	0.73	0.73	0.73
Jacket Thickness, mils	72	72	72
% in Conduit, %	0	0	0
% in Tray, %	50	50	50
% in Free Air, %	50	50	50
Halar Jacketed Cables:			
Total Footage, ft.	N/A	14000	N/A
Total Jacket Weight, lbs	N/A	155.4	N/A
Average Cable OD, in.	N/A	0.236	N/A
Jacket Thickness, mils	N/A	25	N/A
% in Conduit, %	N/A	0	N/A
% in Tray, %	N/A	0	N/A
% in Free Air, %	N/A	100	N/A

7. Fission Product Transport Data

7.1 Steamline ID – 23.647" between MSIVs (References 58 and A-16)
21.562" from the outboard MSIV to the Drain Line Tap
(Piping is horizontal in this area)

7.2 Length of Steamline* – 17.6 ft between MSIVs (9'$8^3/_{16}$" + 6'11" + 12" from Reference A-18)
68.25 ft from Outboard MSIV to Drain Line Tap (Reference A-19)
(See also Reference A-16)

*Minimum values
(Piping is horizontal in this area)

7.3 Approx Containment Dimensions** (References A-7, A-20)
Diameter of Drywell Cylinder – 38.5 feet
Height of Drywell Cylinder – 55 feet
Height of Drywell Sphere Sidewall – 50 feet
Diameter of Drywell Sphere – 67 feet
Major Torus Diameter – 111.5 feet
Minor Torus Diameter – 31 feet
**Reference A-20 not explicitly applicable to Unit 1, but only approximate values needed.

7.4 Generic Flow Area to HP Turbine – 0.0288 in^2 (Attachment 3, page B-6, Reference 29)

7.5 Min Flow Area of Drainline Pathway – 5.41 in^2 (Based on diameter of 2.624" from Reference 58)

7.6 Elevation of LP Turbine/Main Condenser Bellows – 609'1" (Reference 58)

7.7 Elevation of Condenser Centerline– 573'3" (Reference 58)

7.8 Elevation of Bottom of Main Condenser Hotwell – 564'9"
(Reference 58 i.e., 27" of water in hotwell with surface elevation at 567')

7.9 Sedimentation Height in Main Condenser – 8.3 m
(Assumption 7 in Attachment 10 of Reference A-11)

7.10 Surface Area for Elemental Iodine Deposition in Drywell – 3409 m^2 (Attachment 11 of Reference A-11)

8. Thermal-Hydraulic Data

8.1 Core Power - 3952 MW(t) (Reference A-1)

8.2 Reference Pressure for Determination of Coolant Mass and Steam Line Temperature - 1050 psia (Reference A-21)

8.3 Maximum Suppression Pool Temperature – 187 F (Reference A-22, A-24 and A-25)

8.4 Reference Pressure for Drywell to Steamline Volumetric Flow Conversion – 14.4 psia (Reference A-23)

8.5 Accident Conditions to be used for SCFH to CFH conversion (Reference A-24)
Pressure: 62.9 psia (48.5 psig based on Item 8.4 reference pressure)
Temperature: 295.2 F

8.6 Steam Line Temperature – 550.6 F (Reference A-9)

9. System-Related Data (other than volumetric flows)

9.1 Spray (Drywell) Initiation Time – one hour, accident time (Reference A-16)

9.2 Spray Nozzle Type: 7G-25 (Reference A-16)

9.3 Spray Nozzle Differential Pressure – 125 psid (Reference A-12)

9.4 Shield Wall Radius – 14' 3 ¼" (Reference A-26)

9.5 Drywell Floor Elevation – 549.92' (Reference A-26)

9.6 Spray Header Characteristics: (References A-20, A-27, A-28, A-29)
- Number of Nozzles on Upper Header: 153 (A-29)
- Number of Nozzles on Lower Header: 72 (A-27)
- Nozzles per cap: 7 (A-28)
- Upper Header Elevation: 601' (Drawing 260-6 of Ref. A-20)
- Lower Header Elevation: 577.17' (Drawing 260-6 of Ref. A-20)
- Upper Spray Header Radius – 19' 8 3/8" (A-29)

9.7 Integrated doses for EQ on the refueling floor (Reference A-30)
- For one hour: 8.1E2 rads
- For 100 days: 1.9E4 rads

10. Building Arrangement Data

10.1 Dimensions of the opening in the refueling floor with the top plug removed and then with all plugs removed: (References A-31, A-32, A-33, 27d)

The diameter is 41'- 0" (at the top of the floor elevation (664')).
The two plugs are at the top of the reactor well area, and have a slightly angled edge.
The area of the reactor well cavity (below both layers) has a 37'- 11" diameter.

10.2 Thickness of the plugs (assumed to be 150 lbm/ft3 concrete): 3'- 0" (each) (Reference A-34)

10.3 ID of the drywell shell at approximately the location of the drywell head flange: 32'- 4" (N/A for Unit 1) (References A-31 and A-35)

10.4 Thickness of the drywell head (assumed to be carbon steel): 1 1/2" (N/A for Unit 1) (Reference A-35)

10.5 OD and ID of the biological shield wall: ID 24'- 0", OD 28'- 7" (References A-33 and 27d)

10.6 OD of the reactor vessel at approximately the top of the shield wall: 21'- 11 1/4" (251"ID + 2 x 6 1/8" wall thickness) (N/A for Unit 1)* (Reference A-36)

*This item used in support of drywell head skyshine evaluation not needed for Unit 1.

10.7 Elevations (source definition): (References A-33, 27d, A-37, A-38 and A-39)
- drywell floor: ELEV. 549'- 11"
- top of drywell flange: ELEV. 640'- 4"
- top of shield wall: ELEV. 624'- 8"
- base of shield wall (top of pedestal): ELEV. 575'- 8 5/8" (top of steel plates); ELEV. 575'- 4 9/16" (top of chipped concrete)

10.8 Elevations (dose point definition) (References A-33, 27d and A-40)
- refueling elevation: ELEV. 664'- 0"
- top of control room: ELEV. 635'- 0"
- grade: ELEV. 565'- 0"

10.9 Thickness of control room overhead (assumed to be 150 lbm/ft3 concrete): 2.25' (Reference 27d)

10.10 Thickness of control room wall (assumed to be 150 lbm/ft3 concrete): 2.5' (Reference 27d)

10.11 Minimum distance from centerline of reactor to control room wall: 39'-3" (Reference 27d)

11. Computer Codes Used

11.1 RADTRAD Version 3.02a (References A-41 and A-42)

11.2 STARpH Revision 1.04 (Reference A-43)

12. Additional Data Used for AST Taken from (and Referenced in) Main Body (or revised as referenced for AST) | R007

12.1 Turbine Building Roof Exhaust Rate (References 16a-c)

12.2 Base of Stack Leakage (References A-42 & A-45) | R007

12.3 CAD Flow Rate (References 19 and 20)

12.4 Control Room Make-up Flow Rate (References A-42 & A-45) | R007

12.5 Stack Room Volume (Reference 23)

12.6 Hardened Wetwell Vent Flow Rate (Reference 24)

12.7 Assumed ESF Leakage (also referred to as "ECCS" leakage) (References A-42 & A-45) | R007

12.8 Control Room Free Volume (References 27a-d)

12.9 MSIV Test Pressure (Reference 28)

12.10 Control Room Unfiltered Inleakage (References A-42 & A-45) | R007

12.11 Turbine Building Free Volume (Reference 31)

12.12 Offsite X/Q Values (Reference 32)

12.13 SGTS Flow Rate (Reference 40)

12.14 Control Room X/Q Values (References 49, 50, 51, and 59)

12.15 Main Condenser Free Volume (Reference 58)

References

A-1. TVA Calculation NDQ0-999-2001-0017, "Bounding Core Inventory for Alternate Source Term Analyses", Revision 2

A-2. US NRC RG 1.183

A-3. BNF Technical Specification 4.2.1

A-4. NEDO-31400A "Safety Evaluation for Eliminating The Boiling Water Reactor Main Steam Line Isolation Valve Closure Function and Scram Function of the Main Steam Line Monitor"

A-5. ND-Q0000-960003 R1 "Comparison of Fuel Handling Accidents in the Reactor Core and Spent Fuel Storage Pool"

A-6. NEDE-24011-P-A-13 GESTAR II "General Electric Standard Application for Reactor Fuel"

A-7. TVA Form OPL-4A Revision 1 for BFN Units 1, 2, and 3, RIMS# W79040330001

A-8. BFN Technical Specification 5.5.12

A-9. TVA Calculation NDQ0-999-2001-0019, Revision 1, "Ex-Containment Removal Coefficients for Alternative Source Term Analyses"

A-10. Drawing (1)(2)(3)-47E809-2, Rev 16 for Unit 1, Rev 30 for Unit 2, Rev 21 for Unit 3

A-11. "Calculation Package for Application of the Revised Source Term to the Browns Ferry Nuclear Power Plant", PSAT 04000U.04, Revision 2, June 27, 1996, RIMS# R92960718850

A-12. TVA Calculation MD-Q0074-870155, Revision 4

A-13. TVA Calculation ND-Q2031-920088, Revision 2, "CREVS 10 Minute Delayed Start"

A-14. Letter from TVA (R.H. Wright) to Polestar (J. Metcalf) dated 6/10/02, RIMS# R05020610001

A-15. TVA Calculation NDQ0-999-2001-0018, "Post LOCA Suppression Pool pH", Revision 1

A-16. Letter from TVA (R.H. Wright) to Polestar (J. Metcalf) dated 4/16/02, RIMS# R05020416005

A-17. Polestar Calculation PSAT 04101F.02, "Calculation of Fraction of Containment Aerosol Deposited in Water", Revision 0, RIMS# R05020325112

A-18.TVA/BFN Main Steam Piping Drawings 0-47W400-1 Rev. 5, 0-47W400-5 Rev. 2, 1-47W400-5 Rev. 0

A-19. TVA Calculation ND-Q0999-950021, Rev 1, "The Horizontal Surface Area in the Containment for the Gravitational Settling of Aerosols"

A-20. TVA Drawings 47E260-5 Rev. C and 47E260-6 Rev.C, "Drywell Transverse Section", and Reference 27d of Main Calculation

A-21. TVA calculation MDQ0999980105, Revision 2, "Reactor Heat Balance"

A-22. L.King (GE) letter to E.Hartwig (TVA), "TVA BFNP Units 2&3 DBA Long-term Containment Response-Extended to 100 Days," GE-ERO-AEP-02-297, DRF A22-00125-00, General Electric Company, February 5, 2002 RIMS # W79020205003

A-23. TVA BFN "Environmental Design" Design Criteria # BFN 50-715 and associated drawings for Units 1,2 and 3: (1)(2)(3)47E225-100 Rev. 0 for Unit 1, Rev. 0 for Unit 2 and Rev. 5 for Unit 3

A-24. TVA calculation NDQ0064-980007, "Primary Containment Analysis", Revision 6

A-25. GE-NE-0000-0011-4656, Revision 0, March 2004

A-26. Drawings (1)(2)(3)-153F754, Rev.0 for Units 1,2,3

A-27. Contract 90744 Drawing E55, Contract 91750 Drawing 3-E55

A-28. Spraying Systems Company Industrial Spray Products, Catalog 60 page 263 (7G-25 nozzle) R007

A-29. Contract 90744 Drawing 42, Rev. A, Contract 17002 Drawing 42, Rev. B, and Contract 91750 Drawing 42, Rev. B

A-30. Drawings (1)(2)(3)-47E225-122 and "Harsh Environmental Data, Room No. 15, EL 664.0"

A-31. Drawing 0-48N954, Rev 4

A-32. Drawing 48N959, Rev 3

A-33. Drawing 41N700, Rev A

A-34. Drawing 0-48N967, Rev 0

A-35. Pittsburgh-Des Moines E66, Rev C

A-36. Drawing 3-104R935-3, Rev 2

A-37. Drawing 47W200-8, Rev 3

A-38. Drawing 41N830, Rev A

A-39. Drawing 48N830, Rev A

A-40. Drawing 0-41N702, Rev 0

A-41. U.S. NRC NUREG/CR-6604, "RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation", December 1997 (including Supplement 1) R007

A-42. TVA Calculation "Control Room and Offsite Doses due to LOCA", NDQ0031920075, Revision 21

A-43. PSAT C107.02,"STARpH, A Code for Evaluating Containment Water Pool pH During Accidents, Code Description and Validation and Verification Report", Revision 4, February, 2000, RIMS #R05020325102

A-44. Letter from TVA (T.C. Trask) to Polestar (J. Metcalf) dated 4/30/04, RIMS# R05040507001

A-45. TVA Calculation "Offsite and Control Room Doses Due to a Control Rod Drop Accident", NDQ0999980029, Revision 6 R007

Appendix B - Parameters Associated with AST Analysis

with reduced MSIV leak rate and increased Main Condenser bypass flow assuming only alternate leak treatment secondary flow path is available

Assumptions with Technical Justification

Assumption 1: Combined MSIV Tested Leak Rates - 85 scfh total and Per Line MSIV Tested Leak Rate - 60 scfh max. per line

Justification 1: These values are consistent with the proposed Technical Specification change being requested. (Technical specification section 3.6 for containment systems)

The following values are updated from Appendix A pending approval of LAR:

3.7 Volumetric Flowrate, Drywell to Main Condenser -0.363 cfm (21.75 cfh) (Reference B-1)

3.8 Volumetric Flowrate, Condenser to Environment - 1.107 cfm (66.4 cfh) (Reference B-1)

3.9 Combined MSIV Tested Leak Rates - 85 scfh total (Reference See Assumption 1)

3.10 Per Line MSIV Tested Leak Rate - 60 scfh max. per line (Reference See Assumption 1)

3.14 Volumetric Flowrate, Drywell to
Turbine Building (Condenser Bypass Leakage) – 0.3788 cfm (22.73 cfh) (Reference B-1)

4.4 Steam Lines and Main Condenser Removal Efficiencies (Reference B-1)

	Removal Efficiency for Aerosol Particles	Removal Efficiency for Elemental Iodine
Steam Line Leakage (Item 3.7)* (Drywell to Main Condenser)	99.97%	99.70%
MC Bypass (Item 3.14) (Drywell to Environment)	92.9%	25.3%

*These removal efficiencies applied to a leakage entering the main condenser volume include removal in the condenser downstream.

7.5 Min Flow Area of Drainline Pathway - 0.0276 in2
(Based on diameter of 0.1875" orifice) (References B-2 & B-3)

References:

B-1 Calculation NDQ099920010019 R003, "Ex-Containment Removal Coefficients for Alternative Source Term Analyses."

B-2 Calculation MDQ0001870126 R011 "Evaluation of MSSRV Inlet Piping and MS Drain Line Piping Size."

B-3 a. Drawings 1-47E801-1 "Mechanical Flow Diagram Main Steam"
b. Drawings 2-47E801-1 "Flow Diagram Main Steam"
c. Drawings 3-47E801-1 "Flow Diagram Main Steam."

ATTACHMENT 9

CDN0001990113
Seismic Evaluation Report

QA Record

ORIGINAL

TVAN CALCULATION COVERSHEET/CCRIS UPDATE

REV 0 EDMS/RIMS NO.	EDMS TYPE:	EDMS ACCESSION NO (N/A for REV. 0)
R14 990909 102	Calculations(Nuclear)	T78 040722 004

Calc Title: **SEISMIC EVALUATION REPORT**

CALC ID	TYPE	ORG	PLANT	BRANCH	NUMBER	CUR REV	NEW REV	REVISION APPLICABILITY
CURRENT	CN	NUC	BFN	CEB	CDN0 001 99 0113	002	003	Entire calc ☐
NEW	CN	NUC	BFN	CEB				Selected pages ☒

ACTION	NEW ☐ REVISION ☒	DELETE ☐ RENAME ☐	SUPERSEDE ☐ DUPLICATE ☐	CCRIS UPDATE ONLY ☐ (Verifier Approval Signatures Not Required)	No CCRIS Changes ☒ (For calc revision, CCRIS been reviewed and no CCRIS changes required)

UNITS	SYSTEMS	UNIDS
000	001	N/A

DCN,EDC,N/A	APPLICABLE DESIGN DOCUMENT(S)	CLASSIFICATION
51112	N/A	D

QUALITY RELATED?	SAFETY RELATED? (If yes, QR = yes)	UNVERIFIED ASSUMPTION	SPECIAL REQUIREMENTS AND/OR LIMITING CONDITIONS?	DESIGN OUTPUT ATTACHMENT?	SAR/TS AFFECTED
Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☒ No ☐

PREPARER ID	PREPARER PHONE NO	PREPARING ORG (BRANCH)	VERIFICATION METHOD	NEW METHOD OF ANALYSIS
jodizon	(256) 729-7000 x18376	CEB	Design Review	☐ Yes ☒ No

PREPARER SIGNATURE	DATE	CHECKER SIGNATURE	DATE
John O. Dizon J.O. Dizon	7/21/04	S.J. Eder	7/21/04
VERIFIER SIGNATURE	**DATE**	**APPROVAL SIGNATURE**	**DATE**
S.J. Eder	7/21/04	W.H. for RDC	7/22/04

STATEMENT OF PROBLEM/ABSTRACT

This calculation documents the MSIV Seismic Ruggedness Verification for Browns Ferry Nuclear Plant, Units 1, 2 & 3 for the Increased MSIV Leakage Tech Spec Change.

MICROFICHE/EFICHE Yes ☐ No ☒ FICHE NUMBER(S)

☐ LOAD INTO EDMS AND DESTROY
☒ LOAD INTO EDMS AND RETURN CALCULATION TO CALCULATION LIBRARY. ADDRESS: BFN Calculation Library
☐ LOAD INTO EDMS AND RETURN CALCULATION TO:

QA Record

ORIGINAL

TVAN CALCULATION COVERSHEET/CCRIS UPDATE

Page ~~1~~ 1.1 | R003

REV 0 EDMS/RIMS NO.	EDMS TYPE:	EDMS ACCESSION NO (N/A for REV. 0)
R14 990909 102	Calculations(Nuclear)	W78 040603 067

Calc Title: **SEISMIC EVALUATION REPORT**

CALC ID	TYPE	ORG	PLANT	BRANCH	NUMBER	CUR REV	NEW REV	REVISION APPLICABILITY
CURRENT	CN	NUC	BFN	CEB	CDN0 001 99 0113	001	002	Entire calc ☐
NEW	CN	NUC	BFN	CEB				Selected pages ☒

ACTION	NEW ☐ REVISION ☒	DELETE ☐ RENAME ☐	SUPERSEDE ☐ DUPLICATE ☐	CCRIS UPDATE ONLY ☐ (Verifier Approval Signatures Not Required)	No CCRIS Changes ☐ (For calc revision, CCRIS been reviewed and no CCRIS changes required)

UNITS	SYSTEMS	UNIDS
000	001	N/A

DCN,EDC,N/A	APPLICABLE DESIGN DOCUMENT(S)	CLASSIFICATION
51112	N/A	D

QUALITY RELATED?	SAFETY RELATED? (If yes, QR = yes)	UNVERIFIED ASSUMPTION	SPECIAL REQUIREMENTS AND/OR LIMITING CONDITIONS?	DESIGN OUTPUT ATTACHMENT?	SAR/TS AFFECTED
Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☒ No ☐

PREPARER ID	PREPARER PHONE NO	PREPARING ORG (BRANCH)	VERIFICATION METHOD	NEW METHOD OF ANALYSIS
John O. Dizon	(256) 729-7000 x18376	CEB	Design Review	☐ Yes ☒ No

PREPARER SIGNATURE	DATE	CHECKER SIGNATURE	DATE
John O. Dizon J.O. Dizon	6/02/04	S Eder S.J. Eder	6/02/04
VERIFIER SIGNATURE	**DATE**	**APPROVAL SIGNATURE**	**DATE**
S Eder S.J. Eder	6/02/04	William D. Crouch for RDC	6/3/04

STATEMENT OF PROBLEM/ABSTRACT

This calculation documents the MSIV Seismic Ruggedness Verification for Browns Ferry Nuclear Plant, Units 1, 2 & 3 for the Increased MSIV Leakage Tech Spec Change.

MICROFICHE/EFICHE Yes ☐ No ☒ FICHE NUMBER(S)

☐ LOAD INTO EDMS AND DESTROY
☒ LOAD INTO EDMS AND RETURN CALCULATION TO CALCULATION LIBRARY. ADDRESS: BFN Calculation Library
☐ LOAD INTO EDMS AND RETURN CALCULATION TO:

TVAN CALCULATION COVERSHEET/CCRIS UPDATE

Page ~~1A~~ 1.2 | R003

CALC ID	TYPE	ORG	PLANT	BRANCH	NUMBER	REV
	CN	NUC	BFN	CEB	CDN0 001 99 0113	002

ALTERNATE CALCULATION IDENTIFICATION

BLDG	ROOM	ELEV	COORD/AZIM	FIRM	Print Report
00	N/A	N/A	N/A	Bechtel	Yes

CATEGORIES F06

KEY NOUNS (A-add, D-delete)

ACTION (A/D)	KEY NOUN	A/D	KEY NOUN
A	MSIV		
A	RUGGEDNESS		
A	CONDENSER		
A	ANCHORAGE		

CROSS-REFERENCES (A-add, C-change, D-delete)

ACTION (A/C/D)	XREF CODE	XREF TYPE	XREF PLANT	XREF BRANCH	XREF NUMBER	XREF REV
A	P	CN	BFN	CEB	CDN0 001 98 0038	
A	P	CN	BFN	CEB	CDN0 001 98 0039	
A	P	CN	BFN	CEB	CDN1 000 2004 0041	

CCRIS ONLY UPDATES:
Following are required only when making keyword/cross reference CCRIS updates and page 1 of form NEDP-2-1 is not included:

PREPARER SIGNATURE	DATE	CHECKER SIGNATURE	DATE

PREPARER PHONE NO. | EDMS ACCESSION NO. W78 040603 067

QA Record

ORIGINAL

TVAN CALCULATION COVERSHEET

Title	Seismic Evaluation Report	Plant BFN	Page 1 of see rev. log
		Unit 0	

Preparing Organization	Key Nouns (For EDM)		
NE/CEB	Seismic, Component Qualification, Piping, Pipe Support		
Calculation Identifier	Each time these calculations are issued, preparer must ensure that the original (R0) RIMS/EDM accession number is filled in.		
CD-N0001-990113	Rev	(for EDM use)	EDM Accession Number
Applicable Design Document(s) BFN-50-C-7100 BFN-50-C-7107, BFN-50-C-7306	R0		R14 990909 102
	R1		R14 000613 106
UNID System(s) 001	R2		
	R3		

	R0	R1	R2	R3	Quality Related?	Yes ■	No ☐
DCN, EDC, NA	N/A	T41182A, ~~[illegible]~~			Safety related? If yes, mark Quality Related yes	Yes ☐	No ■
Prepared	F Caramante FC 9/8/99	[signature] 6/7/00					
Checked	[signature] 9/8/99	[signature] 6-8-00 J.N. HUDGINS			These calculations contain unverified assumption(s) that must be verified later?	Yes ☐	No ■
Design Verified	[signature] 9/8/99	[signature] 6-8-00 J.N. HUDGINS			These calculations contain special requirements and/or limiting conditions?	Yes ☐	No ■
Approved	L.R. Madison [signature]	EJ Frowell for LRM			These calculations contain a design output attachment?	Yes ☐	No ■
Approval Date	9-9-99	6-13-00			Calculation Classification	D	
SAR Affected?	Yes ☐ No ■	Yes ☐ No ☒	Yes ☐ No ☐	Yes ☐ No ☐	Microfiche generated	Yes ☐	No ■
Revision applicability	Entire calc ■	Entire calc ☒ Selected pgs☐	Entire calc ☐ Selected pgs☐	Entire calc ☐ Selected pgs ☐	Number		

Statement of Problem:

The Main Steam piping downstream of the outboard MSIV's is desired to be capable of with standing an earthquake so that any leakage through the MSIV's from the Reactor side can be contained and diverted to the main condenser. This calculation supports the MSIV leakage tech spec change at BFN.

Abstract

This calculation is documents the "Browns Ferry Nuclear Plant - Increased MSIV Leakage Tech Spec Change Submittal Seismic Evaluation Report", (200918-R-002); August 1999, By EQE International, Oakland, CA. Additionally, Bounding Calculations (200918-C-002) "Seismic evaluation for the Condensers" and (200918-C-001) "Seismic verification of the main steam drain piping and supports associated with the MSIV alternate leakage treatment pathway" are contained in this calculation.

|R1 No change to abstract

☒ Microfilm and return calculation to Calculation Library. Address: POB-1A-BFN

☐ Microfilm and destroy.

☐ Microfilm and return calculation to:

TVAN CALCULATION RECORD OF REVISION	
CALCULATION IDENTIFIER	**CDN0 001 99 0113**
Title	**SEISMIC EVALUATION REPORT**

Revision No.	DESCRIPTION OF REVISION
000	Initial Issue **Total Number of Pages = 125**
001	Minor revision to correct Table of Contents page, change Attachment Section 11.0 to 9.0 and delete reference to Appendices and minor changes to the EQE "Seismic Evaluation Report", page A40 show valves 71-6B and 73-6B as open, and add Reference 10 on page A75 and add reference to Reference 10 to pages A44 and A46. **Total Number of Pages = 125**
002	Add pages i, iA, ii & iii; delete page 2 (previous revision log); minor revision to pages 4, 5 & 6 to reference Attachment D; and add Attachment D to this revision. The impact to the FSAR and Tech Specs has been addressed by the 10 CFR 50.59 review for DCN 51112. **Total Number of Pages = 131**
003	Add Rev. 003 cover sheet (page 1.3); replace page 2 (record of revision) & page 3 (verification form; and delete page iii (R002 verification form) and page A3 of Attachment A. Minor revisions to pages 1.1, 1.2, 4; and page A4 of Attachment A. The impact to the FSAR and Tech Specs has been addressed by the 10 CFR 50.59 review for DCN 51112. **Total Number of Pages = 130**

TVAN CALCULATION VERIFICATION FORM		
Calculation Identifier **CDN0 001 99 0113**		Revision **003**
Method of verification used: 1. Design Review ☒ 2. Alternate Calculation ☐ 3. Qualification Test ☐	Verifier [signature] Stephen .J. Eder	Date 7/21/04

Comments:

This revision of the calculation has been reviewed by the Design Review Methodology and has been determined to be technically adequate based on the design input information contained herein using accepted handbook and/or computer applications, and sound engineering practices and techniques, supplemented by applicable industry-standard guidelines.

TVAN CALCULATION TABLE OF CONTENTS		
Calculation Identifier: **CD-N0001-990113**	Revision: 1	Page 4

TABLE OF CONTENTS

* Page A3 deleted in R003 R003

SECTION 1.0: PURPOSE

The purpose of this calculation is to document the "Browns Ferry Nuclear Plant - Increased MSIV Leakage Tech Spec Change Submittal Seismic Evaluation Report", (200918-R-002); August 1999, By EQE International, Oakland, CA. Additionally, Bounding Calculations (200918-C-002) "Seismic evaluation for the Condensers" and (200918-C-001) "Seismic verification of the main steam drain piping and supports associated with the MSIV alternate leakage treatment pathway" are contained within this calculation.

SECTION 2.0: ASSUMPTIONS:

There are no unverified assumptions in this calculation.

SECTION 3.0: REQUIREMENTS/LIMITING CONDITION:

This calculation does not generate any requirements or limiting conditions which limit system or plant operation from that currently documented in the design, place special requirements on a safety evaluation, or place special requirements on the physical configuration that are generally outside the stated purpose of the calculation.

SECTION 4.0 REFERENCES:

See Attachment A, Section 5.; Attachment B, Section 3.0 And Attachment C, Section 3.0 for references used by EQE. See also Section D.3 of Attachment D. 2

SECTION 5.0 DESIGN INPUT DATA:

See Attachment A, B, And C, design input data is identified where it has been used. See also applicable sections of the references listed in Attachment D. 2

SECTION 6.0 SUPPORTING GRAPHICS:

See Attachment A, sheet 5 TABLES and FIGURES; Attachment B, sheet 2 TABLES and FIGURES, and Attachment C, sheet 2 TABLES and FIGURES for graphics used by EQE. See also applicable tables and figures of the references listed in Attachment D. 2

SECTION 7.0 COMPUTATIONS AND ANALYSIS:

See Attachment A, Section 5. for computations and analysis performed by EQE See also applicable sections of the references listed in Attachment D. 2

SECTION 8.0 SUMMARY:

See Attachment A, Section 4.1.3, Attachment B, Section 5.0 and Attachment C, Section 5.0. See also applicable sections of the references listed in Attachment D 2

CALCULATION SHEET

Document: CD-N0001-990113	Rev.: 0	Plant: BFN 0	Page: 6
Subject: Seismic Evaluation Report		Prepared By: FC3 Checked By:	Date: 9/8/1999 Date:

SECTION 9.0 ATTACHMENTS:

Attachment A, "Browns Ferry Nuclear Plant - Increased MSIV Leakage Tech Spec Change Submittal Seismic Evaluation Report", (200918-R-002); August 1999, By EQE International, Oakland, CA.

Attachment B, Bounding Calculation (200918-C-002) "Seismic evaluation for the Condensers"; August 1999, By EQE International, Oakland, CA.

Attachment C, Bounding Calculation (200918-C-001) "Seismic verification of the main steam drain piping and supports associated with the MSIV alternate leakage treatment pathway"; August 1999, By EQE International, Oakland, CA.

Attachment D, MSIV Seismic Evaluation Report Application to BFN Unit 1 MSIV Seismic Ruggedness Verification Program. 2

This Page Added By Revision 0

EQE INTERNATIONAL

Browns Ferry Nuclear Plant Increased MSIV Leakage Tech Spec Change Submittal

Seismic Evaluation Report

Prepared for:

TENNESSEE VALLEY AUTHORITY

August 1999

EQE Job Number: 50147.16 & 200918.01

APPROVAL COVER SHEET

Title:	Browns Ferry Nuclear Plant Increased MSIV Leakage Tech Spec Change Submittal – Seismic Evaluation Report
Report Number:	200918-R-002
Client:	Tennessee Valley Authority
Project Number:	200918.01

Revision Number	Approval Date	Prepared	Reviewed	Approved
0	8/31/99	J.O. Dixon	[illegible]	J.O. Dixon

TABLE OF CONTENTS

* Page A3 deleted by Rev. 003

R003

TABLES

FIGURES

FIGURES (CONT.)

FIGURES (CONT.)

1. INTRODUCTION

This report summarizes the engineering activities performed for the supplemental plant specific Main Steam piping seismic verification to support the increased Main Steam Isolation Valve (MSIV) leakage tech spec change at Browns Ferry Nuclear Plant (BFN). The verification program was performed in accordance with the recommendations of the General Electric Boiling Water Reactor Owners Group (BWROG) Report for Increasing MSIV Leakage Rate Limits and Elimination of Leakage Control Systems (Reference 1). The U.S. Nuclear Regulatory Commission (NRC) has reviewed the BWROG report and issued a safety evaluation report (SER) on its application for addressing the MSIV leakage issues (Reference 2), subject to certain limitations.

Engineering activities associated with the supplemental plant specific seismic verification program, as recommended in the BWROG report, consist of the following key elements:

- Seismic Experience Database Comparisons
- Seismic Verification Walkdowns
- Seismic Assessments of Selected Components

Detailed discussions of each of these activities are presented in the following sections of the report.

2. SEISMIC EXPERIENCE DATABASE COMPARISONS

The seismic experience data are derived from an extensive database on the performance of power plants and industrial facilities in past strong-motion earthquakes. These performance data are compiled by EQE for the Seismic Qualification Utility Group, the Electric Power Research Institute and others, and included over 100 facilities in more than 60 earthquakes that have occurred around the world from 1934 to present. Of interest to the MSIV leakage issues are the performance of the non-seismically analyzed main steam system piping, related components and supports, and condensers.

The BWROG Report (Reference 1) summarizes data on the performance of main steam piping and condensers in past strong-motion earthquakes and compares these piping and condensers with those in typical U.S. GE Mark I, II, and III nuclear plants. The earthquake experience data and similarity comparisons are then used to draw conclusions on how the GE piping and condensers would perform in a design basis earthquake (DBE).

The following sections present experience database comparisons that are plant-specific to Browns Ferry Nuclear Plant for use to support the increased MSIV leakage tech spec change submittal.

2.1 SEISMIC GROUND MOTIONS

Ground motion estimates of 13 database sites were reviewed and accepted by the NRC staff for inclusion in the BWROG's earthquake experience database, and are presented in the referenced NRC Safety Evaluation Report (SER, Reference 2). To establish applicability of the BWROG's earthquake experience-based methodology for demonstrating the seismic ruggedness of non-seismically analyzed main steam piping and associated components at Browns Ferry, comparisons of the ground response spectra of selected database facilities with BFN design basis ground spectrum were made.

The majority of the MSIV alternate leakage treatment (ALT) path and associated piping systems and the condensers at Browns Ferry are located in the lower elevations of the Turbine Building. BFN Turbine Building is classified as a Class II structure, hence, no dynamic analysis of the building was performed. The building below the operating floor is a reinforced concrete framed structure supported on steel H-piles to bedrock. The horizontal ground spectrum is conservatively taken as the BFN 5% damped design basis DBE input spectrum (0.2g Housner spectrum defined at rock outcrop) and scaled by 1.6 to account for soil amplification.

A composite comparison of the ground response spectra of selected earthquake experience database facilities with the Browns Ferry design basis DBE ground spectrum is shown in Figure 2-1. The selected ground motions include the following 10 sites from among the 13 database facilities reviewed and accepted by the NRC:

- Valley Steam Plant - USGS estimate
  1971 San Fernando Earthquake (M6.6)
- Burbank Power Plant - USGS estimate
  1971 San Fernando Earthquake (M6.6)
- El Centro Steam Plant - E/W direction
  1979 Imperial Valley Earthquake (M6.6)
- Moss Landing Power Plant - PG&E estimate
  1989 Loma Prieta Earthquake (M7.1)
- Humboldt Bay Nuclear Power Plant - Average
  1975 Ferndale Earthquake (M5.5)
- Coolwater Power Plant - Longitudinal direction
  1992 Landers Earthquake (M7.3)
- Commerce Refuge to Energy Plant (LA Bulk Mail) - N/S direction
  1987 Whittier Narrows Earthquake (M5.9)
- Grayson Power Plant (Glendale) - N200E direction
  1971 San Fernando Earthquake (M6.6)
- Ormond Beach Power Plant - N270E direction
  1973 Point Mugu Earthquake (M5.8)

- PALCO Cogeneration Plant (Rio Dell) – Average
  1992 Petrolia Earthquake (M6.9)

The individual comparison plots of the 5% damped ground spectra of the above 10 database facilities with the Browns Ferry DBE ground spectrum are shown in Figures 2-2 to 2-11. In general, the earthquake experience database sites have experienced strong ground motions that are in excess of the Browns Ferry DBE at the frequency range of interest (i.e., about 1 Hz. and above), with the exception of the Ormond Beach site. Many of the database site ground motions envelope the conservatively estimated BFN DBE ground spectrum by large factors in various frequency bands within the 1 Hz. and above range.

Based on the above observations and comparison, it is concluded that the Browns Ferry DBE ground spectrum is generally bounded by those of the earthquake experience database sites at the frequencies of interest. Hence, the use of earthquake experience-based approach for demonstrating the seismic ruggedness of non-seismically analyzed main steam piping and associated components at Browns Ferry, consistent with the BWROG's recommendations and limitations of the SER, is appropriate.

2.2 PIPING, EQUIPMENT AND OTHER PLANT FEATURES

The main steam piping and condensers in the earthquake experience database exhibited substantial seismic ruggedness, even when they are typically not designed to resist earthquakes. This is a common conclusion in studies of this type on other plant items such as welded steel piping in general, anchored equipment such as motor control centers, pumps, valves, structures, and so forth. That is, with limited exceptions, normal industrial construction and equipment typically have substantial inherent seismic ruggedness, even when they are not designed for earthquakes. No failures of the main steam piping were found. Anchored condensers have also performed well in past earthquakes with damage limited to minor internal tube leakage.

The BWROG Report (Reference 1) contains detailed discussions and comparisons of main steam piping and condenser design in several earthquake experience database sites and example GE Mark I, II, and III plants in the U.S. The general conclusions of these comparisons are as follows:

- GE plant designs are similar to or more rugged than those in the earthquake experience database that exhibited good earthquake performance;
- The possibility of significant failure in GE BWR main steam piping or condensers in the event of an eastern U.S. design basis earthquake is highly unlikely; and that
- Any such failure would also be contrary to a large body of historical earthquake experience data, and thus unprecedented.

Plant-specific comparisons of the main steam piping, related components and supports, and condensers at Browns Ferry with those in the selected earthquake experience database facilities are provided in Section 4 of this report.

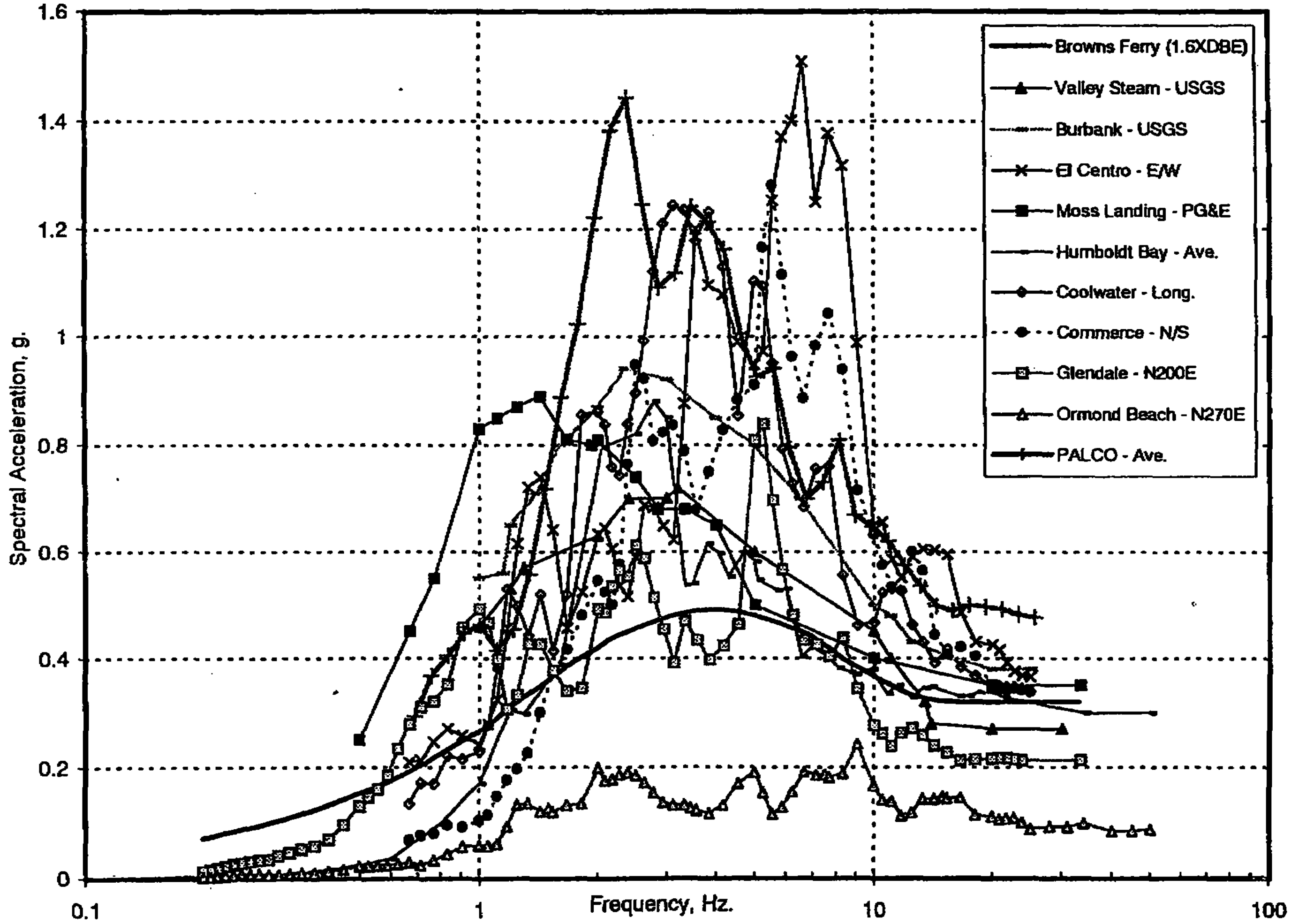


Figure 2-1 Comparison of Browns Ferry DBE Ground Spectrum and Selected Database Site Spectra

CD-N0001-990113 Page A13
Attachment A

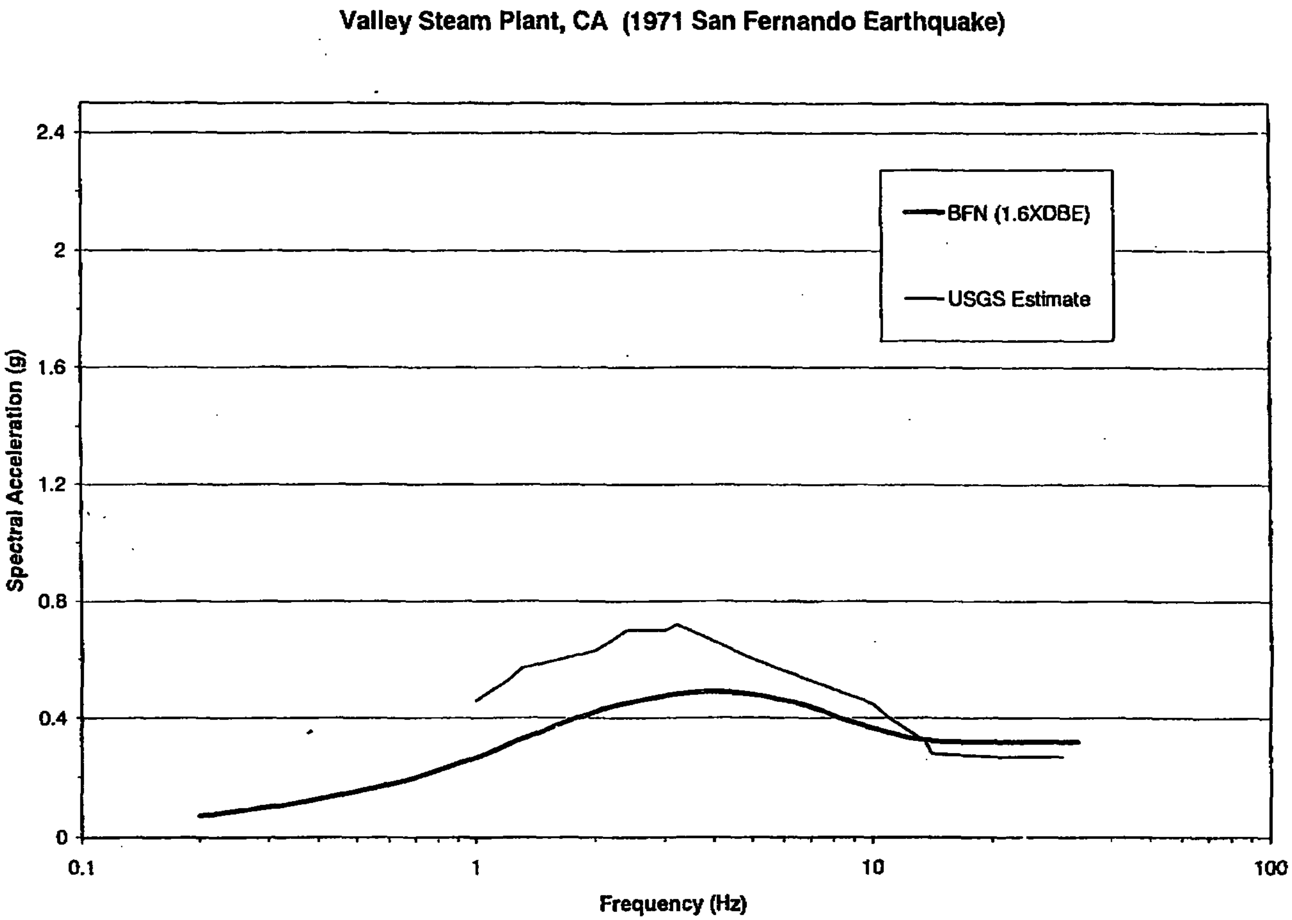


Figure 2-2 Comparison of Browns Ferry DBE and Valley Steam Plant Ground Spectra

CD-N0001-990113 Page A14
Attachment A

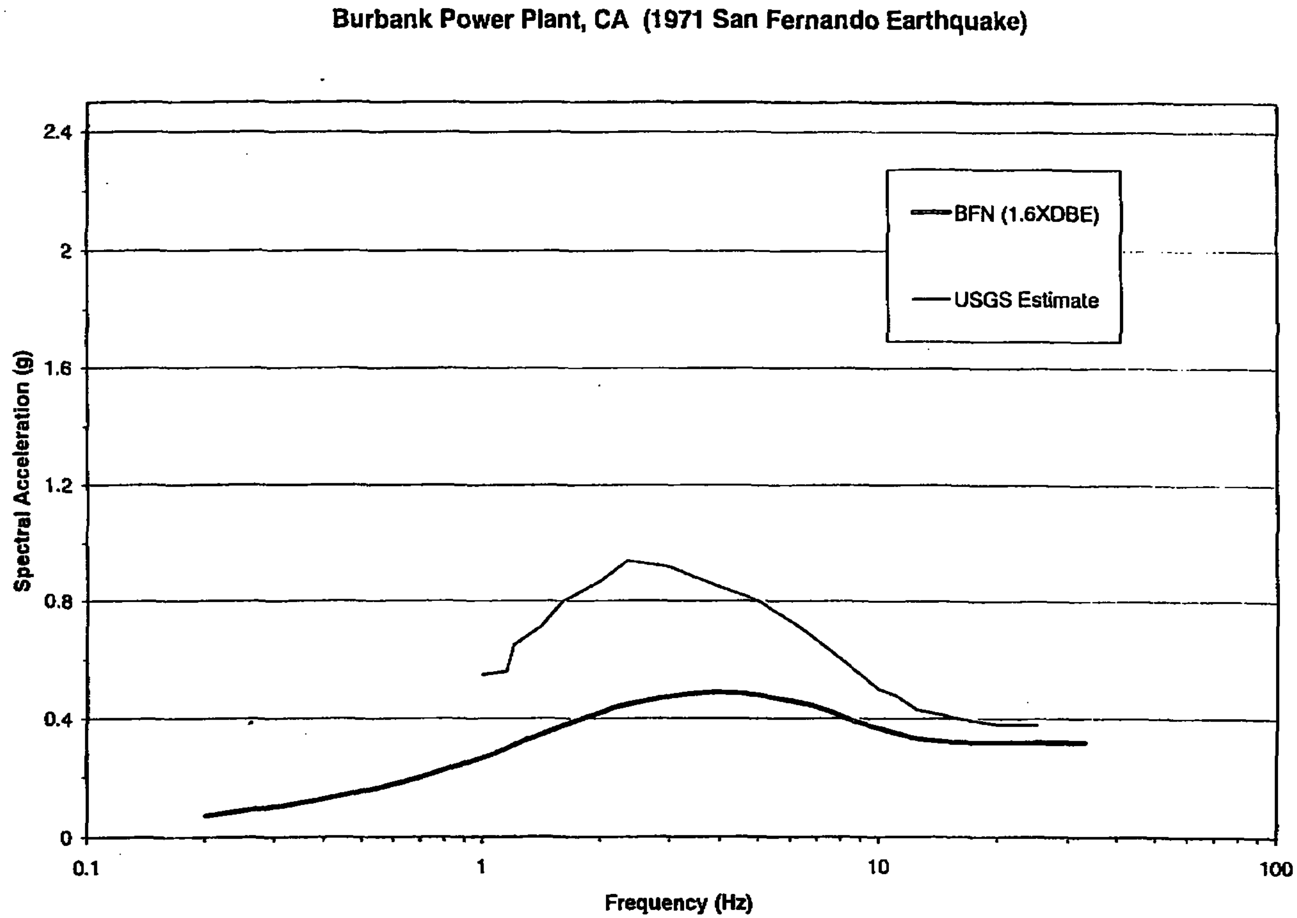


Figure 2-3 Comparison of Browns Ferry DBE and Burbank Power Plant Ground Spectra

El Centro Steam Plant, CA (1979 Imperial Valley Earthquake)

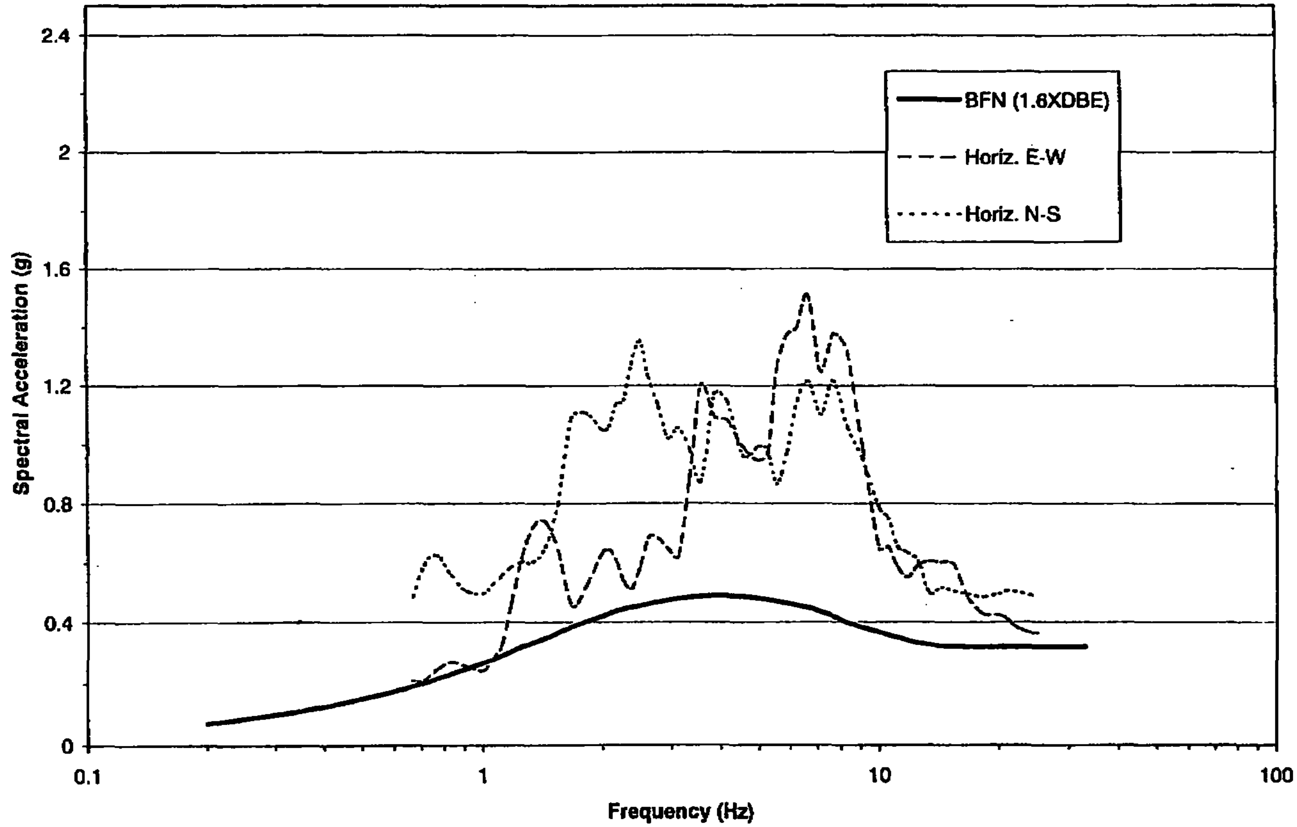


Figure 2-4 Comparison of Browns Ferry DBE and El Centro Steam Plant Ground Spectra

CD-N0001-990113 Page A16
Attachment A

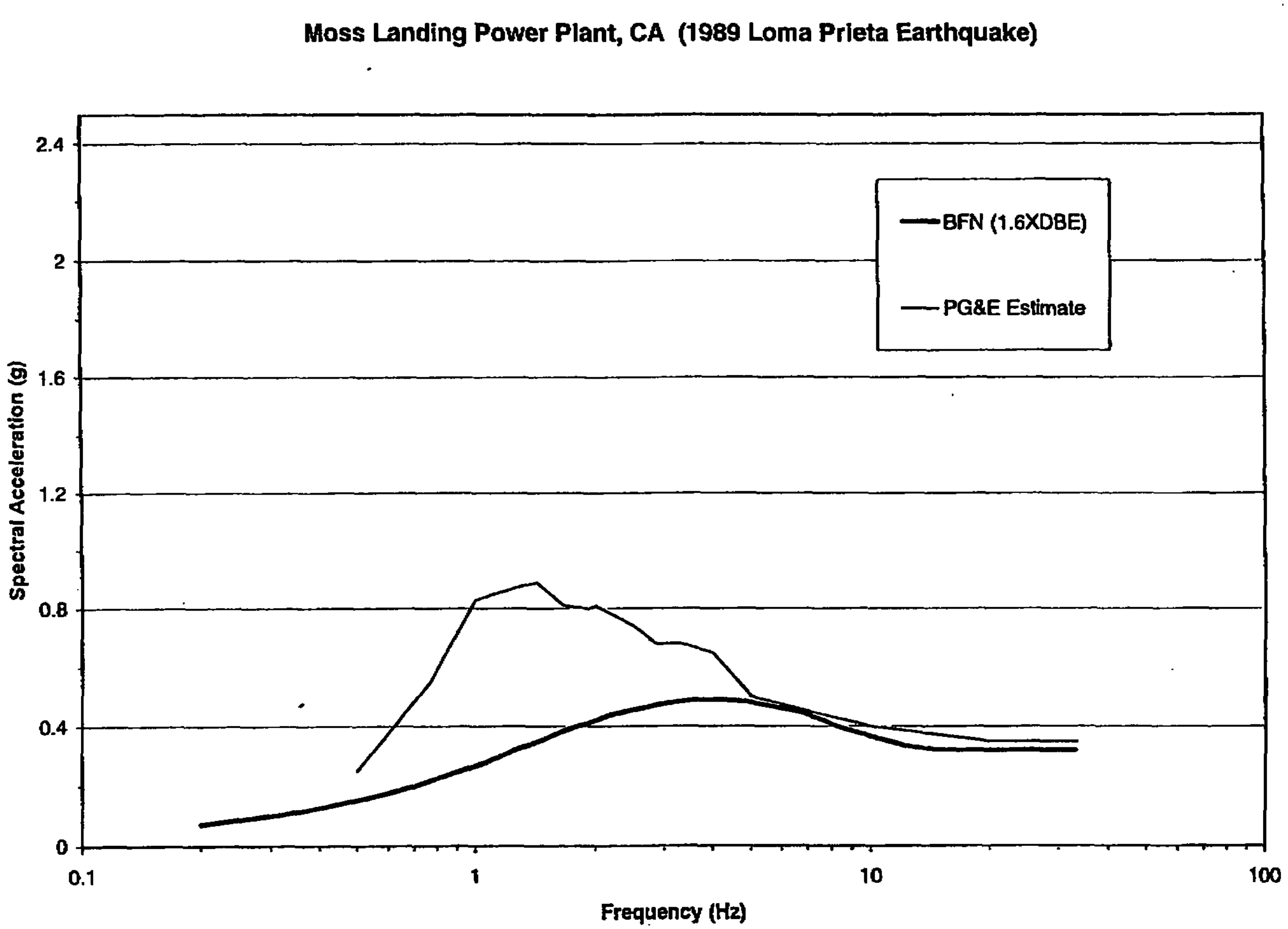


Figure 2-5 Comparison of Browns Ferry DBE and Moss Landing Power Plant Ground Spectra

CD-N0001-990113 Page A17
Attachment A

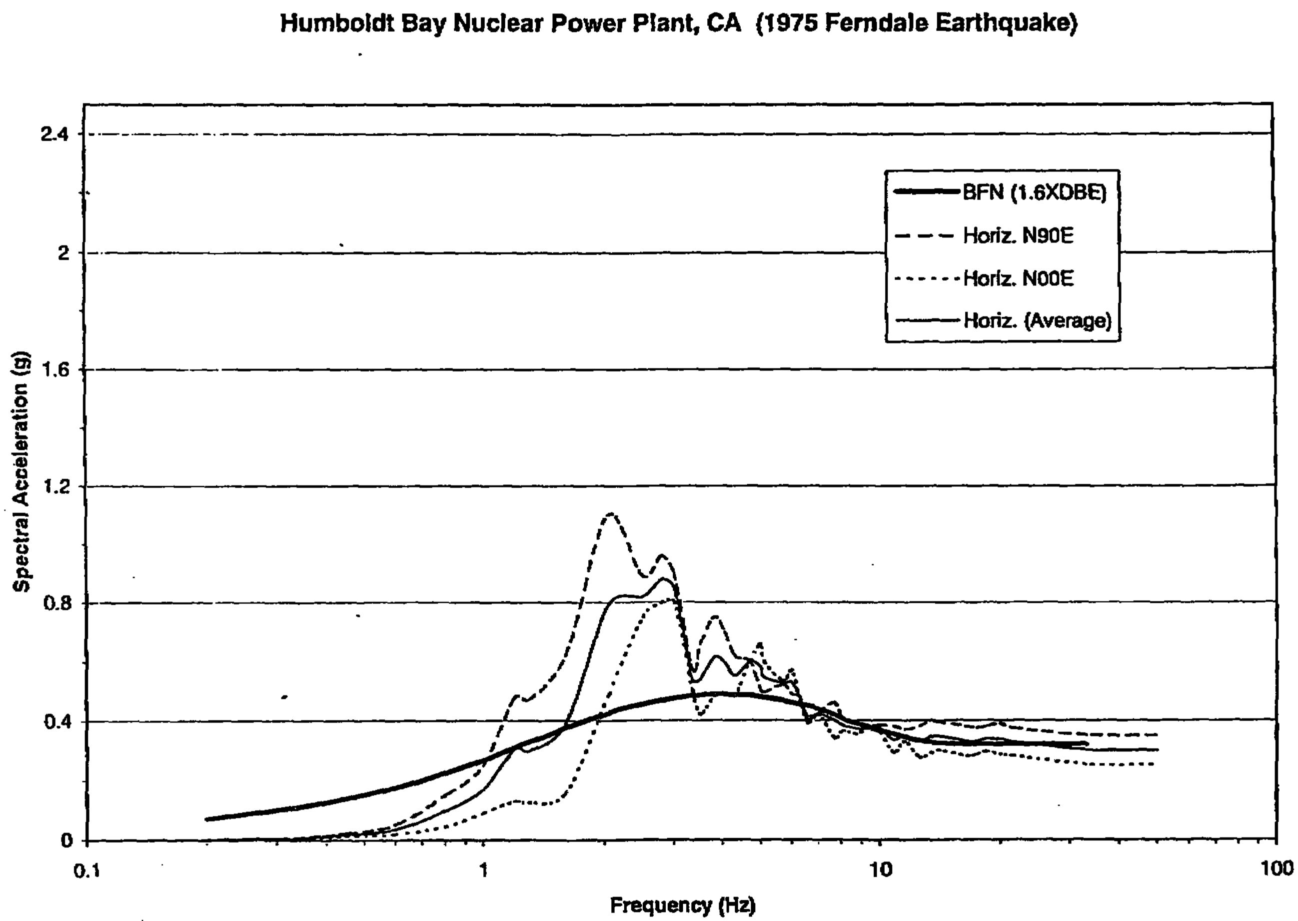


Figure 2-6 Comparison of Browns Ferry DBE and Humboldt Bay Nuclear Power Plant Ground Spectra

CD-N0001-990113 Page A18
Attachment A

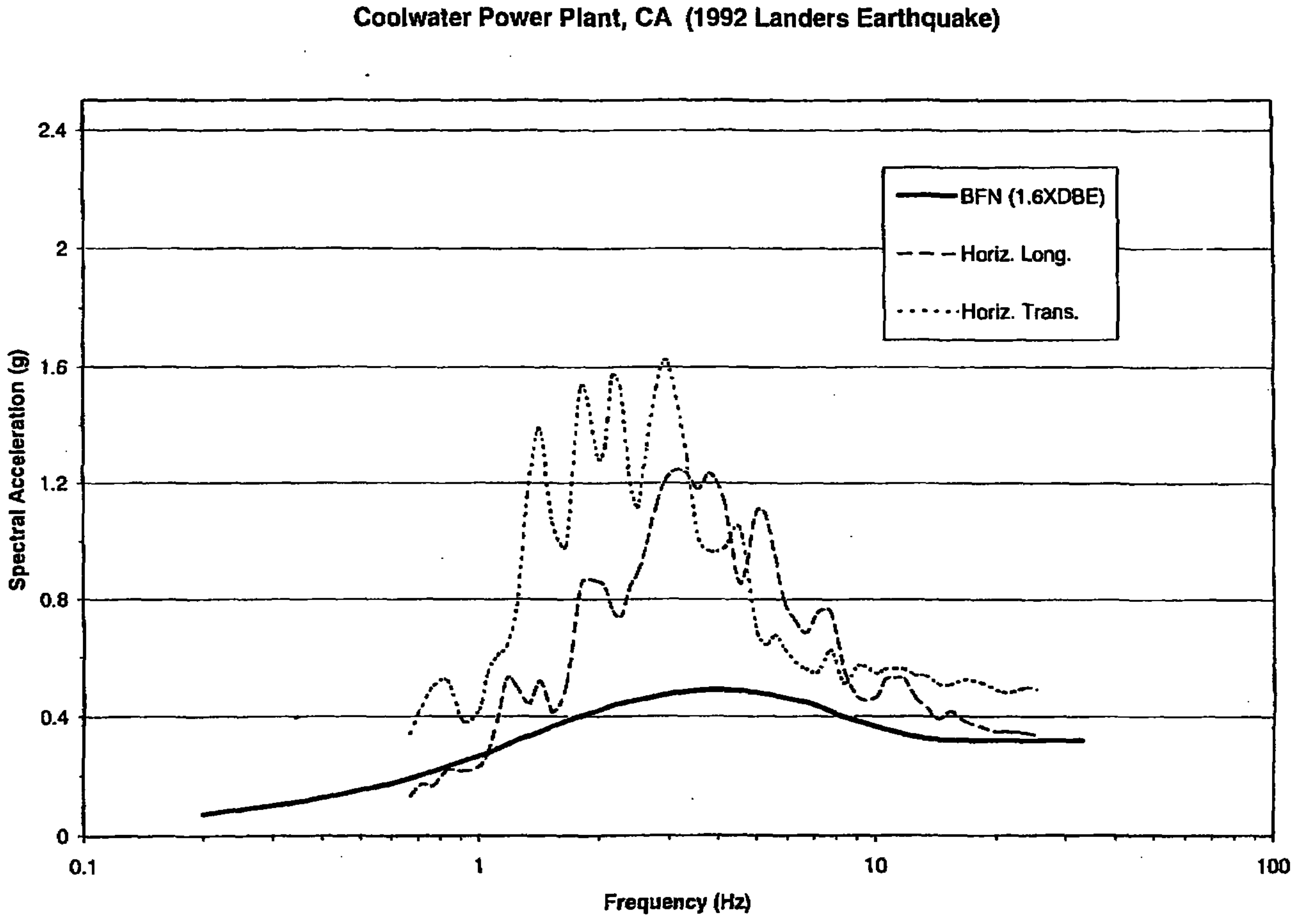


Figure 2-7 Comparison of Browns Ferry DBE and Coolwater Power Plant Ground Spectra

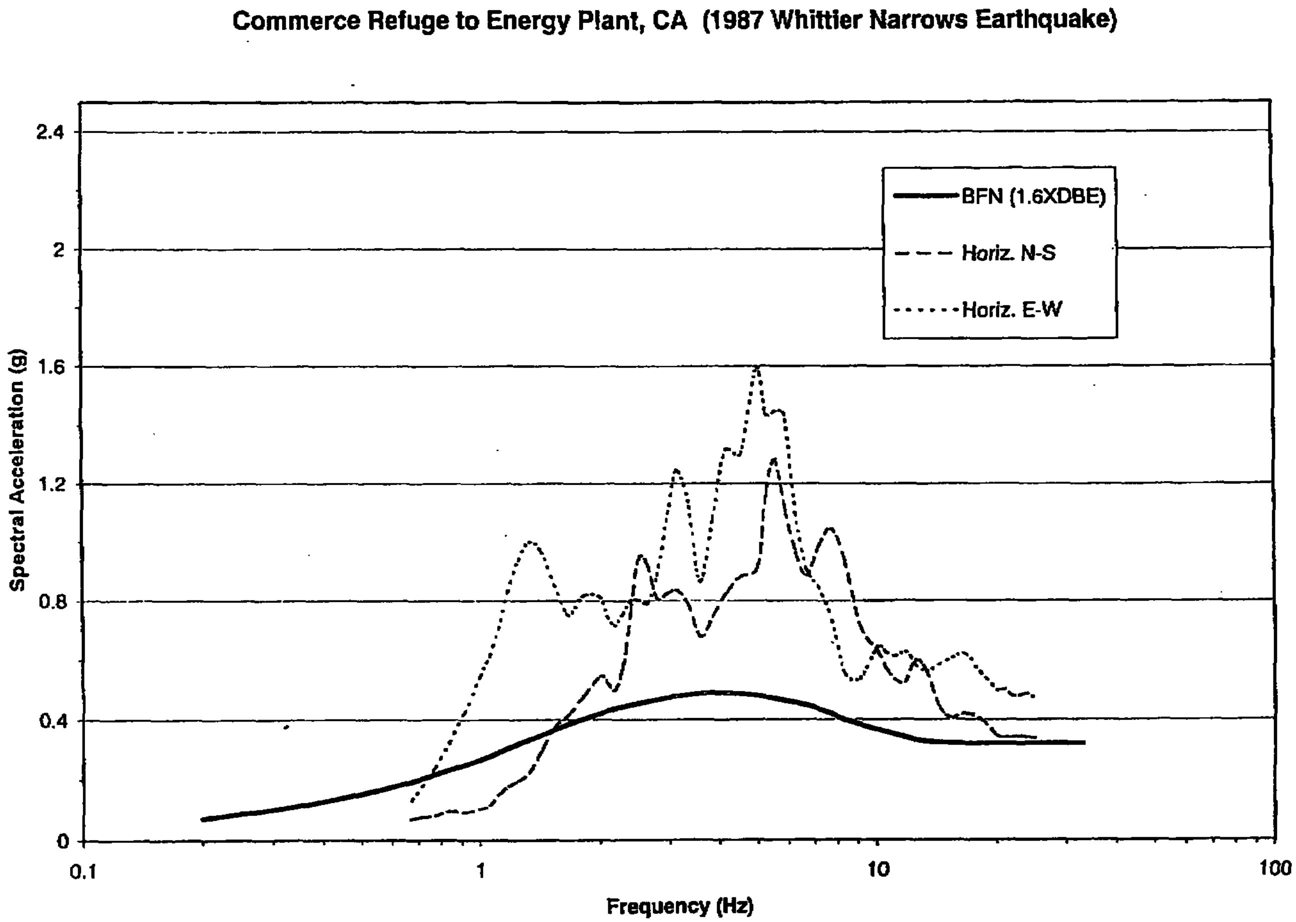


Figure 2-8 Comparison of Browns Ferry DBE and Commerce Refuge to Energy Plant Ground Spectra

CD-N0001-990113 Page A20
Attachment A

Grayson Power Plant, Glendale, CA (1971 San Fernanado Earthquake)

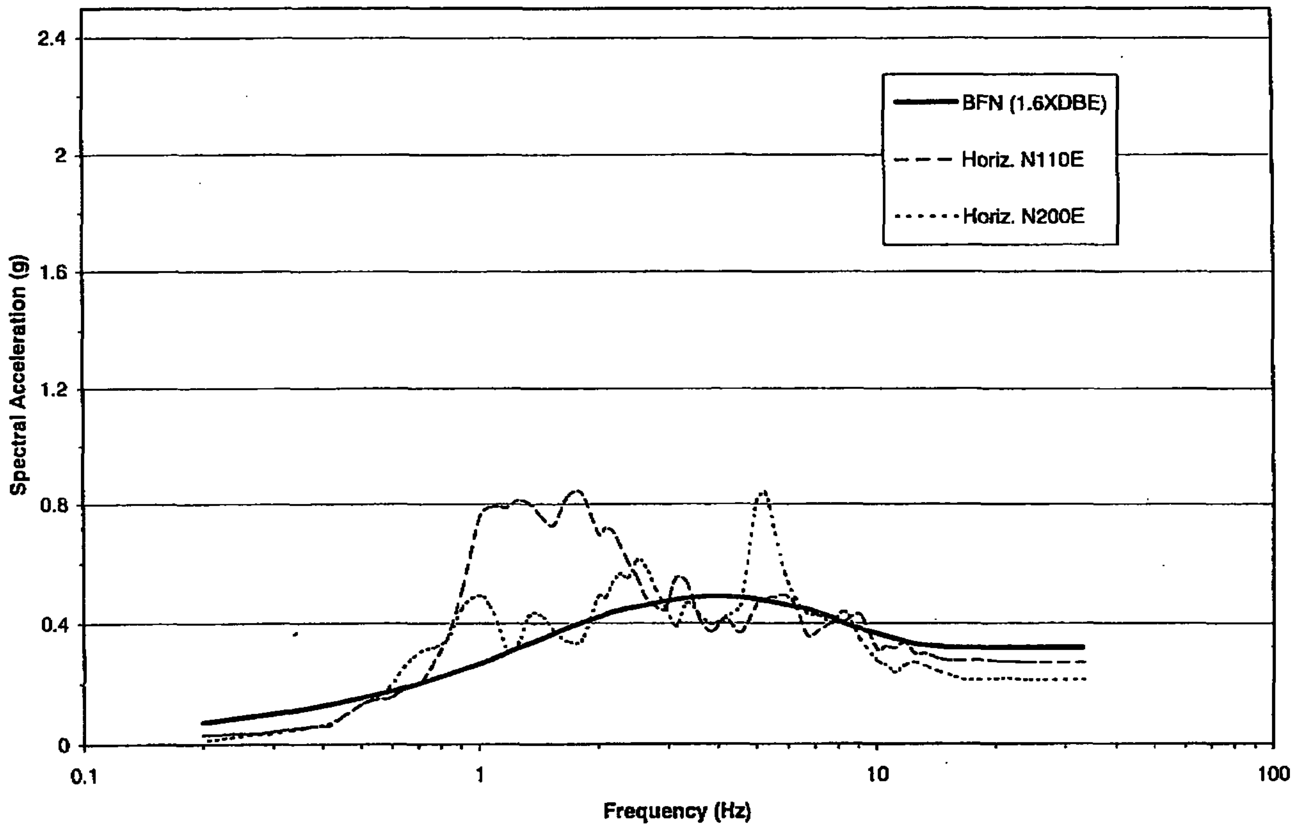


Figure 2-9 Comparison of Browns Ferry DBE and Grayson Power Plant Ground Spectra

CD-N0001-990113 Page A21
Attachment A

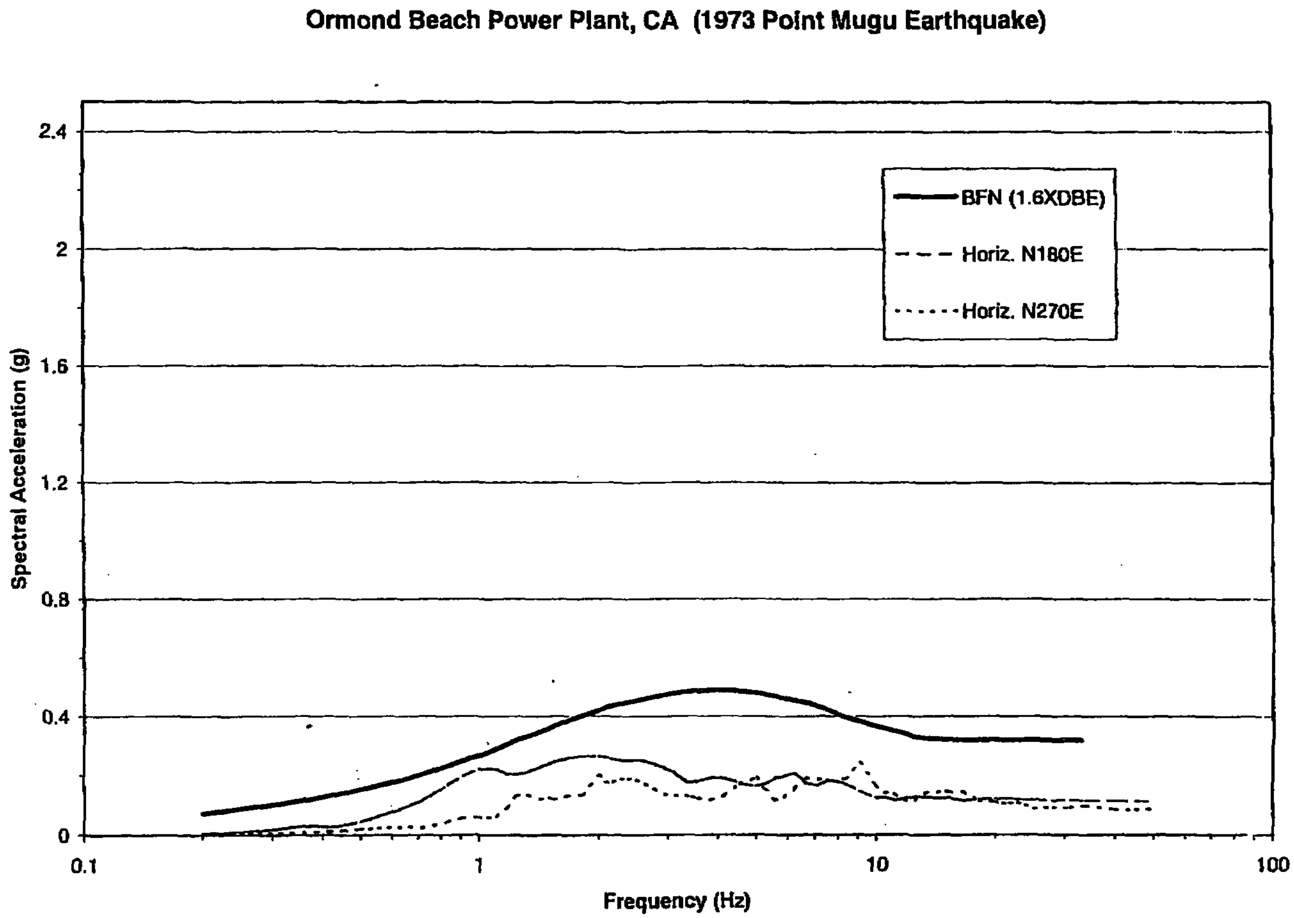
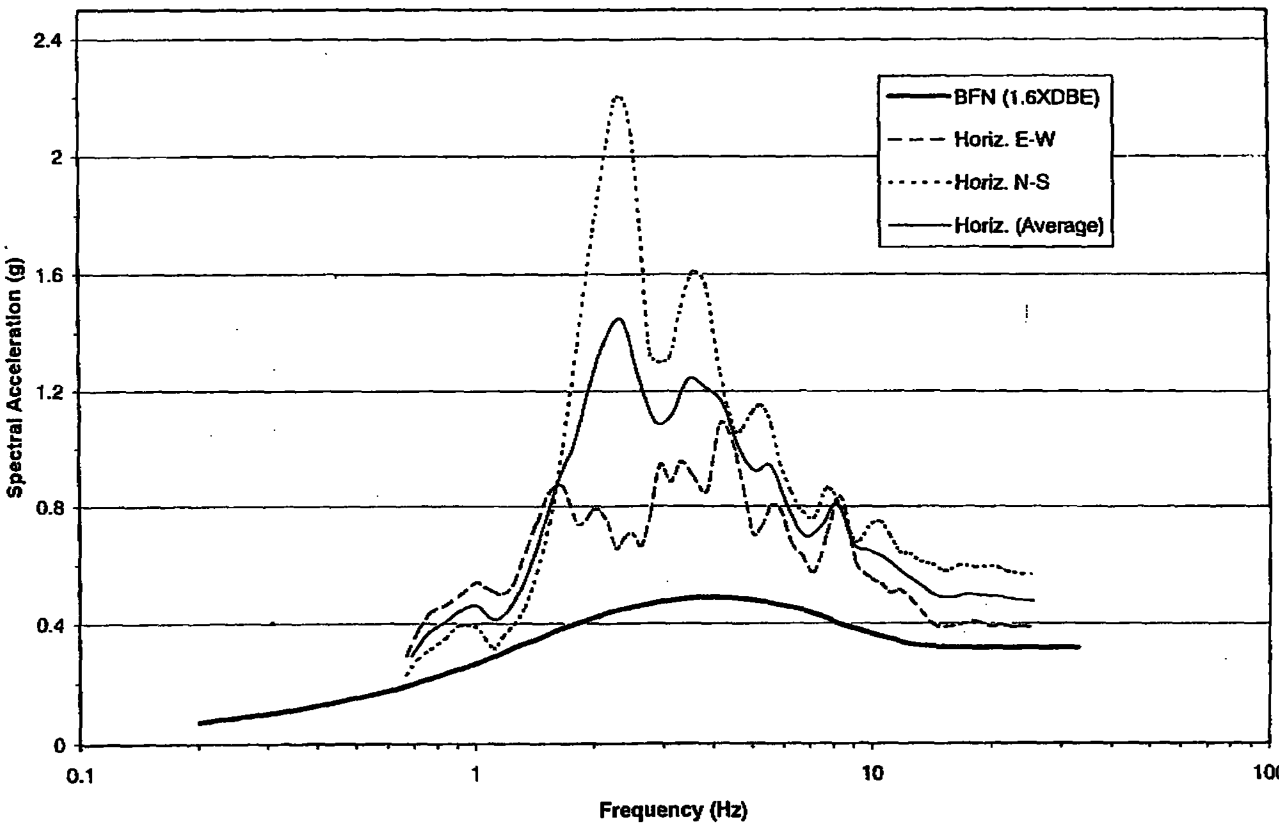


Figure 2-10 Comparison of Browns Ferry DBE and Ormond Beach Power Plant Ground Spectra

PALCO Cogeneration Plant, CA (1992 Petrolia Earthquake)



CD-N0001-990113 Page A23
Attachment A

Figure 2-11 Comparison of Browns Ferry DBE and PALCO Cogeneration Plant Ground Spectra

3. SEISMIC VERIFICATION WALKDOWNS

Very few components of nuclear plant systems are unique to the nuclear facilities. Nuclear plant systems include equipment, piping, tubing, conduit, and many other items that are common components of conventional power plants and industrial facilities. Seismic experience data based methods have been developed to address seismic issues associated with the adequate performance of these equipment and commodities not designed, procured and installed to current nuclear seismic criteria. By reviewing the performance of the database facilities that contain equipment similar to that found in nuclear plants, conclusions can be drawn about the performance of nuclear plant equipment during and after earthquake events.

Extensive work has been performed documenting the performance of power plant equipment performance and the common sources of seismic damage to equipment and piping. In general, equipment, piping and tubing systems in the seismic experience database have performed very well in earthquakes, even though they were typically designed for deadweight and operating loads only, with little or no consideration for seismic loads. Performance of piping and equipment in past earthquakes are summarized in Appendix D of the BWROG Report (Reference 1). Earthquake experience-based methods provide the basis for the seismic review of the main steam piping and equipment within the MSIV alternate leakage treatment (ALT) boundary at BFN.

3.1 SEISMIC VERIFICATION REVIEW GUIDELINES

Various design attributes of the as-installed scope of equipment, piping, and tubing were reviewed and evaluated by the Seismic Walkdown Teams to ensure that the BFN installations are representative of database design practice and that components are free of known seismic vulnerabilities. Earthquake experience has identified conditions that have resulted in failure of piping and tubing systems and components. The conditions evaluated in the walkdown reviews included:

- Piping, Pipe Support and Equipment Design Attributes
- Seismic Anchor Movement Issues
- Seismic Interaction Issues (II/I & Proximity)
- Valve Design Attributes

The above design attributes and conditions are briefly discussed below.

3.1.1 Piping, Pipe Support and Equipment Design Attributes

The Seismic Walkdown reviewed the piping and tubing systems, and associated supports to ensure that the design attributes and conditions are consistent with good design and industry standard practices. The systems were also screened to ensure that they are free from known seismic vulnerabilities identified from earthquake experience data. These design attributes include:

- Piping with dead weight support spacing greatly in excess of the B31.1 suggested spans, or tubing with excessive sagging.
- Heavy, unsupported in-line components.
- Piping constructed of non-ductile materials such as cast iron or PVC.
- Non-standard fittings or unusual attachments that could cause excessive localized stresses.
- Pipe supports that exhibit non-ductile behavior.
- Presence of severe corrosion.

In addition, anchorage of terminal equipment to piping and tubing systems were reviewed for adequacy.

3.1.2 Seismic Anchor Movement Issues

The experience database includes instances of seismic damage to piping, tubing and supports that were attributed to seismic anchor movement. Damage was the result of excessive movement of terminal end equipment, differential movement between supports in adjacent buildings, and excessive movements imposed on branch lines by flexible headers. These attributes were evaluated during the piping walkdowns.

3.1.3 Seismic Interaction Issues (II/I and Proximity)

The seismic interaction review was a visual inspection of structures, piping, or equipment adjacent to the components under evaluation. The seismic interaction review evaluated conditions where seismically induced failures (II/I) and displacements of adjacent structures, piping, or equipment (proximity) could adversely affect the required seismic performance of the system and components under consideration.

3.1.4 Valve Design Attributes

Screening guidelines are provided for valves that are relied upon to establish the ALT pathway or are part of the Seismic Verification Boundary. The guidelines are consistent with the SQUG Generic Implementation Procedure (GIP, Reference 5) and include provisions for air-operated diaphragm valves, spring-operated pressure relief valves, piston-operated valves of light-weight construction, motor-operated valves, and substantial piston-operated valves.

3.2 SEISMIC VERIFICATION BOUNDARY

The walkdown scope included the Main Steam drain path that will be established to convey leakage past the outboard Main Steam Isolation Valves (MSIV) to the isolated condenser and includes piping, instrumentation, valves and equipment that would be required to maintain the drain pathway.

The Seismic Verification Boundary for the MSIV Alternate Leakage Treatment path was developed in consultation with TVA Browns Ferry Systems Engineering, and is shown in

Figure 3-1. The associated flow diagrams are listed on Table 3-1, and the piping isolation boundaries defining the seismic verification boundary are shown on Table 3-2. The Seismic Verification Boundary generally consists of the following portions of the Main Steam (MS) system beyond the outboard MSIV's:

1. Main Steam drain path to the condenser for any leakage past the isolated outboard MSIVs.
2. Main Steam piping from the outboard MSIV to the Main Steam Stop Valves (MSV).
3. Main Steam Bypass piping from the Main Steam lines to the Bypass Valve chest.
4. Main Condensers.
5. Additional piping and instrumentation within the Seismic Verification Boundary includes:
    - Stop Valve Above Seat Drains to Condenser
    - Steam Sample System
    - HPCI/RCIC Steam Drains to Main Steam
    - Auxiliary Boiler Drains to Main Steam
    - Main Steam Instrumentation
    - Main Steam Supply to the Reactor Feed Pumps
    - Main Steam Supply to the Steam Jet Air Ejectors
    - Main Steam Supply to the Off-Gas Preheaters

The above Seismic Verification Boundary was originally developed for Unit 3 seismic walkdown. The Unit 2 Seismic Verification Boundary was less than that shown above for Unit 3. The original Unit 2 boundary assumed the addition of an isolation valve to isolate the steam path to the RFP Turbines and that the steam feed shutoff valve 8-575 would be qualified as an isolation boundary to the Steam Seal system. The Unit 2 Seismic Verification Boundary will be expanded and additional walkdown will be performed during the Unit 2 Cycle 11 outage to remove the assumptions of the isolation valves noted above, hence, eliminating the unit differences with Unit 3 Seismic Verification Boundary.

3.3 WALKDOWN RESULTS

Field walkdowns of the main steam lines, ALT drain path and associated appendages within the Seismic Verification Boundary were conducted during the Unit 3 recovery outage in April 1995, and during the Unit 2 refueling outage in April 1996 by EQE engineers. Plant specific guidance, systems expertise and support were provided by BFN Site Engineering staff. All members of the MSIV Seismic Verification Walkdown Teams are degreed engineers, have ten to twenty years of experience in structural engineering and/or earthquake engineering application to nuclear power plants, and are familiar with the earthquake experience methodology. EQE engineers have performed the complete MSIV Seismic Verification Walkdowns in accordance with the recommendations of the GE NEDC-31858P (BWROG Report, Reference 1) at several other plants.

Results of the Seismic Verification Walkdowns, including the identified walkdown open items or "Outliers", are discussed in detail in References 3 and 4 for Browns Ferry, Unit 3 and Unit 2, respectively. A brief summary of the walkdown results is presented below, with walkdown outliers summarized in Table 3-3 and 3-4 for Browns Ferry, Unit 3 and Unit 2, respectively.

3.3.1 Unit 3 Seismic Walkdown

The main steam drain piping included in the Unit 3 MSIV alternate leakage treatment (ALT) path to the condenser generally conform to ANSI B31.1 design guidelines. Piping are typically insulated, and constructed from carbon steel, SA-106 Grade B, with butt-welded or socket-welded joints. In addition, pipe supports consist of a combination of rigid struts and U-bolt brackets, floor-mounted stanchions, and spring or rod hangers. The as-installed configurations are inherently rugged and are similar to those found in the earthquake experience database facilities that have performed well during past earthquakes.

The piping systems within the Unit 3 MSIV Seismic Verification Boundary were divided into the following 13 portions for walkdown purposes:

1. Main Steam drain line in the Turbine Building
2. Main Steam lines in the Turbine Building
3. Main Steam and Main Steam drain lines in the Reactor Building MSIV vault
4. HPCI/RCIC/Auxiliary Boiler drains in the Reactor Building and above the Torus
5. Main Steam PT instrumentation lines
6. Main Steam sampling lines to the Sample Station
7. Main Steam bypass lines
8. Main Steam stop valve above seat drains
9. Steam supply to Steam Seal Regulators
10. Steam supply to RFP Turbines
11. Steam supply to Steam Jet Air Ejectors
12. Steam supply to Off-Gas Preheaters
13. Condensers

Conditions not meeting the Seismic Verification Review guidelines, as discussed in Section 3.1 of this report, were identified and documented as "Outliers" for further evaluation and resolution by the Seismic Walkdown Teams. These conditions included limited numbers of piping overspans, equipment anchorage or support integrity issues, proximity or falling interaction concerns, flexibility concerns due to seismic anchor movements or differential displacements, boundary valve integrity issues, and general maintenance or housekeeping items. Table 3-3 presents a summary of Unit 3 MSIV walkdown outliers.

3.3.2 Unit 2 Seismic Walkdown

Similar to Unit 3, the main steam drain piping included in the Unit 2 MSIV alternate leakage treatment (ALT) path to the condenser generally conform to ANSI B31.1 design guidelines. Piping are typically insulated, and constructed from carbon steel, SA-106 Grade B, with butt-welded or socket-welded joints. Pipe supports consist of a combination of rigid struts and U-bolt brackets, floor-mounted stanchions, and spring or rod hangers. The as-installed configurations are inherently rugged and are similar to those found in the earthquake experience database facilities that have performed well during past earthquakes.

The piping systems within the scope of the original Unit 2 MSIV Seismic Verification Walkdown Boundary were divided into the following 11 portions for walkdown purposes:

1. Main Steam drain line in the Turbine Building
2. Main Steam lines in the Turbine Building
3. Main Steam and Main Steam drain lines in the Reactor Building MSIV vault
4. HPCI/RCIC/Auxiliary Boiler drains in the Reactor Building and above the Torus
5. Main Steam PT instrumentation lines
6. Main Steam sampling lines to the Sample Station
7. Main Steam bypass lines
8. Main Steam stop valve above seat drains
9. Steam supply to Steam Feed valve 8-575 (proposed isolation boundary)
10. Steam supply to RFP Turbines (with proposed manual isolation valve to be located on the Turbine Building operating deck, El. 617')
13. Condensers

Conditions not meeting the Seismic Verification Review guidelines, as discussed in Section 3.1 of this report, were identified and documented as "Outliers" for further evaluation and resolution by the Seismic Walkdown Teams. As in the Unit 3 walkdown, these conditions included limited numbers of piping overspans, equipment anchorage or support integrity issues, proximity or falling interaction concerns, flexibility concerns due to seismic anchor movements or differential displacements, boundary valve integrity issues, and general maintenance or housekeeping items. Table 3-4 presents a summary of the Unit 2 MSIV walkdown outliers.

As mentioned in Section 3.2 above, the original Unit 2 Seismic Verification Boundary will be expanded and additional walkdown will be performed during the Unit 2 Cycle 11 outage to remove the assumptions of the isolation valves, hence, eliminating the unit differences with Unit 3 Seismic Verification Boundary.

3.3.3 Additional Seismic Walkdown

As mentioned in Section 3.2 above, the Unit 2 Seismic Verification Boundary will be expanded to include portions of the steam supply lines from the Main Steam Header to the turbine drives for the Reactor Feed Pumps, the Steam Jet Air Ejectors, the Off-Gas Preheaters, and the Steam Seal Regulators, i.e., extension of piping portions 9 and 10, and portions 11 and 12, as in the Unit 3 walkdown scope. The resulting Unit 2 Seismic Verification Boundary will then be consistent with that of Unit 3, hence, eliminating any unit differences between them. Additional seismic verification walkdown for the expanded scope will be performed during the Unit 2 Cycle 11 outage to verify the seismic ruggedness of the MS piping and associated components, and all identified outliers will be resolved during the same outage. Design Change Notice (DCN) will address any physical changes to restore the drain path into compliance.

Table 3-1

BROWNS FERRY MSIV LEAKAGE BOUNDARY FLOW DIAGRAMS

Drawing Number	System Description
Unit 2	
2-47E801-1	Main Steam System
2-47E801-2	Main Steam System
2-47E805-3	Heater Drains & Vents and Miscellaneous Piping Systems
2-47E807-1	Turbine Drains and Miscellaneous Piping Systems
2-47E807-2	Turbine Drains and Miscellaneous Piping Systems
2-47E812-1	High Pressure Coolant Injection System
2-47E813-1	Reactor Core Isolation Cooling System
0-47E815-1 2-47E815-4	Auxiliary Boiler System
2-47E610-43-1	Sampling and Water Quality System
Unit 3	
3-47E801-1	Main Steam System
3-47E801-2	Main Steam System
3-47E805-3	Heater Drains & Vents and Miscellaneous Piping Systems
3-47E807-1	Turbine Drains and Miscellaneous Piping Systems
3-47E807-2	Turbine Drains and Miscellaneous Piping Systems
3-47E812-1	High Pressure Coolant Injection System
3-47E813-1	Reactor Core Isolation Cooling System
3-47E815-5	Auxiliary Boiler System
3-47E610-43-6	Sampling and Water Quality System

Table 3-2
BFN MSIV LEAKAGE BOUNDARY POINTS

Leakage Boundary Point *	Flow Diagram/ Drawing *	Comment
FCV-1-15	47E801-1	MSIV for Main Steam Line A
FCV-1-27	47E801-1	MSIV for Main Steam Line B
FCV-1-38	47E801-1	MSIV for Main Steam Line C
FCV-1-52	47E801-1	MSIV for Main Steam Line D
FCV-1-56	47E801-1	Outboard Containment Isolation valve for Primary Containment steam drains
1-521 1-527	47E801-1	Normally closed Main Steam Drain manual isolation valves
43-631	2-47E610-43-1 3-47E610-43-6	Normally closed Main Steam Sample System manual isolation valve
43-631A	2-47E610-43-1 3-47E610-43-6	Normally closed Main Steam Sample System manual isolation valve
43-632	2-47E610-43-1 3-47E610-43-6	Normally closed Main Steam Sample System manual isolation valve
FCV-1-74	47E801-2	Main Turbine Stop Valve for Steam Line A
FCV-1-78	47E801-2	Main Turbine Stop Valve for Steam Line B
FCV-1-84	47E801-2	Main Turbine Stop Valve for Steam Line C
FCV-1-88	47E801-2	Main Turbine Stop Valve for Steam Line D
FCV-1-61 FCV-1-62 FCV-1-63 FCV-1-64 FCV-1-65 FCV-1-66 FCV-1-67 FCV-1-68 FCV-1-69	47E801-2	Main Steam Bypass Valve Chest
FCV-73-6B	47E812-1	Normally open air operated isolation valve – HPCI
FCV-71-6B	47E813-1	Normally open air operated isolation valve – RCIC
12-635	2-47E815-4 3-47B815-5	Normally closed manual isolation valve – Aux. Boiler

Table 3-2 (CONT.)

BFN MSIV LEAKAGE BOUNDARY POINTS

Leakage Boundary Point *	Flow Diagram/ Drawing *	Comment
12-637	2-47E815-4 3-47B815-5	Normally closed manual isolation valve – Aux. Boiler
12-623	2-47E815-4 3-47B815-5	Normally closed manual isolation valve – Aux. Boiler
12-625	2-47E815-4 3-47B815-5	Normally closed manual isolation valve – Aux. Boiler
2-12-822	0-47E815-1	Normally closed manual isolation valve – Aux. Boiler (Unit 2 only)
FCV-6-100	47E807-1	Normally closed motor operated isolation valve - Stop valve above seat drains
FCV-6-101	47E807-1	Normally closed motor operated isolation valve - Stop valve above seat drains
FCV-6-102	47E807-1	Normally closed motor operated isolation valve - Stop valve above seat drains
FCV-6-103	47E807-1	Normally closed motor operated isolation valve - Stop valve above seat drains
FCV-1-127	47E801-2	Reactor Feed Pump Turbine A Stop Valve
FCV-1-135	47E801-2	Reactor Feed Pump Turbine B Stop Valve
FCV-1-143	47E801-2	Reactor Feed Pump Turbine C Stop Valve
FCV-6-153	47E807-2	Normally closed motor operated isolation valve - RFP
FCV-6-155	47E807-2	Normally closed motor operated isolation valve - RFP
FCV-6-157	47E807-2	Normally closed motor operated isolation valve - RFP
FCV-6-122	47E807-2	Normally closed motor operated isolation valve - RFP
FCV-6-127	47E807-2	Normally closed motor operated isolation valve - RFP
FCV-6-132	47E807-2	Normally closed motor operated isolation valve - RFP
PCV-1-151	47E801-2	Normally open air operated isolation valve - SJAE
PCV-1-166	47E801-2	Normally open air operated isolation valve - SJAE
PCV-1-153	47E801-2	Normally open air operated isolation valve - SJAE
PCV-1-167	47E801-2	Normally open air operated isolation valve - SJAE
6-826	47E805-3	Check valve – SJAE
6-822	47E805-3	Check valve – SJAE

Table 3-2 (CONT.)
BFN MSIV LEAKAGE BOUNDARY POINTS

Leakage Boundary Point *	Flow Diagram/ Drawing *	Comment
FCV-1-145	47E807-2	Normally closed motor operated isolation valve – Steam Seal Regulator
FCV-1-154	47E807-2	Normally closed motor operated isolation valve – Steam Seal Regulator
FCV-1-147	47E807-2	Air operated pressure regulating valve – Steam Seal Regulator
CKV-1-742	47E801-2	Check valve (NEW) – Off-Gas Preheater A
CKV-1-744	47E801-2	Check valve (NEW) – Off-Gas Preheater B
Condenser A	---	The condenser is the ultimate boundary for the MSIV leakage path.
Condenser B	---	The condenser is the ultimate boundary for the MSIV leakage path.
Condenser C	---	The condenser is the ultimate boundary for the MSIV leakage path.
Miscellaneous test, vent, drain and instrument connections	47E801-1 47E801-2	---

NOTE:

* Boundary component ID's and flow diagram/drawing nos. are generally applicable to both Units 2 and 3, unless noted otherwise specifically (i.e., 2- for Unit 2; 3- for Unit 3; and 0- for common)

Table 3-3
BROWNS FERRY UNIT 3
MSIV WALKDOWN "OUTLIERS"

SYSTEM DESCRIPTION	ID[1]	OUTLIER[2]	A	F	P	D	V
Main Steam Drain Line-Turbine Bldg.	1						
MS Drain Taps	1-1	MS Line differential motion				X	
MS Drain Taps	1-2	Impact with conduit supports			X		
FCV 1-58	1-3	Extended valve operators					X
FCV 1-58/59 Conduit	1-4	Unknown routing at TB/RB joint				X	
Main Steam Lines -- Turbine Bldg.	2						
MS Stop Valves	2-1	Valve performance	X				X
MSH-17	2-2	Missing eyebolt nut	X				
MSH-17,18 & 19	2-3	Grating clearance			X		
Main Steam Drain Line- MSIV Vault	3						
FCV 1-15, 27, 38 & 52	3-1	Valve performance	X				X
FCV 1-56	3-2	Manual operator					X
HPCI/RCIC Drain	4						
HPCI Drain at MS drain connection	4-1	Inadequate bending leg	X				
MS PT 1-72, 76, 82, 86 & 93	5						
MS instrument tubing	5-1	Overspan on 1" pipe to PT 1-86		X			
1/2 Line to PT 1-86	5-2	Interaction with steel & pipe			X		
Main Steam Sample to Station	6						
Sample lines B & D	6-1	Missing tubing support clamps		X			
Sample lines A, B, C, D	6-2	Inadequate flex legs at MS line				X	
PT 16A/B	6-3	Inadequate flex legs at MS line				X	
Sample Station	6-4	Temperature bath anchorage	X				
Main Steam Bypass	7						
Main Steam Bypass Valve	7-1	Valve performance	X				X
SV Above Seat Drains	8						
FCV 6-100, 101, 102, 103	8-1	Short rod hangers		X			
Steam to Steam Seal Regulator	9						
MS to FCV 1-146	9-1	Overspan piping		X			
PCV 1-147	9-2	Handwheel proximity to WF			X		
PCV 1-147 airline	9-3	Inadequate flexibility & blockwall			X	X	
PCV 1-147	9-4	Extended valve operator					X

Table 3-3 (CONT.)
BROWNS FERRY UNIT 3
MSIV WALKDOWN "OUTLIERS"

SYSTEM DESCRIPTION	ID[1]	OUTLIER[2]	A	F	P	D	V
Steam Supply to RFP Turbines	**10**						
Steam supply line	10-1	Inadequate flex leg at MS header				X	
Steam supply line	10-2	Stanchion supports		X			
Steam supply line	10-3	TB crane overhead			X		
RFP Stop Valve above seat drains	10-4	Large mass on the 1/2 & 3/4 inch lines	X				
Tubing to PI 1-126	10-5	Missing tubing clamps – overspan		X			
Steam Supply to SJAE	**11**						
SJAE 3A/B	11-1	Anchorage	X				
SJAE 3B	11-2	Loose anchor bolt nut	X				
Drain to Condenser	11-3	Drain ties to multi system collector					X
Steam to Off-Gas Preheaters	**12**						
PCV 1-175A/B	12-1	Masonry wall			X		
Steam supply line to FCV 1-178A/B	12-2	Vert. restraint of line at FCV 1-178				X	
PCV 1-175A/B, FCV 1-178A/B	12-3	Valve performance					X
Condenser	**13**						
Condenser and anchorage adequacy	13-1	Evaluate condenser/anchorage	X				

KEY TO ISSUES:

A Anchorage or Support Capacity

F Failure and Falling (II/I)

P Proximity and Impact

D Differential Displacement

V Valve Screening

NOTES:

1 - ID - Refers to MSIV Walkdown package identifier.

2 - "Outliers" are plant conditions which require further evaluation.

Table 3-4

BROWNS FERRY UNIT 2
MSIV WALKDOWN "OUTLIERS"

SYSTEM DESCRIPTION	ID[1]	OUTLIER[2]	A	F	P	D	V
Main Steam Drain Line-Turbine Bldg.	1						
MS Drain Taps		1-1: MS Line differential motion				X	
FCV-1-58		1-2: Extended valve operators					X
Main Steam Lines – Turbine Bldg.	2						
MS Stop Valves		2-1: Valve performance	X				X
RB MSIV Vault - MS and MS Drain	3						
FCV-1-15, -27, -38 & -52		3-1: Valve performance					X
HPCI/RCIC/Aux. Boiler Drains	4A						
HPCI Drain at MS drain connection		4-1: Inadequate bending leg	X			X	
HPCI Drain in RB Steam Vault		4-2: Piping overspan	X				
HPCI Drain in RB SE Corner Rm		4-3: Piping overspan	X				
HPCI/RCIC/Aux. Boiler Drains	4B						
HPCI & Aux. Boiler drain lines supports		4-4: Miscellaneous maintenance items	X				
HPCI Drain above the Torus		4-5: Piping overspan	X				
RCIC Drain above the Torus		4-6: Inadequate support	X				
MS PT-1-72, -76, -82 & -86	5						
1/2" PT Piping from Steam Lines		5-1: Interaction with platform steel				X	
Main Steam Sampling	6						
PT-16A/B Piping		6-1: Interaction with Feedwater piping			X		
Sample lines A, B, C, D		6-2: Inadequate flex legs at MS line				X	
PT-16A/B		6-3: Inadequate flex legs at MS line				X	
Sample Station		6-4: Temperature bath anchorage	X			X	
PT-16A/B		6-5: Interaction with oil drum			X		
Main Steam Bypass	7						
Main Steam Bypass Valve		7-1: Valve performance	X				X
SV Above Seat Drains	8						
FCV-6-100, -101, -102 & -103		8-1: Short rod hangers	X				
1" Drain Piping from Steam Line D		8-2: Interaction with MS piping/steel			X		

Table 3-4 (CONT.)

BROWNS FERRY UNIT 2
MSIV WALKDOWN "OUTLIERS"

SYSTEM DESCRIPTION	ID[1]	OUTLIER[2]	A	F	P	D	V
Steam to Steam Feed Valve	9						
Rod Hanger Downstream of Valve 8-575		9-1: Disengaged rod hanger	X				
Verification Boundary Valve 8-575 (Proposed in the Original Scope)		9-2: Normally open manual valve					X
Steam Supply to RFP Turbines	10						
Steam supply line		10-1: Inadequate flex leg at MS header				X	
Steam supply line		10-2: Stanchion supports		X			
Steam supply line		10-3: TB overhead crane		X	X		
Verification Boundary Valve 1-RFPT (Proposed in the Original Scope)		10-4: Installation of valve					X
Condensers	13						
Condenser anchorage		13-1: Evaluate anchorage	X				

KEY TO ISSUES:

A Anchorage or Support Capacity

F Failure and Falling (II/I)

P Proximity and Impact

D Differential Displacement

V Valve Screening

NOTES:

1 - ID - Refers to MSIV Walkdown package identifier.

2 - "Outliers" are plant conditions which require further evaluation.

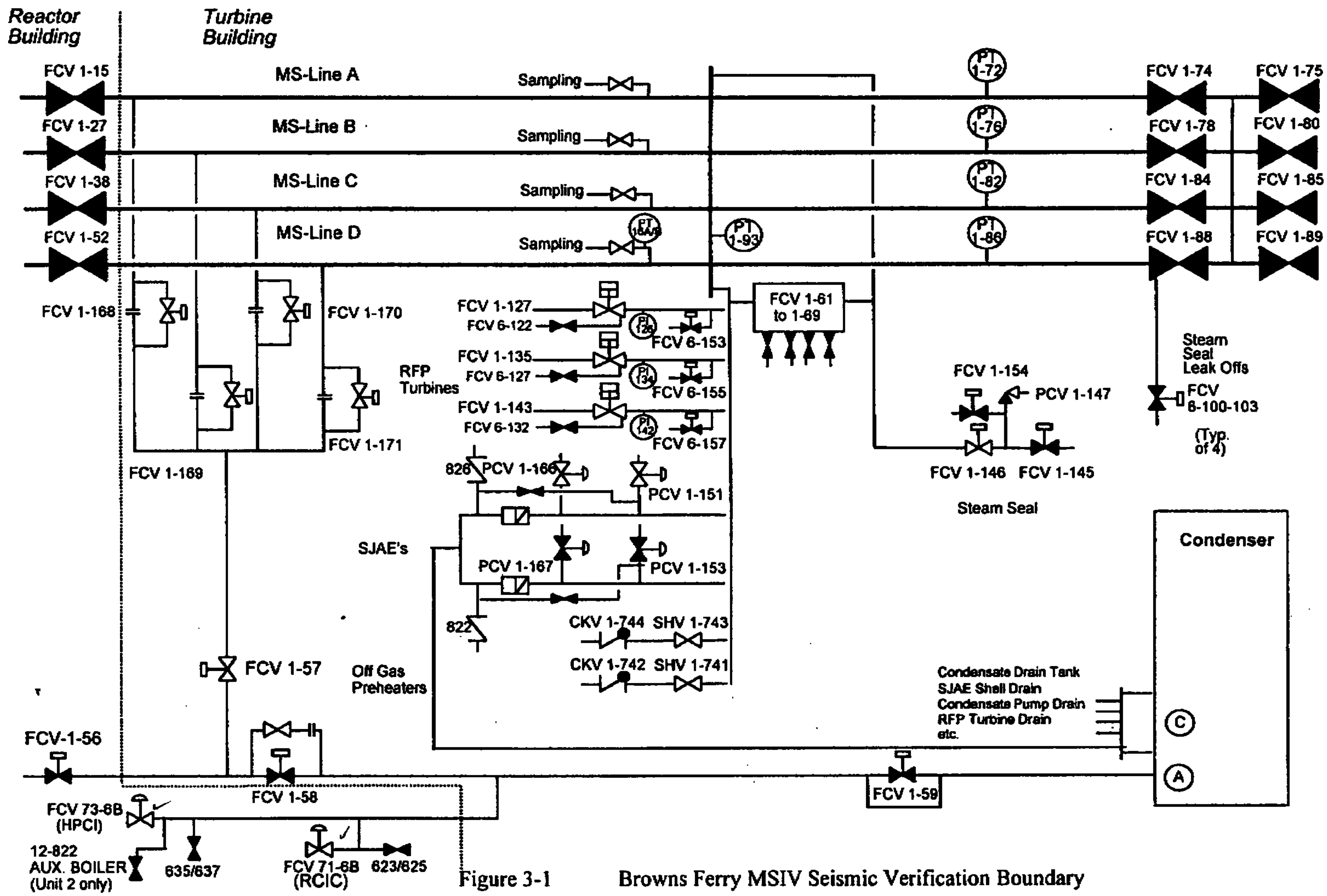


Figure 3-1 Browns Ferry MSIV Seismic Verification Boundary

R1

THIS PG REPLACED BY REV 1

CD-N0001-990113 Page A40
Attachment A

4. SEISMIC ASSESSMENTS

As part of the supplemental plant specific seismic verification program to support the increased MSIV leakage tech spec change at BFN, various engineering evaluations and assessments were performed to verify the seismic adequacy of the Alternate Leakage Treatment (ALT) piping, related components and supports, and condensers. The following sections discuss the technical bases and methods used in these evaluations and assessments. Results of the seismic evaluations are also presented.

4.1 OUTLIER RESOLUTION

Conditions which did not meet the walkdown screening guidelines (Section 3.1) or which were judged by the Seismic Walkdown Team to require further review were documented as "Outliers" during the Units 2 and 3 Seismic Verification Walkdowns at Browns Ferry Nuclear Plant. For BFN Unit 3, the walkdown outliers have been resolved on a deterministic basis and dispositioned as described in more detail below. The proposed resolution for Unit 2 outliers will follow similar Unit 3 approaches and/or utilize existing Unit 3 analyses, as applicable. The Unit 3 outlier resolution are documented in BFN calculations (References 6 and 7).

4.1.1 Seismic Demand

The BFN Turbine Building is classified as a Class II structure, hence, no dynamic analysis of the building was performed and no in-structure response spectra were available for the structure. For seismic evaluations and outlier resolution, the horizontal seismic demand for components located within about 40 feet of the Turbine Building effective grade elevation (EL. 568') is conservatively taken as the BFN 5% damped design basis DBE input spectrum (0.2g Housner curve) scaled by 1.6 to account for soil amplification per BFN General Design Criteria (Reference 8) for soil founded structures, and 1.5 for building amplification per GIP. For components located above 40 feet of the Turbine Building effective grade elevation, an additional amplification factor of 1.5 is conservatively applied. In the vertical direction, seismic demand is taken as 2/3 that of the horizontal direction, with a soil amplification factor of 1.1 instead of 1.6.

4.1.2 Seismic Capacity

For outlier resolution and evaluation of ALT piping, and related components and supports, the following load combinations and stress allowables, as applicable, were used:

Component	Load Combination	Stress Allowables
Piping	D + P + I + A (Primary + Secondary)	2.0 Sy
Pipe Supports	D + T + I + A	AISC
Equipment Anchorage	D + I	AISC, GIP
Valve	3g load check	GIP

where,
D – Dead load
P – Pressure load
T – Thermal load
I – Seismic (DBE) inertial load
A – Load due to seismic anchor movement
Sy – Material yield strength at temperature
AISC – American Institute of Steel Construction
GIP – Generic Implementation Procedure

4.1.3 Summary of Results

Table 4-1 provides a summary of the proposed resolution methods for the outliers associated with the Unit 2 MSIV Seismic Verification Walkdown. Similarly, the results of the resolution of outliers associated with the Unit 3 MSIV Seismic Verification Walkdown are summarized in Table 4-2.

As mentioned in Section 3.3.3 above, additional Unit 2 Seismic Verification Walkdown for the expanded scope will be performed during its Cycle 11 outage to verify the seismic ruggedness of the MS piping and associated components. Any additional outliers identified during this walkdown will be addressed and resolved within the same outage period. Design Change Notice (DCN) will address any physical changes to restore the drain path into compliance.

4.2 ALTERNATE LEAKAGE TREATMENT PIPING AND SUPPORTS

Majority of the MSIV alternate leakage treatment (ALT) piping systems and related components at Browns Ferry, i.e., those portions downstream of the outboard Main Steam Isolation Valves (MSIV's) and the outboard Main Steam Drain Isolation Valve (MSDIV), are located in the Turbine Building and are not designated as Seismic Class I systems. In general, these piping systems are not seismically analyzed, and are typically designed to the requirements of USAS B31.1-1967.

As part of the plant specific seismic verification of the non-seismic ALT piping, related supports and components using the earthquake experience-based approach as outlined in the BWROG Report, the following reviews were performed to demonstrate that the piping and related supports fall within the bounds of the experience database:

- Review of the design codes and standards, piping design parameters, and support configurations.
- Seismic verification walkdown to identify potential piping concerns.

The Browns Ferry ALT piping systems consist of welded steel pipe and standard support components. Support spacing generally meets the B31.1 recommended span. The design bases for the portions of piping associated with the ALT pathway to the condensers are tabulated in Table 4-3. Table 4-4 presents a general summary of the piping data that constitute the seismic experience data. Comparison of Browns Ferry and selected database piping parameters is presented in Table 4-5, along with Figure 4-1, which presents a comparison of D/t ratios of the BFN ALT drain piping with those found in the database. Overall, the BFN piping design is similar to and well represented by those found in the experience database sites that have shown to perform well in past earthquakes.

Browns Ferry FSAR does not reference Appendix A to 10 CFR Part 100. The seismic adequacy of the ALT piping is addressed by performing seismic verification walkdowns to identify specific design attributes associated with poor seismic performance, following the guidelines outlined in Section 3.1 of this report. Bounding evaluations were performed for typical support configurations using evaluation criteria as discussed in Section 4.1. Table 4-6 summarizes the results of the support and anchorage evaluations for the selected bounding configurations (Reference 10).
2/E: THIS CALC., ATT C | R1

The seismic evaluations, consisting of verification walkdowns, bounding support evaluations, and resolution of the identified walkdown outliers, provide reasonable assurance that the ALT drain path piping, related supports and components will remain functional in the event of a Design Basis Earthquake (DBE) at Browns Ferry.

4.3 TURBINE BUILDING

Performance of the turbine building and other non-seismic structures during a seismic event is of interest to the MSIV leakage issue only to the extent that the building structure and its internal components should survive and not degrade the capabilities of the selected main steam and condenser pathways. A BWROG (Reference 1) survey of this type of industrial structures has, in general, confirmed that excellent past seismic performance exists. There are no known cases of structural collapse of either turbine buildings at power stations or structures of similar construction.

The majority of the MSIV alternate leakage treatment (ALT) piping and the condensers at Browns Ferry are located in the Turbine Building, while small portions of the ALT piping are located in the Reactor Building which is a seismically designed, Class I structure. BFN Turbine Building is classified as a Class II structure in the BFN FSAR. The BFN Design Criteria for Class II structures are that they shall not degrade the integrity of any Class I structure. Those portions of Class II structures required to remain structurally competent in order to support the operation of Class I structures or equipment shall be designed for earthquake in accordance to the Uniform Building Code. Table 4-7 provides the design basis of the BFN Turbine Building and the applicable design codes used.

BFN Turbine Building below the operating floor at El. 617 feet is a reinforced concrete framed structure supported on steel H-piles to the bedrock at El. 519 feet. Piles are spaced far enough apart within each cluster to ensure that the maximum average unit bearing stress on the rock area is limited to 500 psi. Stresses in the piles are limited to one third of the yield stress. The concrete beams and slabs are designed to ACI 318-63 code using the working stress method. Similarly, the columns are also designed to ACI 318-63 code using the working stress method and checked by the ultimate strength design method using a load factor of 1.8.

The superstructure above the operating deck consists of transverse welded steel rigid frames spanning approximately 107 feet. An expansion joint is provided between a two-bay frame for Units 1 and 2, and a single-bay frame for Unit 3. For longitudinal expansion, the superstructure is provided with joints by using double rows of frames spaced at 4 feet apart. The steel frames, which form the Turbine Building structure above the concrete structure, are braced to provide rigidity in the direction of the Reactor Building as well as to provide support for the turbine cranes. These frames are designed to resist lateral forces from the overhead cranes and wind loads, in addition to supporting the vertical dead and live loads. The design of the steel superstructure is based on 1963 AISC code. All material conforms to ASTM-36, except for anchor rods which are ASTM A-307 steel. Shop connections are ASTM A-502 Gr. 1 rivets or welded, and field connections are ASTM A-325 high-strength bolts.

Based on the above design bases for the BFN Turbine Building, and the excellent seismic performance of this similar type of industrial structure in past strong-motion earthquakes as documented in the BWROG Report, the Browns Ferry Turbine Building is expected to remain structurally intact following a DBE.

4.4 CONDENSER

The BFN condensers consist of three single-pass, single pressure, radial flow type surface condensers. Each condenser is located beneath each of the three low pressure turbines, and is structurally independent. Table 4-8 lists the design data for BFN condensers and for the two experience database sites listed in the BWROG Report. In addition, design characteristic comparisons of the BFN condensers with the selected database condensers are shown in Figures 4-2 to 4-5. The BFN condenser design data is comparable to the data for these two database sites. The BFN condensers were also evaluated for structural integrity subject to seismic DBE loads. Results of the evaluation indicate that the condenser shell stresses are small. Maximum stress ratios, based on AISC allowables, are 0.12 for combined axial and bending and 0.10 for shear (Reference 10). |R1

I.E: THIS CALC, ATT B

The condenser support anchorage consists of a center key and six support feet that are arranged as shown in Figure 4-6. The center support is a fixed anchor, and consists of a built-up wide flange H section embedded 4 feet into the concrete pedestal which is connected to the Turbine Building base mat, and welded to the bottom plate of the condenser. The support plates consist of 2 to 3 anchors of 2- to 2-1/2- inch diameter bolts. Each anchor bolt has greater than 5 feet nominal length with approximately 48 inches of embedment into the concrete pedestal which is connected to the Turbine Building base mat. These supports are designed to resist vertical operating loads, and are slotted radially from the center key to allow for thermal growth. Shear forces are transferred to the wide flange shaped anchor in the center and to the anchor bolts and shear keys to the support feet and carried through the concrete pedestal to the Turbine Building base mat.

The BFN condenser anchorage was compared with the performance of similar condenser in the earthquake experience database. The shear areas of the condenser anchorage, in the directions parallel and transverse to the turbine generator axis, divided by the seismic demand, were used to compare with those presented in the BWROG Report (Reference 1), and are shown in Figures 4-7 and 4-8, respectively. The BFN condenser anchorage shear area to seismic demand is substantially greater than the selected database sites. The condenser support anchorage was also

THIS PG. REPLACED BY REV 1

evaluated and the results indicate that the combined seismic DBE and operational demand is less than the anchorage capacity based on the AISC allowables. Maximum stress ratios are 0.70 for bolt tension in the perimeter support feet, and 0.86 for shear in the center support built-up section (Reference 7).

The above comparisons of the condenser seismic experience data and the anchorage capacity evaluations demonstrate that the conclusions presented in the BWROG Report (Reference 1) can be applied to the BFN condensers. That is, a significant failure of the condenser in the event of a DBE at BFN is highly unlikely and contrary to the large body of historical earthquake experience data.

Table 4-1

BROWNS FERRY UNIT 2
MSIV "OUTLIERS" RESOLUTION SUMMARY

SYSTEM DESCRIPTION	OUTLIER	OUTLIER DESCRIPTION	RESOLUTION METHOD
Main Steam Drain Line-Turbine Bldg.			
MS Drain Taps	1-1	MS line differential motion	Modify supports per DCN
FCV 1-58	1-2	Extended valve operators	To be resolved per BFN Calc. CD-N0001-980038
Main Steam Lines			
MS Stop Valves	2-1	Valve performance	To be resolved per BFN Calc. CD-N0001-980038
Main Steam Drain Line- MSIV Vault			
FCV 1-15, 27, 38 & 52	3-1	Valve performance	To be resolved per BFN Calc. CD-N0001-980039
HPCI/RCIC/Aux. Boiler Drains – MSIV Pit			
HPCI Drain at MS drain connection	4-1	Inadequate bending leg	Modify supports per DCN
HPCI Drain in RB Steam Vault	4-2	Piping overspan	Install new supports per DCN
HPCI Drain in RB SE Corner Room	4-3	Piping overspan	Install new supports per DCN
HPCI/Aux. Boiler drain line supports	4-4	Misc. maintenance items	Misc. maintenance items to be addressed by WR C340989
HPCI Drain above the Torus	4-5	Piping overspan	Install new supports per DCN
RCIC Drain above the Torus	4-6	Inadequate support (RCIC-09)	Modify support per DCN
MS PT 1-72, 76, 82, 86 & 93			
1/2 in. PT Piping from Steam Lines	5-1	Interaction with platform steel	Re-route piping/instrumentation line per DCN
Main Steam Sample to Station			
PT-16A/B Piping	6-1	Interaction with Feedwater piping	Re-route piping and modify support per DCN
Sample lines A, B, C, D	6-2	Inadequate flex legs at MS line	Remove existing supports and install new supports per DCN

Table 4-1 (CONT.)

BROWNS FERRY UNIT 2
MSIV "OUTLIERS" RESOLUTION SUMMARY

SYSTEM DESCRIPTION	OUTLIER	OUTLIER DESCRIPTION	RESOLUTION METHOD
Main Steam Sample to Station (cont.)			
PT 16A/B	6-3	Inadequate flex legs at MS line	Modify supports per DCN
Sample Station	6-4	Temperature bath anchorage	Provide equipment anchorage per DCN
PT-16A/B	6-5	Interaction with oil drum	Initiate Work Request to relocate the oil drum
Main Steam Bypass			
Main Steam Bypass Valve	7-1	Valve performance	To be resolved per BFN Calc. CD-N0001-980038
SV Above Seat Drains			
FCV 6-100, 101, 102, 103	8-1	Short rod hangers	Modify rod hangers per DCN
1" Drain piping from Steam Line D	8-2	Interaction with MS piping/steel	Re-route drain piping and modify support per DCN
Steam to Steam Seal Regulator			
Rod hanger downstream of Valve 8-575	9-1	Disengaged rod hanger	Maintenance item to be addressed by WR C341864
Verification Boundary Valve 8-575 (Proposed)	9-2	Valve performance	Walkdown scope to be expanded to remove the assumption
Steam Supply to RFP Turbines			
Steam supply line	10-1	Inadequate flex leg at MS header	Modify supports per DCN
Steam supply line	10-2	Stanchion supports	Modify supports per DCN
Steam supply line	10-3	TB overhead crane	To be resolved per BFN Calc. CD-N0001-980039
Verification Boundary Valve 1-RFPT (Proposed)	10-4	Installation of boundary valve	Walkdown scope to be expanded to remove the assumption
Condenser			
Condenser and anchorage adequacy	13-1	Evaluate condenser/anchorage	To be resolved per BFN Calc. CD-N0001-980038

Table 4-2

BROWNS FERRY UNIT 3
MSIV "OUTLIERS" RESOLUTION SUMMARY

SYSTEM DESCRIPTION	OUTLIER	OUTLIER DESCRIPTION	RESOLUTION METHOD
Main Steam Drain Line-Turbine Bldg.			
MS Drain Taps	1-1	MS line differential motion	Relocated three supports per DCN T40871A and BFN Calc. No. CD-N0001-980039
MS Drain Taps	1-2	Impact with conduit supports	Resolved per BFN Calc. No. CD-N0001-980038
FCV 1-58	1-3	Extended valve operators	Resolved per BFN Calc. No. CD-N0001-980038
FCV 1-58/59 Conduit	1-4	Unknown routing at TB/RB joint	Resolved per BFN Calc. No. CD-N0001-980038
Main Steam Lines			
MS Stop Valves	2-1	Valve performance	Resolved per BFN Calc. No. CD-N0001-980038
MSH-17	2-2	Missing eyebolt nut	Nut replaced per WR C164362
MSH-17,18 & 19	2-3	Grating clearances	Modified grating clearances per DCN T40871A
Main Steam Drain Line-MSIV Vault			
FCV 1-15, 27, 38 & 52	3-1	Valve performance	Resolved per BFN Calc. No. CD-N0001-980039
FCV 1-56	3-2	Manual operator	Valve replaced by DCN W17935A
HPCI/RCIC/Aux. Boiler Drains - MSIV Pit			
HPCI Drain at MS drain connection	4-1	Inadequate bending leg	Modified two supports per DCN T40871A and BFN Calc. No. CD-N0001-980039
MS PT 1-72, 76, 82, 86 & 93			
MS instrument tubing	5-1	Overspan on 1" pipe to PT 1-86	Missing clamp replaced per DCN T40871A
1/2 in. Line to PT 1-86	5-2	Interaction with steel & pipe	Re-route piping/instrumentation line per DCN T40871A and BFN Calc. No. CD-N0001-980039

Table 4-2 (CONT.)

BROWNS FERRY UNIT 3
MSIV "OUTLIERS" RESOLUTION SUMMARY

SYSTEM DESCRIPTION	OUTLIER	OUTLIER DESCRIPTION	RESOLUTION METHOD
Main Steam Sample to Station			
Sample lines B & D	6-1	Missing tubing support clamps	Missing clamps replaced per WR C193204
Sample lines A, B, C, D	6-2	Inadequate flex legs at MS line	Added four supports and removed four supports per DCN T40871A and BFN Calc. No. CD-N0001-980039
PT 16A/B	6-3	Inadequate flex legs at MS line	Modified two supports per DCN T40871A and BFN Calc. No. CD-N0001-980039
Sample Station	6-4	Temperature bath anchorage	Anchorage provided per DCN T40871A and BFN Calc. No. CD-N0001-980039
Main Steam Bypass			
Main Steam Bypass Valve	7-1	Valve performance	Resolved per BFN Calc. No. CD-N0001-980038
SV Above Seat Drains			
FCV 6-100, 101, 102, 103	8-1	Short rod hangers	Modified rod hangers per DCN T40871A and BFN Calc. No. CD-N0001-980039
Steam to Steam Seal Regulator			
MS to FCV 1-146	9-1	Overspan piping	Resolved per BFN Calc. No. CD-N0001-980039
PCV 1-147	9-2	Hand wheel in proximity to WF section	Resolved per BFN Calc. No. CD-N0001-980039
PCV 1-147 air line	9-3	Inadequate flexibility & blockwall interaction	Resolved per BFN Calc. No. CD-N0001-980039
PCV 1-147	9-4	Extended valve operator	Resolved per BFN Calc. No. CD-N0001-980039

Table 4-2 (CONT.)

BROWNS FERRY UNIT 3
MSIV "OUTLIERS" RESOLUTION SUMMARY

SYSTEM DESCRIPTION	OUTLIER	OUTLIER DESCRIPTION	RESOLUTION METHOD
Steam Supply to RFP Turbines			
Steam supply line	10-1	Inadequate flex leg at MS header	Remove hanger per DCN T40871A and BFN Calc. No. CD-N0001-980039
Steam supply line	10-2	Stanchion supports	Replace two spring hangers per DCN T40871A and BFN Calc. No. CD-N0001-980039
Steam supply line	10-3	TB crane overhead	Resolved per BFN Calc. No. CD-N0001-980039
RFT Stop Valve above seat drains	10-4	Lass mass on 1/2 and 3/4 inch lines	Resolved per BFN Calc. No. CD-N0001-980039
Tubing to PI 1-126	10-5	Missing tubing clamps – overspan	Missing clamps replaced per WR-C193201
Steam Supply to SJAE's			
SJAE 3A/B	11-1	Anchorage and cracked pedestal	Anchorage resolved per BFN Calc. No. CD-N0001-980039; Cracked concrete pedestal repaired per WR-C193206
SJAE 3B	11-2	Loose anchor bolt nut	Re-torqued loose nut per WR-C193205
Drain to Condenser	11-3	Drain ties to multi-system collector	Re-route piping per DCN T40871A and BFN Calc. No. CD-N0001-980039
Steam Supply to Off-Gas Preheaters			
PCV 1-175A/B	12-1	Masonry wall	To be resolved by the proposed installation of NEW boundary valves to Preheaters A & B
Steam supply line to FCV 1-178A/B	12-2	Vertical restraint of line at FCV 1-178	Resolved per BFN Calc. No. CD-N0001-980039
PCV 1-175A/B, FCV 1-178A/B	12-3	Valve performance	To be resolved by the proposed installation of NEW boundary valves to Preheaters A & B
Condenser			
Condenser and anchorage adequacy	13-1	Evaluate condenser/anchorage	Resolved per BFN Calc. No. CD-N0001-980038

Table 4-3

Design Basis for Browns Ferry ALT Related Piping and Supports

Piping Description	Design Temp. (°F)	Design Press. (psig)	Pipe Size (NPS)	Pipe Sch.	D / t	Piping Material	Typical Support Types	Piping Design Basis
MS Lines from outboard MSIV's to MS Header and to Turbine Stop Valves	562	1146	24 1	80 160	20 5	ASTM A-106 Grade B	Spring hangers Vertical struts	USAS B31.1- 1967
Main Steam Header	562	1146	24	80	20	ASTM A-155 Grade KC-70	Spring hangers	USAS B31.1- 1967
MS Stop Valve Above Seat Leak-off	562	1146	1	160	5	ASTM A-106 Grade B	Rod hangers	USAS B31.1- 1967
Turbine Bypass Valve Header	562	1146	18	80	19	ASTM A-106 Grade B	Rigid supports Rod and Spring hangers	USAS B31.1- 1967
MS Steam Supply to RFP Turbine Stop Valves	562	1146	6 4	80 80	15 13	ASTM A-106 Grade B	Rod and Spring hangers Stanchion supports	USAS B31.1- 1967
MS Steam Supply from MS Header to SJAE's to the Condenser	562	1146	3 2 1-1/2 1	160 160 160 160	8 7 7 5	ASTM A-106 Grade B	Rod and Spring hangers	USAS B31.1- 1967

CD-N0001-990113 Page A53
Attachment A

Table 4-3 (CONT.)

Design Basis for Browns Ferry ALT Related Piping and Supports

Piping Description	Design Temp. (°F)	Design Press. (psig)	Pipe Size (NPS)	Pipe Sch.	D / t	Piping Material	Typical Support Types	Piping Design Basis
MS Steam Supply to Steam Seal Regulators	562	1146	4	80	13	ASTM A-106 Grade B	Rod hangers	USAS B31.1- 1967
MS Steam Supply from MS Header to the Off-Gas Preheaters A & B	562	1146	2	160	7	ASTM A-106 Grade B	Rod hangers	USAS B31.1- 1967
			2	160	7	ASTM A-335 Grade P11	New piping associated with the proposed installation of new boundary valves to Preheaters A & B	
MS Outboard Drains from MS Lines to the Main Drain Line	562	1146	3 2 1	160 160 160	8 7 5	ASTM A-106 Grade B	Stanchion supports	USAS B31.1- 1967
			3 2	160 160	8 7	ASTM A-333 Grade 1		
Main Drain Line to the Condenser	562 / 450	1146 / 400	4 3 1	80 160 160	13 8 5	ASTM A-106 Grade B	Rod and Spring hangers Stanchion supports	USAS B31.1- 1967

CD-N0001-990113 Page A54
Attachment A

Table 4-3 (CONT.)

Design Basis for Browns Ferry ALT Related Piping and Supports

Piping Description	Design Temp. (°F)	Design Press. (psig)	Pipe Size (NPS)	Pipe Sch.	D / t	Piping Material	Typical Support Types	Piping Design Basis
HPCI Drain to MS Drain; RCIC Drain to HPCI Drain; Aux. Boiler Drains to HPCI/RCIC/ Reactor Building Drain Line	450	400	2 1	160 160	7 5	ASTM A-106 Grade B	Rigid supports	USAS B31.1- 1967
	270	415	1	160	5			
Misc. PT Instrument Lines Sample Lines to Sample Station	562	1146	1	160	5	ASTM A-106 Grade B	Rigid supports	USAS B31.1- 1967
			¼" tubing	.049" (wall t)	--	ASTM A-213 SS Gr. TP-304	Rigid supports (tube clamps)	--

CD-N0001-990113 Page A55
Attachment A

Table 4-4

Seismic Experience Database Piping Data

Facility	Pipe Size (NPS)	Pipe O.D. (inch)	Schedule	Wall Thickness (inch)	D/t
Valley Steam Plant Units 1 & 2	24	24.0	20	0.375	64
	20	20.0	20	0.375	53
	18	18.0	30	0.437	41
	16	16.0	30	0.375	43
	14	14.0	30	0.375	37
	12	12.75	40	0.406	31
	12	12.75	30	0.330	39
	10	10.75	160	1.125	10
	8	8.625	160	0.906	10
	6	6.625	40	0.280	24
	4	4.50	160	0.531	8
	4	4.50	40	0.237	19
	3	3.50	160	0.437	8
	3	3.50	80	0.300	12
	3	3.50	40	0.216	16
	2	2.375	160	0.343	7
	2	2.375	40	0.154	15
	1½	1.90	160	0.281	7
	1½	1.90	40	0.145	13
	1	1.315	40	0.133	10
	¾	1.05	160	0.218	5
	¾	1.05	40	0.113	9

Table 4-4 (CONT.)

Seismic Experience Database Piping Data

Facility	Pipe Size (NPS)	Pipe O.D. (inch)	Schedule	Wall Thickness (inch)	D/t
El Centro Steam Plant	20	20.0	STD	0.375	53
	18	18.0	160	1.781	10
	18	18.0	XS	0.500	36
	18	18.0	STD	0.375	48
	14	14.0	40	0.437	32
	14	14.0	STD	0.375	37
	12	12.75	160	1.312	10
	12	12.75	STD	0.375	34
	10	10.75	40	0.365	29
	8	8.625	160	0.906	10
	8	8.625	120	0.718	12
	8	8.625	40	0.322	27
	6	6.625	120	0.562	12
	6	6.625	40	0.280	24
	4	4.50	80	0.337	13
	4	4.50	40	0.237	19
	3	3.50	160	0.437	8
	3	3.50	80	0.300	12
	3	3.50	40	0.216	16
	2	2.375	160	0.343	7
	2	2.375	80	0.218	11
	2	2.375	40	0.154	15
	1½	1.90	160	0.281	7
	1½	1.90	80	0.200	10
	1½	1.90	40	0.145	13
	1	1.315	80	0.179	7
	1	1.315	40	0.133	10
	¾	1.05	80	0.154	7
	¾	1.05	40	0.113	9

Table 4-4 (CONT.)
Seismic Experience Database Piping Data

Facility	Pipe Size (NPS)	Pipe O.D. (inch)	Schedule	Wall Thickness (inch)	D/t
Moss Landing Units 1, 2 & 3	16	16.0	--	1.394	11
	12	12.75	--	1.148	11
	8	8.625	160	0.906	10
	8	8.625	30	0.277	31
	6	6.625	160	0.562	12
	6	6.625	40	0.280	24
	4	4.50	160	0.531	8
	4	4.50	80	0.337	13
	4	4.50	40	0.237	19
	3	3.50	160	0.437	8
	3	3.50	80	0.300	12
	3	3.50	40	0.216	16
	2	2.375	160	0.343	7
	2	2.375	80	0.218	11
	2	2.375	40	0.154	15
	1½	1.90	160	0.281	7
	1½	1.90	80	0.200	10
	1	1.315	160	0.250	5
	1	1.315	80	0.179	7
	¾	1.05	160	0.218	5
	¾	1.05	80	0.154	7

Table 4-4 (CONT.)

Seismic Experience Database Piping Data

Facility	Pipe Size (NPS)	Pipe O.D. (inch)	Schedule	Wall Thickness (inch)	D/t
Moss Landing Units 4 & 5	24	24.0	40	0.687	35
	24	24.0	--	1.066	23
	--	18.8	--	2.287	8
	16	16.0	40	0.500	32
	16	16.0	--	0.902	18
	--	13.2	--	1.668	8
	8	8.625	160	0.906	10
	8	8.625	40	0.322	27
	6	6.625	160	0.562	12
	6	6.625	40	0.280	24
	4	4.50	160	0.531	8
	4	4.50	80	0.337	13
	4	4.50	40	0.237	19
	3	3.50	160	0.437	8
	3	3.50	80	0.300	12
	3	3.50	40	0.216	16
	2	2.375	160	0.343	7
	2	2.375	80	0.218	11
	2	2.375	40	0.154	15
	1½	1.90	160	0.281	7
	1½	1.90	80	0.200	10
	1½	1.90	40	0.145	13
	1	1.315	160	0.250	5
	1	1.315	80	0.179	7
	1	1.315	40	0.133	10
	¾	1.05	160	0.218	5
	¾	1.05	80	0.154	7
	¾	1.05	40	0.113	9

Table 4-4 (CONT.)

Seismic Experience Database Piping Data

Facility	Pipe Size (NPS)	Pipe O.D. (inch)	Schedule	Wall Thickness (inch)	D/t
Moss Landing Units 6 & 7	30	30.0	--	0.632	47
	26	26.0	--	1.128	23
	18	18.0	--	3.444	5
	12	12.75	--	2.444	5
	12	12.75	--	0.601	21
	8	8.625	--	1.650	5
	8	8.625	40	0.322	27
	6	6.625	--	1.268	5
	6	6.625	40	0.280	24
	4	4.50	--	0.861	5
	4	4.50	80	0.337	13
	4	4.50	40	0.237	19
	3	3.50	80	0.300	12
	3	3.50	40	0.216	16
	2½	2.875	--	0.550	5
	2½	2.875	80	0.276	10
	2½	2.875	40	0.178	16
	2	2.375	--	0.519	5
	2	2.375	80	0.218	11
	2	2.375	40	0.154	15
	1½	1.90	--	0.428	4
	1½	1.90	80	0.200	10
	1½	1.90	40	0.145	13
	1	1.315	--	0.301	4
	1	1.315	80	0.179	7
	1	1.315	40	0.133	10
	¾	1.05	160	0.218	5
	¾	1.05	80	0.154	7
	¾	1.05	40	0.113	9
	½	1.05	--	0.210	4
	¼	0.54	--	0.153	4

Table 4-4 (CONT.)
Seismic Experience Database Piping Data

Facility	Pipe Size (NPS)	Pipe O.D. (inch)	Schedule	Wall Thickness (inch)	D/t
Ormond Beach Units 1 & 2	30	30.0	-	1.298	23
	30	30.0	-	0.719	42
	21	21.0		3.793	6
Humboldt Bay Unit 3	12	12.75	80	0.687	19
	10	10.75	80	0.593	18
	6	6.625	80	0.432	15

Table 4-5

Comparison of Browns Ferry and Selected Database Piping Parameters

Piping Parameter	Browns Ferry	Database Sites
Pipe Diameter (inch)	1.315 – 24.0	1.05 – 30.0
Wall Thickness (inch)	0.25 – 1.218	0.113 – 3.793
Diameter-to-Thickness Ratio (D/t)	5 - 20	4 – 64

Table 4-6

Bounding Evaluations of Typical Support Configurations

Support Type	Critical Component	Stress Ratio
Cantilever bracket	Anchor bolts	.73
Rod hanger	Overhead weld attachment	.70

Table 4-7

Browns Ferry Turbine Building Design Basis

Design Attribute	Description
Lateral Force Resisting System Above the Operating Deck	The Turbine Building above the operating deck is framed by transverse welded steel rigid frames with fixed bases and braced in the direction of the Reactor Building to provide the resistance to lateral forces.
Lateral Force Resisting System Below the Operating Deck	The Turbine Building below the operating deck is a reinforced concrete structure. Concrete walls serve as shear walls for the lateral loads in the direction of the Reactor Building.
Design Codes	General: Uniform Building Code (UBC) Concrete: American Concrete Institute (ACI 318-1963) Steel: American Institute of Steel Construction (AISC) -1963
Seismic Design Basis	UBC zone 1
Wind Design Basis	Wind speed of 100 mph

Table 4-8

Comparison of Browns Ferry and Selected Database Condensers

Design Attributes	Moss Landing Units 6 & 7	Ormond Beach Units 1 & 2	Browns Ferry
Condenser Manufacturer	Ingersoll-Rand	Southwestern	Foster Wheeler
Flow Type	Single Pass	Single Pass	Single Pass
Condenser Dimensions (LxWxH)	65 ft. x 36 ft. x 47 ft.	52 ft. x 27 ft. x 20 ft.	58 ft. x 32 ft. x 47 ft.
Condenser Surface Area	435,000 sq. ft.	210,000 sq. ft.	222,000 sq. ft.
Condenser Shell Material	Cu Bearing ASTM A-285C	Cu Bearing ASTM A-285C	ASTM A-285C
Condenser Shell Thickness	3/4"	3/4"	7/8"
Condenser Operating Weight	3,115 kips	1,767 kips	2,076 kips
Tube Material	Al-Brass	90-10 Cu-Ni	Al-6XN
Tube Size	1" dia.	1" dia.	7/8" dia.
Tube Length	65 ft.	53 ft.	50 ft.
Tube Wall Thickness	18 BWG	20 BWG	22 BWG

Table 4-8 (CONT.)

Comparison of Browns Ferry and Selected Database Condensers

Design Attributes	Moss Landing Units 6 & 7	Ormond Beach Units 1 & 2	Browns Ferry
Number of Tubes	25,590	15,220	19,480
Tube Sheet Material	Muntz	Muntz	ASTM A-285C
Tube Sheet Thickness	1-1/2"	1-1/4"	1-1/4"
No. of Tube Support Plates	15	14	15
Tube Support Plate Material	Not Given	Cu Bearing ASTM A-285C	ASTM A-285C
Tube Support Plate Thickness	3/4"	5/8"	7/8"
Tube Support Plate Spacing	48 in.	36 in.	39 in.
Water Box Material	2% Ni Cast Iron ASTM A-48 Class 30	Cu Bearing ASTM A-285C	ASTM A-285C
Expansion Joint	Rubber Belt	Stainless Steel	Rubber Belt
Hotwell Capacity	20,000 gal.	34,338 gal.	28,000 gal. (max.)

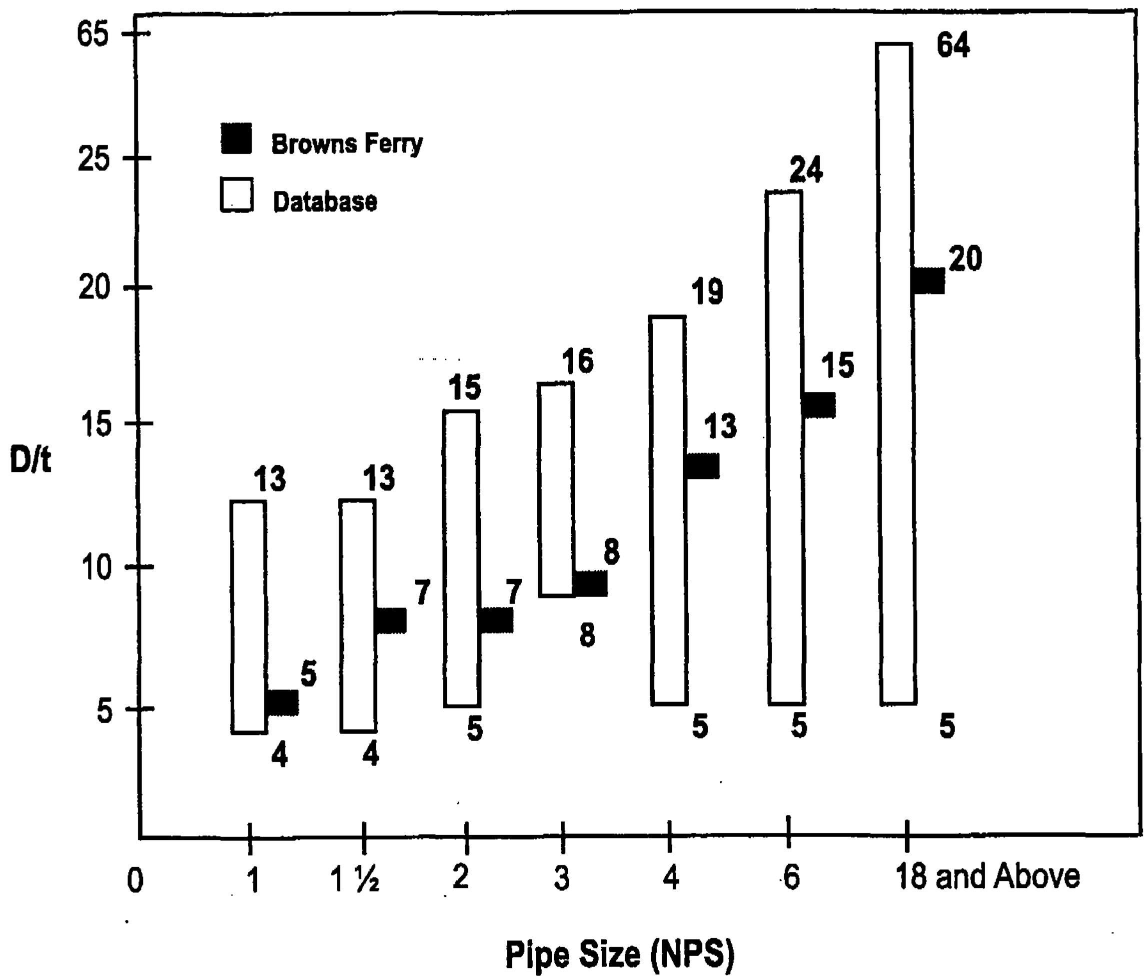


Figure 4-1 Comparison of Browns Ferry and Selected Database Piping D/t Ratios

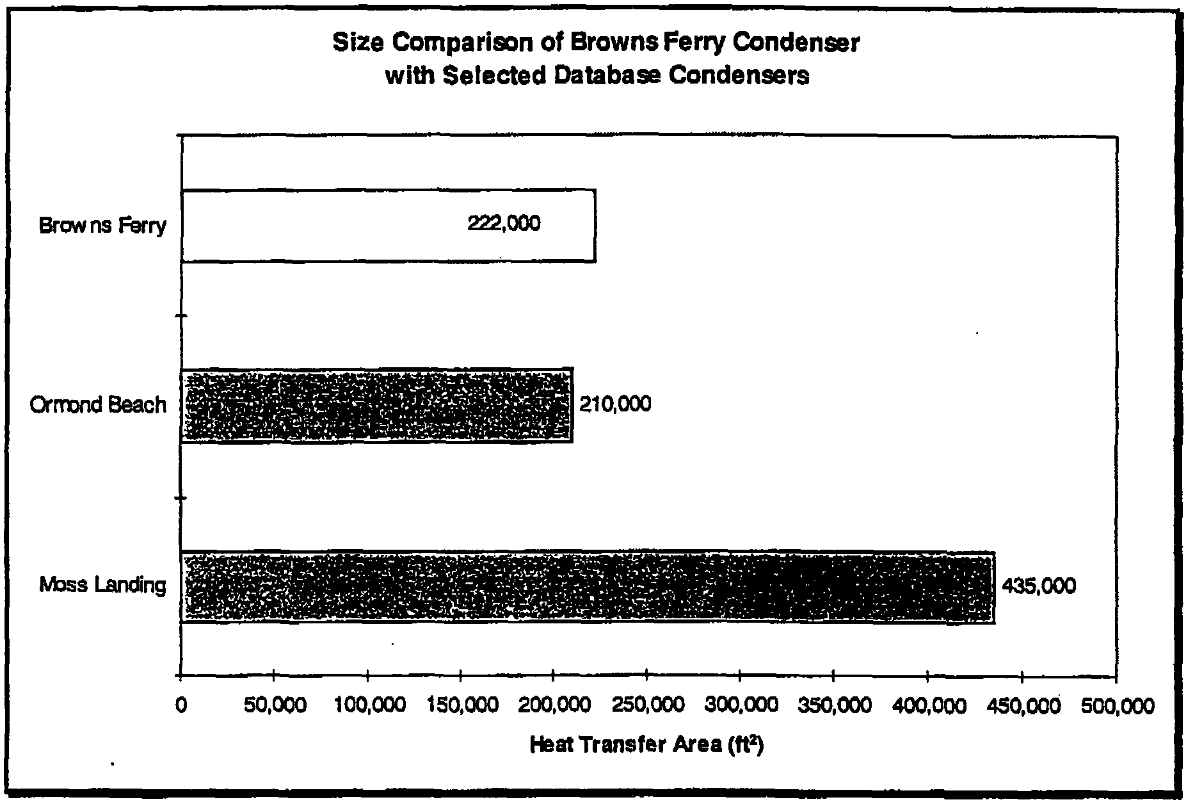


Figure 4-2 Size Comparison of Browns Ferry Condenser with Selected Database Condensers

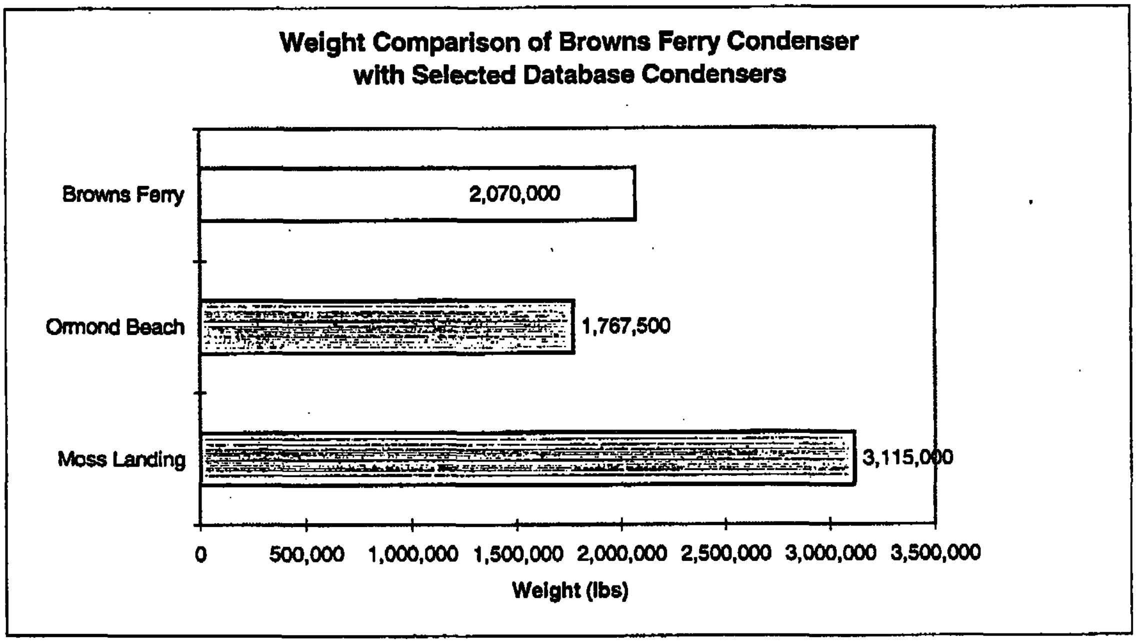


Figure 4-3 Weight Comparison of Browns Ferry Condenser with Selected Database Condensers

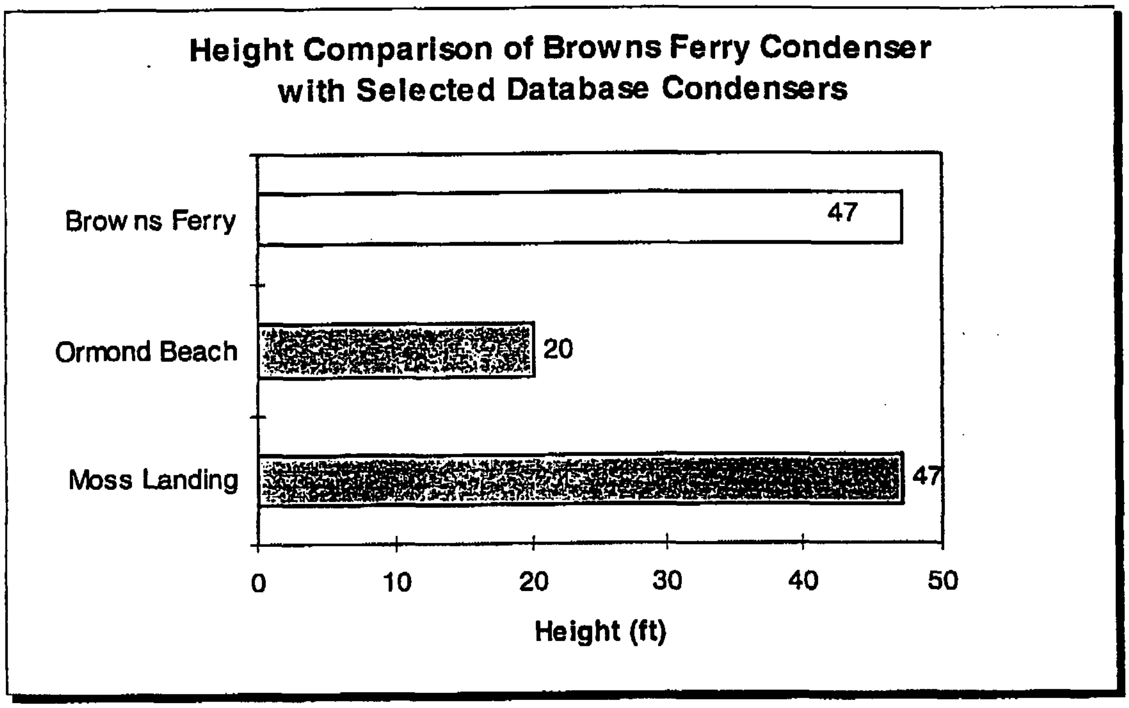
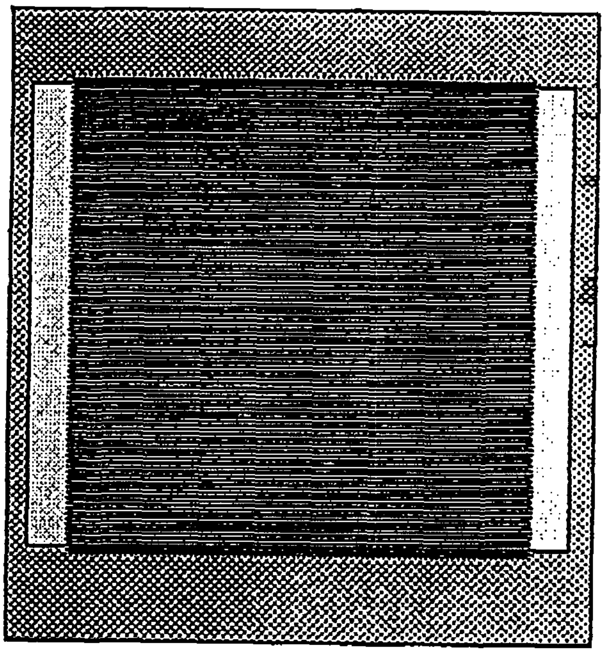


Figure 4-4 Height Comparison of Browns Ferry Condenser with Selected Database Condensers



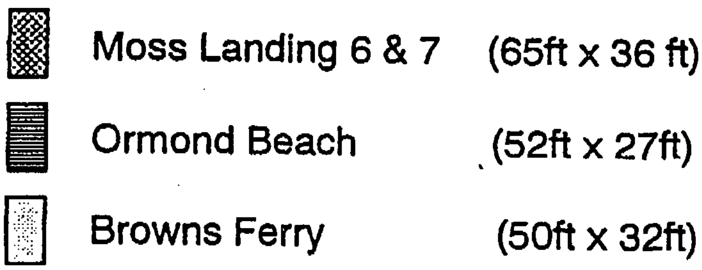
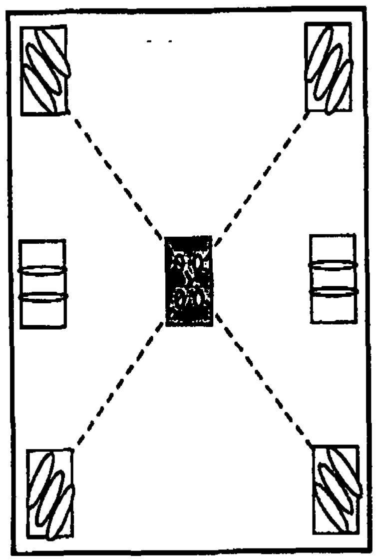


Figure 4-5 Plan Dimension Comparison of Browns Ferry Condenser with Selected Database Condensers



Anchor bolts with slotted holes directed from center anchor plate

Anchor bolts with slotted holes perpendicular

Fixed anchor plate

Figure 4-6 Schematic Plan View of Browns Ferry Condenser Anchorage

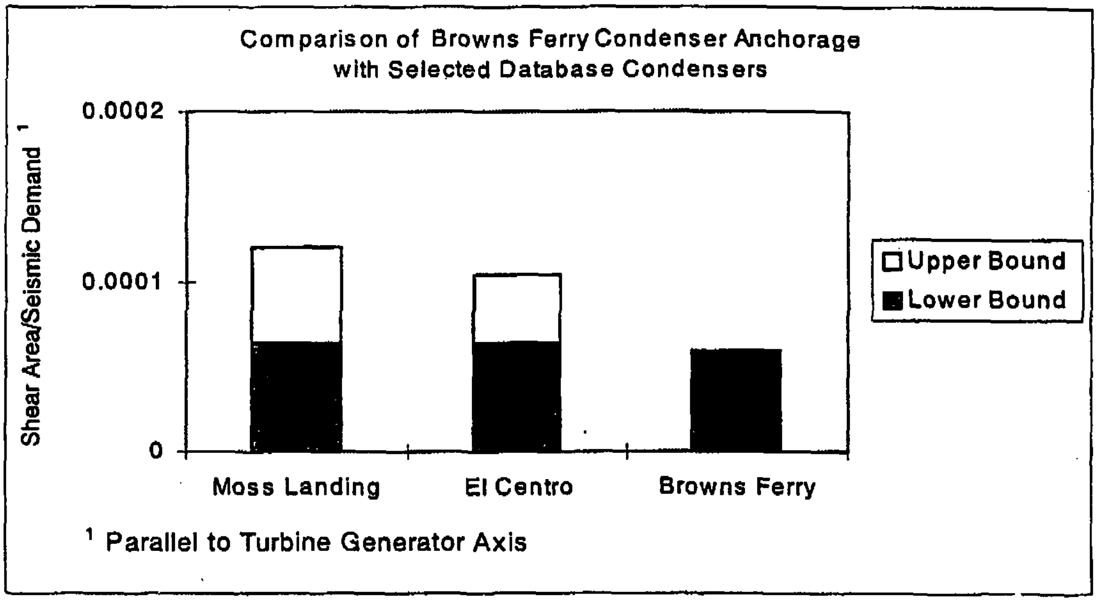


Figure 4-7 Comparison of Browns Ferry and Selected Database Condenser Anchorage to Seismic Demand for Direction Parallel to the Turbine Generator Axis

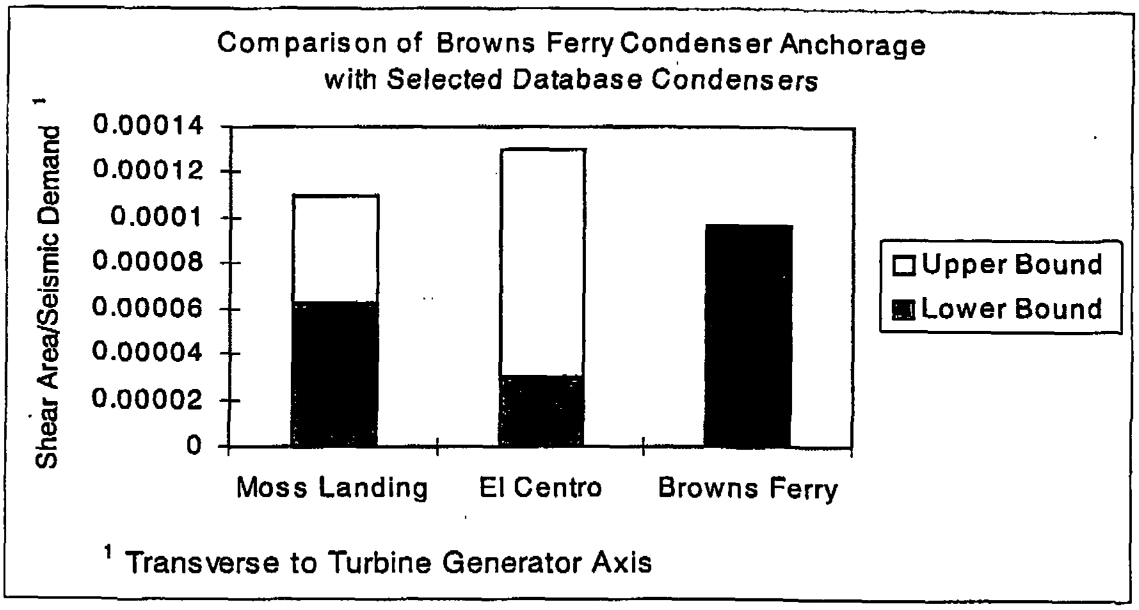


Figure 4-8 Comparison of Browns Ferry and Selected Database Condenser Anchorage to Seismic Demand for Direction Transverse to the Turbine Generator Axis

5. REFERENCES

1. "BWROG Report for Increasing MSIV Leakage Rate Limits and Elimination of Leakage Control Systems", GE NEDC-31858P, Revision 2, September 1993.

2. Safety Evaluation of GE Topical Report, NEDC-31858P, Revision 2, "BWROG Report for Increasing MSIV Leakage Rate Limits and Elimination of Leakage Control Systems", U.S. Nuclear Regulatory Commission, March 3, 1999.

3. "Browns Ferry - Unit 3, MSIV Seismic Verification Summary Report", EQE Report No. 200621-R-001, Revision 0, September 1998.

4. "Browns Ferry - Unit 2, MSIV Seismic Verification Summary Report", EQE Report No. 200918-R-001, Revision 0, August 1999.

5. "Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment", Rev. 2A, March 1993, Prepared by Winston & Strawn, EQE, et al., for the Seismic Qualification Utility Group (SQUG).

6. BFN Calculation No. CD-N0001-980039, "Main Steam Seismic Ruggedness Verification".

7. BFN Calculation No. CD-N0001-980038, "Main Steam Seismic Ruggedness Evaluation".

8. BFN General Design Criteria, BFN-50-C-7102, "Seismic Design", Revision 3.

9. BFN Detailed Design Criteria, BFN-50-C-7306, "Qualification Criteria for Seismic Class II Piping, Pipe Supports, and Components", Revision 1.

10. BFN Calculation No. CD-N0001-990113, "MSIV Seismic Evaluation Report". R1 R1

EQE INTERNATIONAL

CALCULATION COVER SHEET

Calculation No. 200918-C-002

Project: TVA BFN MSIV LEAKAGE TECH SPEC CHANGE

Calculation Title: ADDITIONAL SEISMIC EVALUATIONS FOR THE BFN CONDENSERS

References: See Section 3.0

Attachments:

Total Number of Pages (Including Cover Sheet): 15

Revision Number	Approval Date	Description of Revision	Originator	Checker	Approver
0	8/30/99	ORIGINAL ISSUE	F.R. BEIGI FBeigi	J.O. DIZON J.O. Dizon	J.O. DIZON J.O. Dizon

EQE INTERNATIONAL

JOB NO.	200918	JOB	BFN MSIV TECH SPEC CHANGE	BY	JB	DATE	8/24/99
CALC. NO.	C-002	SUBJECT	ADDITIONAL SEISMIC EVALUATIONS FOR THE BFN CONDENSERS	CHK	JOD	DATE	8/30/99

SHEET NO. 2

Table of Contents

Tables

Figures

1.0 PURPOSE

The purpose of this calculation is to document the results of the additional seismic evaluation performed on the BFN condensers, as part of the seismic adequacy verification of the components associated with the MSIV Alternate Leakage Treatment (ALT) pathway.

2.0 SCOPE & METHODOLOGY

The BFN condensers are the terminal boundary points of the MSIV alternate leakage treatment (ALT) pathway, hence, they are necessary to maintain structural integrity following a Design Basis Earthquake (DBE). The condensers are located in the Turbine Building and are not designated as Seismic Class I systems.

As part of the plant specific seismic verification of the non-seismic components using the earthquake experience-based approach as outlined in the BWROG Report (Reference 1), the following reviews are performed to demonstrate that the BFN condensers fall within the bounds of the experience database and/or exhibit adequate seismic capacity:

- Review of the condenser design codes and standards, design characteristics and parameters, and support/anchorage configurations.
- Verification walkdown to identify potential seismic interaction concerns.
- Engineering evaluations of the condenser and support configurations.

The BFN condensers are evaluated using both seismic experience data from past earthquakes and engineering analysis. Analytical evaluations of the condenser and support anchorage are performed in accordance with the guidelines in the Generic Implementation Procedure (GIP, Reference 5), and the general requirements of the American Institute of Steel Construction (AISC, Reference 6), as applicable.

3.0 REFERENCES

1. "BWROG Report for Increasing MSIV Leakage Rate Limits and Elimination of Leakage Control Systems", GE NEDC-31858P, Revision 2, September 1993.

2. Safety Evaluation of GE Topical Report, NEDC-31858P, Revision 2, "BWROG Report for Increasing MSIV Leakage Rate Limits and Elimination of Leakage Control Systems", U.S. Nuclear Regulatory Commission, March 3, 1999.

3. "Browns Ferry - Unit 2, MSIV Seismic Verification Summary Report", EQE Report No. 200918-R-001, Revision 0, August 1999.

4. "Browns Ferry - Unit 3, MSIV Seismic Verification Summary Report", EQE Report No. 200621-R-001, Revision 0, September 1998.

5. "Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment", Rev. 2A, March 1993, Prepared by Winston & Strawn, EQE, et al., for the Seismic Qualification Utility Group (SQUG).

6. AISC, "Manual of Steel Construction", Eighth Edition, 1980.

7. TVA Calculation No. CD-N0001-980039, "Main Steam Seismic Ruggedness Verification".

8. TVA Calculation No. CD-N0001-980038, "Main Steam Seismic Ruggedness Evaluation".

9. ASME, "Boiler and Pressure Vessel Code, Section III, Division I, Appendices", 1980 Edition.

4.0 SEISMIC EVALUATIONS

The BFN condensers consist of three single-pass, single pressure, radial flow type surface condensers. Each condenser is located beneath each of the three low pressure turbines, and is structurally independent. Table 1 lists the design data for BFN condensers and for the two experience database sites listed in the BWROG Report (i.e., Moss Landing 6 & 7, and Ormond Beach 1 & 2). Design characteristic comparisons of the BFN condensers with the above two selected database condensers are presented in details in Reference 8. These include size (surface area), weight, height, and plan comparisons. The BFN condenser design data is comparable to the data for these two database sites.

The BFN condenser anchorage was compared with the performance of similar condenser in the earthquake experience database. The shear areas of the condenser anchorage, in the directions parallel and transverse to the turbine generator axis, divided by the seismic demand, were used to compare with those presented in the BWROG Report (Reference 1). The BFN condenser anchorage shear area to seismic demand is substantially greater than the selected database sites. The condenser support anchorage was also evaluated and the results indicate that the combined seismic DBE and operational demand is less than the anchorage capacity based on the AISC allowables. Maximum stress ratios are 0.70 for bolt tension in the perimeter support feet, and 0.86 for shear in the center support built-up section. Detailed description of the BFN condenser support anchorage and anchorage evaluations are presented in Reference 8.

A composite comparison of the ground response spectra of selected earthquake experience database sites with the conservatively estimated BFN DBE ground spectrum (i.e., 0.2g Housner input spectrum at rock outcrop scaled by 1.6 to account for soil amplification) is shown in Figure 1. In general, the earthquake experience database sites have experienced strong ground motions that are in excess of the BFN DBE at the frequency range of interest (i.e., about 1 Hz. and above), with the exception of the Ormond Beach site. Many of the database site ground motions envelope the conservatively estimated BFN DBE ground spectrum by large factors in various frequency bands within the 1 Hz. and above range. Figures 2 and 3 show the individual comparison plots of the conservatively estimated BFN DBE ground spectrum with the Moss Landing and Ormond Beach site spectra, respectively.

						SHEET NO.	6
JOB NO.	200918	JOB	BFN MSIV TECH SPEC CHANGE	BY	JB	DATE	8-24-99
CALC. NO.	C-002	SUBJECT	ADDITIONAL SEISMIC EVALUATIONS FOR THE BFN CONDENSERS	CHK	JSD	DATE	8/30/99

The Ormond Beach Power Plant was affected by the magnitude 5.8, Point Mugu Earthquake in 1973, which was considered to be a relatively moderate earthquake, and was substantially lower than the 1989 Loma Prieta Earthquake (Magnitude 7.1) as experienced in the Moss Landing Power Plant as well as those experienced by most of the other database sites.

To ensure that adequate seismic margins exist in the BFN condensers in the event of a plant DBE, additional seismic evaluation was performed to verify the overall structural integrity of the condensers, as shown in pages 7 to 9 of this calculation. Results of the evaluation indicate that the condenser shell stresses due to the seismic DBE loads are small. Maximum stress ratios, based on AISC allowables, are 0.12 for combined axial and bending and 0.10 for shear.

EQE INTERNATIONAL

SHEET NO. 7

JOB NO. 200918 JOB BFN MSIV BY 7Beij DATE 8-24-99
CALC. NO. C-002 SUBJECT Condenser Shell Evaluation CHK'D DATE 8/30/99

CONDENSER SHELL

Check combined stresses in the condenser shell due to seismic Loads (DBE).

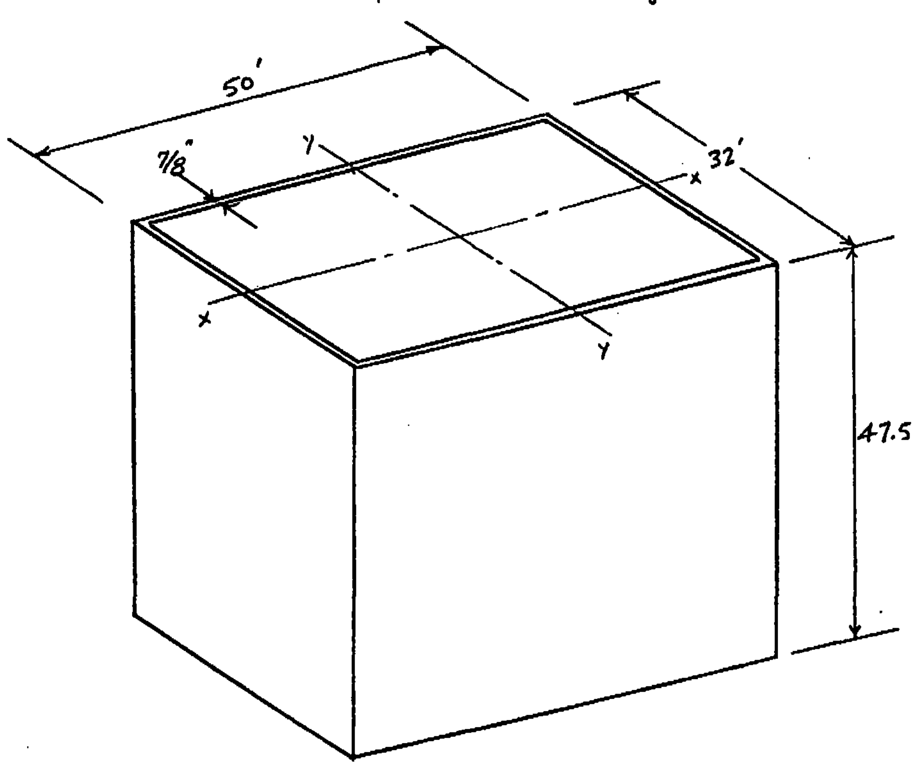
From Figure 1, BFN 5% damped DBE Ground spectrum

a_h = horizontal acceleration = 0.32g
a_v = vertical acceleration = 0.2g (2/3 × horiz.)

P = Condenser dead wt., including contents = 2070^k (Ref. 8)

C.G. = center of gravity of overall condenser = 12.72' (Ref. 8)

Condenser overall dimensions = 50' × 32' × 47.5' (h) (Ref. 8)
shell Thickness = 7/8"
shell Material = ASTM A285C (F_y = 30 ksi) (Ref. 9)



EQE INTERNATIONAL

SHEET NO. 8

JOB NO. 200918 JOB BFN MSIV BY 7Bej DATE 8-24-99
CALC. NO. C-002 SUBJECT Condenser Shell Evaluation CHK'D [illegible] DATE 8/30/99

CONDENSER SHELL (CONT'd)

- section properties :

$$A = (7/8'')(2)(50' + 32')(12) = 1722 \quad IN^2$$

$$I_{xx} = 2 \times \frac{7/8\,(32' \times 12)^3}{12} + 2 \times (7/8 \times 50' \times 12)\left(\frac{32' \times 12}{2}\right)^2 = 4.70 \times 10^7 \quad IN^4$$

$$\Rightarrow \quad S_{xx} = \frac{I_{xx}}{(32' \times 12)/2} = 2.45 \times 10^5 \quad IN^3$$

$$I_{yy} = 2 \times \frac{7/8\,(50' \times 12)^3}{12} + 2 \times (7/8 \times 32' \times 12)\left(\frac{50' \times 12}{2}\right)^2 = 9.20 \times 10^7 \quad IN^4$$

$$\Rightarrow \quad S_{yy} = \frac{I_{yy}}{(50' \times 12)/2} = 3.07 \times 10^5 \quad IN^3$$

- Axial + Bending stresses

$$f_a = \frac{P(1+a_v)}{A} = \frac{2070^k(1+0.2)}{1722} = 1.44 \quad ksi$$

$$f_{bx} = \frac{M}{S_{xx}} = \frac{(2070^k \times 0.32g)(12.72' \times 12)}{2.45 \times 10^5} = 0.41 \quad ksi$$

$$f_{by} = \frac{M}{S_{yy}} = \frac{(2070^k \times .32g)(12.72' \times 12)}{3.07 \times 10^5} = 0.33 \quad ksi$$

Combined stress = $f_a + f_{bx} + f_{by} = 1.44 + .41 + .33 = 2.18$ ksi

AISC Allowables - (Ref. 6)

$$F_b = 0.6 \times 30^{ksi} = 18 \text{ ksi} \quad \gg \quad 2.18 \text{ ksi} \qquad \text{ok}$$

$$D/C = \frac{2.18}{18} = 0.12 \quad \ll 1.0 \qquad \text{ok}$$

EQE INTERNATIONAL

SHEET NO. 9

JOB NO. 200918 JOB BFN MSIV BY FBej DATE 8-24-99
CALC. NO. C-002 SUBJECT Condenser shell Evaluation CHK'D JoD DATE 8/30/99

CONDENSER SHELL (Cont'd)

- Shear

$P_H = P \times a_h = 2070^k \times 0.32g = 662.4^k$

$A_V = 2 \times (32' \times 12)\ 7/8'' = 672\ IN^2$

$f_v = \frac{662.4}{672} = 1.0$ ksi

$F_V = 0.4 \times 30 = 12$ ksi $\gg f_v = 1.0$ ksi ok

$D/C = \frac{1.0}{12} = 0.1 \ll 1.0$ ok

Table 1

Comparison of Browns Ferry and Selected Database Condensers

Design Attributes	Moss Landing Units 6 & 7	Ormond Beach Units 1 & 2	Browns Ferry
Condenser Manufacturer	Ingersoll-Rand	Southwestern	Foster Wheeler
Flow Type	Single Pass	Single Pass	Single Pass
Condenser Dimensions (LxWxH)	65 ft. x 36 ft. x 47 ft.	52 ft. x 27 ft. x 20 ft.	58 ft. x 32 ft. x 47 ft.
Condenser Surface Area	435,000 sq. ft.	210,000 sq. ft.	222,000 sq. ft.
Condenser Shell Material	Cu Bearing ASTM A-285C	Cu Bearing ASTM A-285C	ASTM A-285C
Condenser Shell Thickness	3/4"	3/4"	7/8"
Condenser Operating Weight	3,115 kips	1,767 kips	2,076 kips
Tube Material	Al-Brass	90-10 Cu-Ni	Al-6XN
Tube Size	1" dia.	1" dia.	7/8" dia.
Tube Length	65 ft.	53 ft.	50 ft.
Tube Wall Thickness	18 BWG	20 BWG	22 BWG

EQE INTERNATIONAL

JOB NO.	200918	JOB	BFN MSIV TECH SPEC CHANGE	BY	[illegible]	SHEET NO. 11
CALC. NO.	C-002	SUBJECT	ADDITIONAL SEISMIC EVALUATIONS FOR THE BFN CONDENSERS	CHK	JOD	DATE 8/24/99 / DATE 8/30/99

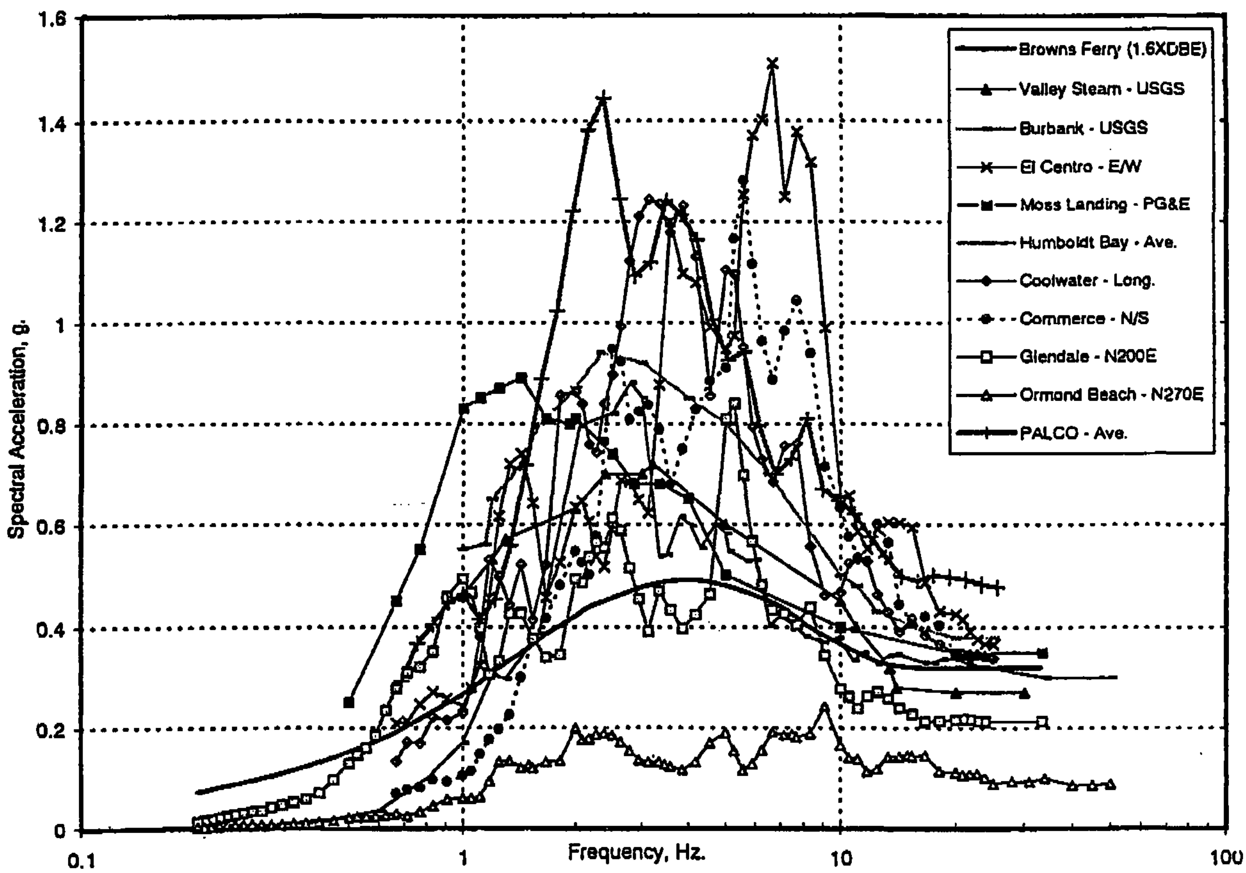
Table 1 (cont.)

Comparison of Browns Ferry and Selected Database Condensers

Design Attributes	Moss Landing Units 6 & 7	Ormond Beach Units 1 & 2	Browns Ferry
Number of Tubes	25,590	15,220	19,480
Tube Sheet Material	Muntz	Muntz	ASTM A-285C
Tube Sheet Thickness	1-1/2"	1-1/4"	1-1/4"
No. of Tube Support Plates	15	14	15
Tube Support Plate Material	Not Given	Cu Bearing ASTM A-285C	ASTM A-285C
Tube Support Plate Thickness	3/4"	5/8"	7/8"
Tube Support Plate Spacing	48 in.	36 in.	39 in.
Water Box Material	2% Ni Cast Iron ASTM A-48 Class 30	Cu Bearing ASTM A-285C	ASTM A-285C
Expansion Joint	Rubber Belt	Stainless Steel	Rubber Belt
Hotwell Capacity	20,000 gal.	34,338 gal.	28,000 gal. (max.)

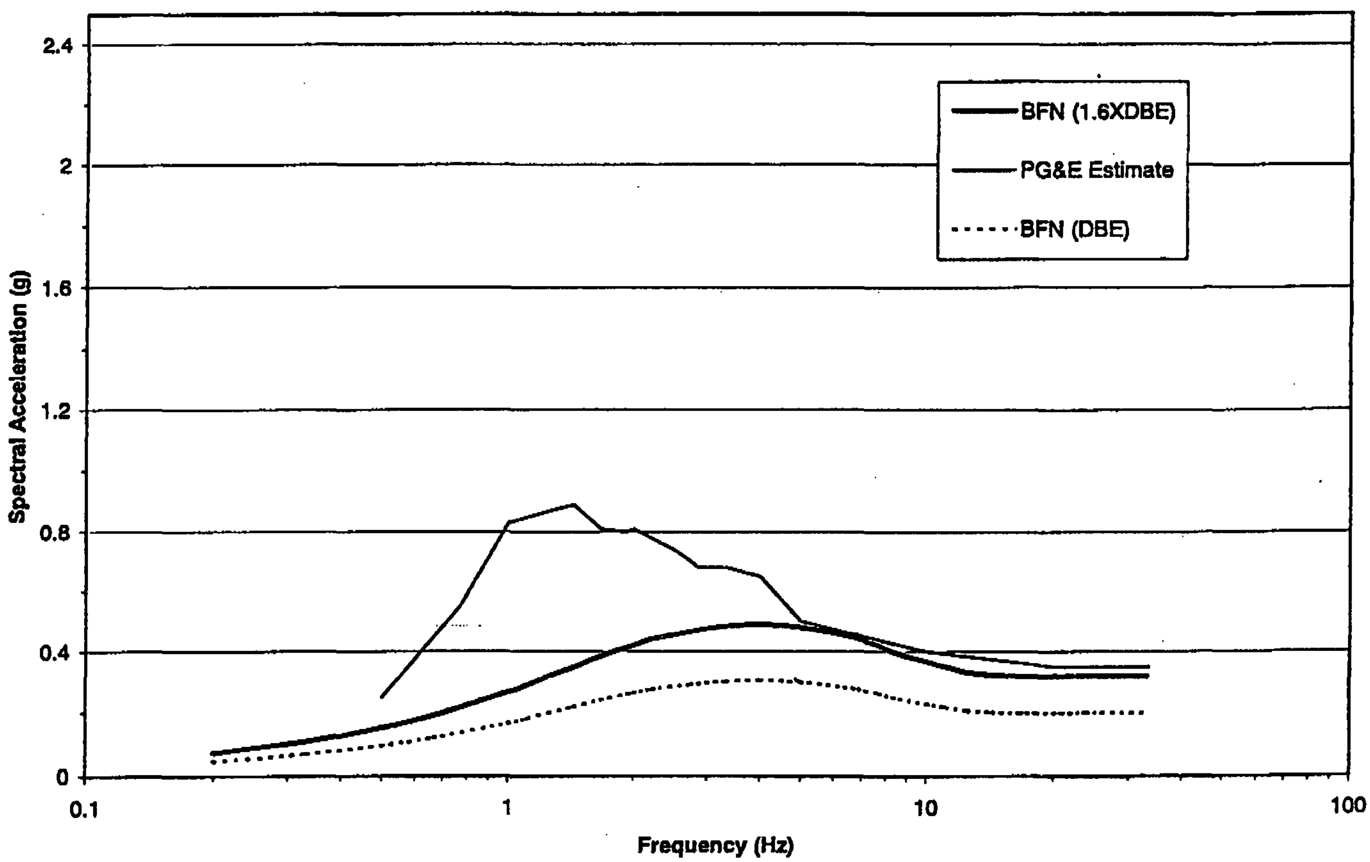
						SHEET NO.	12
JOB NO.	200918	JOB	BFN MSIV TECH SPEC CHANGE	BY	B	DATE	8/24/99
CALC. NO.	C-002	SUBJECT	ADDITIONAL SEISMIC EVALUATIONS FOR THE BFN CONDENSERS	CHK	JJD	DATE	8/30/99

Figure 1
Comparison of Browns Ferry DBE Ground Spectrum with Selected Database Site Spectra



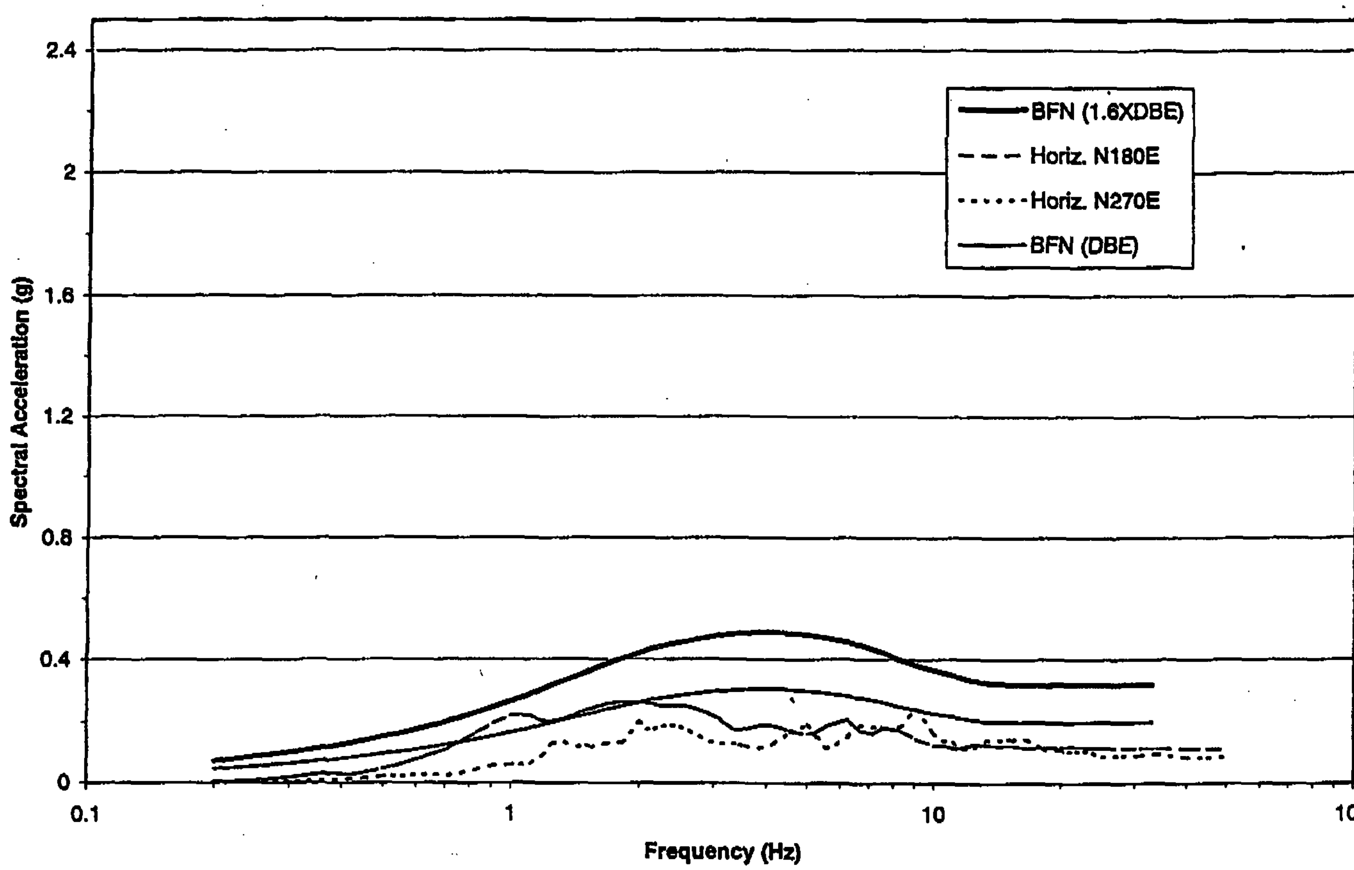
						SHEET NO.	13
JOB NO.	200918	JOB	BFN MSIV TECH SPEC CHANGE	BY	B	DATE	8/24/99
CALC. NO.	C-002	SUBJECT	ADDITIONAL SEISMIC EVALUATIONS FOR THE BFN CONDENSERS	CHK	JoD	DATE	8/30/99

Figure 2
Comparison of Browns Ferry DBE and Moss Landing Power Plant Ground Spectra



JOB NO.	200918	JOB	BFN MSIV TECH SPEC CHANGE	BY	73	SHEET NO. 14 / DATE 8/24/99
CALC. NO.	C-002	SUBJECT	ADDITIONAL SEISMIC EVALUATIONS FOR THE BFN CONDENSERS	CHK	JSD	DATE 8/30/99

Figure 3
Comparison of Browns Ferry DBE and Ormond Beach Power Plant Ground Spectra



						SHEET NO.	15
JOB NO.	200918	JOB	BFN MSIV TECH SPEC CHANGE	BY	TB	DATE	8/24/99
CALC. NO.	C-002	SUBJECT	ADDITIONAL SEISMIC EVALUATIONS FOR THE BFN CONDENSERS	CHK	JOD	DATE	8/30/99

5.0 CONCLUSIONS

The comparisons of the condenser seismic experience data, supplemented by the additional condenser evaluation and the anchorage capacity evaluations demonstrate that the conclusions presented in the BWROG Report (Reference 1) can be applied to the BFN condensers. That is, a significant failure of the condenser in the event of a DBE at BFN is highly unlikely and contrary to the large body of historical earthquake experience data.

EQE INTERNATIONAL

CALCULATION COVER SHEET

Calculation No. 200918-C-001

Project: TVA BFN MSIV LEAKAGE TECH SPEC CHANGE

Calculation Title: SEISMIC VERIFICATION OF THE MS DRAIN PIPING AND SUPPORTS ASSOCIATED WITH THE MSIV ALTERNATE LEAKAGE TREATMENT PATHWAY

References: See Section 3.0

Attachments:

Total Number of Pages (Including Cover Sheet): 29

Revision Number	Approval Date	Description of Revision	Originator	Checker	Approver
0	8/30/99	ORIGINAL ISSUE	F.R. BEIGI FBeigi	J.O. DIZON J.O. Dizon	J.O. DIZON J.O. Dizon

Table of Contents

Page

Tables

Figures

					SHEET NO.	3
JOB NO.	200918	JOB	BFN MSIV TECH SPEC CHANGE	BY	7Buy	DATE 8-23-99
CALC. NO.	C-001	SUBJECT	SEISMIC VERIFICATION OF THE MSIV ALT PIPING AND SUPPORTS	CHK	JBD	DATE 8/30/99

1.0 PURPOSE

The purpose of this calculation is to document the seismic adequacy verification of the main steam drain piping and related supports that are associated with the MSIV Alternate Leakage Treatment (ALT) pathway.

2.0 SCOPE & METHODOLOGY

The MSIV alternate leakage treatment (ALT) piping systems and related components at Browns Ferry, i.e., those portions downstream of the outboard Main Steam Isolation Valves (MSIV's) and the outboard Main Steam Drain Isolation Valve (MSDIV), are located in the Turbine Building and are not designated as Seismic Class I systems.

As part of the plant specific seismic verification of the non-seismic ALT piping, related supports and components using the earthquake experience-based approach as outlined in the BWROG Report (Reference 1), the following reviews will be performed to demonstrate that the piping and related supports fall within the bounds of the experience database:

- Review of the design codes and standards, piping design parameters, and support configurations.
- Seismic verification walkdown to identify potential piping concerns.
- Seismic evaluations of selected bounding support configurations.

Support evaluations will be performed in accordance to the general requirements of the American Institute of Steel Construction (AISC, Reference 6).

						SHEET NO.	4
JOB NO.	200918	JOB	BFN MSIV TECH SPEC CHANGE	BY	7Bei	DATE	8-23-99
CALC. NO.	C-001	SUBJECT	SEISMIC VERIFICATION OF THE MSIV ALT	CHK	[illegible]	DATE	8/30/99
			PIPING AND SUPPORTS				

3.0 REFERENCES

1. "BWROG Report for Increasing MSIV Leakage Rate Limits and Elimination of Leakage Control Systems", GE NEDC-31858P, Revision 2, September 1993.

2. Safety Evaluation of GE Topical Report, NEDC-31858P, Revision 2, "BWROG Report for Increasing MSIV Leakage Rate Limits and Elimination of Leakage Control Systems", U.S. Nuclear Regulatory Commission, March 3, 1999.

3. "Browns Ferry - Unit 2, MSIV Seismic Verification Summary Report", EQE Report No. 200918-R-001, Revision 0, August 1999.

4. "Browns Ferry - Unit 3, MSIV Seismic Verification Summary Report", EQE Report No. 200621-R-001, Revision 0, September 1998.

5. "Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment", Rev. 2A, March 1993, Prepared by Winston & Strawn, EQE, et al., for the Seismic Qualification Utility Group (SQUG).

6. AISC, "Manual of Steel Construction", Eighth Edition, 1980.

7. USAS B31.1 - Power Piping, 1967. Also, ANSI/ASME B31.1 – Power Piping, 1983.

8. TVA Calculation No. CD-N0001-980039, "Main Steam Seismic Ruggedness Verification".

9. TVA Calculation No. CD-N0001-980038, "Main Steam Seismic Ruggedness Evaluation".

						SHEET NO.	5
JOB NO.	200918	JOB	BFN MSIV TECH SPEC CHANGE	BY	7 Per	DATE	8-23-99
CALC. NO.	C-001	SUBJECT	SEISMIC VERIFICATION OF THE MSIV ALT PIPING AND SUPPORTS	CHK		DATE	8/30/99

4.0 SEISMIC EVALUATIONS

In general, the Browns Ferry ALT piping systems are typically designed to the requirements of USAS B31.1-1967 code (Reference 7), and consist of welded steel pipe and standard support components. Support spacing generally meets the B31.1 recommended span. The design bases for the portions of piping associated with the ALT pathway to the condensers are tabulated in Table 1. Table 2 presents a general summary of the piping data that constitute the seismic experience data. Figure 1 shows the comparison of the selected database site spectra with Browns Ferry DBE ground spectrum which indicates that the BFN DBE ground spectrum is generally bounded by those of the earthquake experience database sites at the frequencies of interest. Hence, the use of earthquake experience-based approaching for demonstrating the seismic ruggedness of non-seismically analyzed piping and related components at BFN, consistent with the BWROG's recommendations, is appropriate. Comparison of Browns Ferry and selected database piping parameters is presented in Table 3, along with Figure 2, which presents a comparison of D/t ratios of the BFN ALT drain piping with those found in the database. Overall, the BFN piping design is similar to and well represented by those found in the experience database sites that have shown to perform well in past earthquakes.

Browns Ferry FSAR does not reference Appendix A to 10 CFR Part 100. As such, bounding analysis for the selected portion of the ALT piping system is not required (Reference 2). The seismic adequacy of the ALT piping is addressed by performing seismic verification walkdowns to identify specific design attributes associated with poor seismic performance, following the guidelines as presented in the BWROG Report (Reference 1). The results of the walkdowns, including the resolution of the identified outliers, were presented in the respective MSIV Walkdown Summary Reports for Units 2 and 3 (References 3 and 4).

Furthermore, bounding evaluations are performed for typical support configurations as shown in pages 6 to 15 of this calculation. Table 4 summarizes the results of the support and anchorage evaluations.

CD-N0001-990113 Page C6
Attachment C

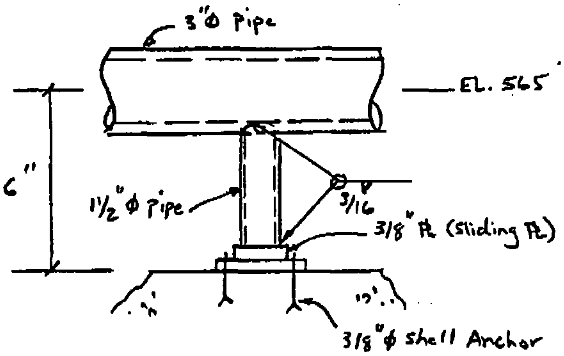
EQE INTERNATIONAL

SHEET NO. 6

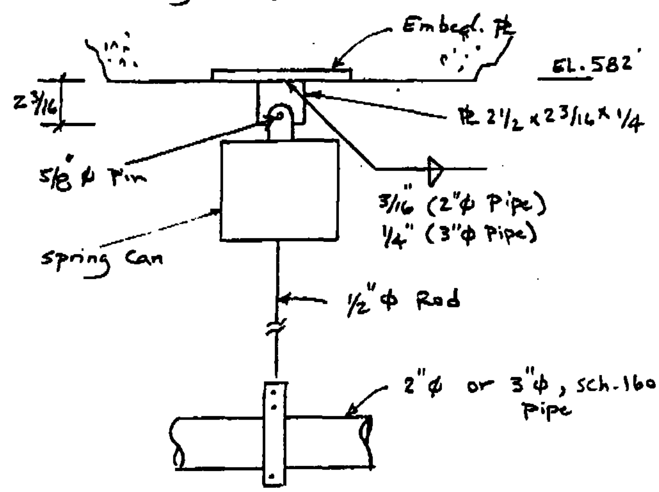
JOB NO. 200918 JOB BFN MSIV BY 7Beigi DATE 8-19-99
CALC. NO. C-001 SUBJECT Support Evaluations CHK'D JOD DATE 8/30/99

Support Assessment

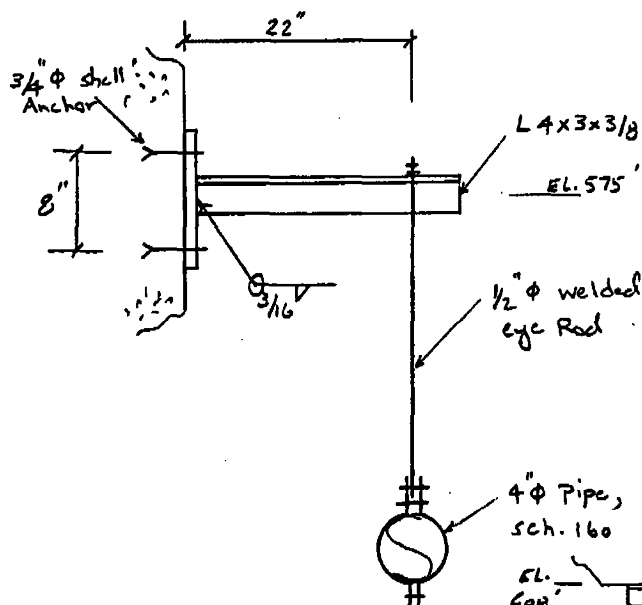
Typical support configurations on the Main Steam Drain piping are shown below. These also represent the bounding configurations w.r.t. dimensions shown and the member sizes.



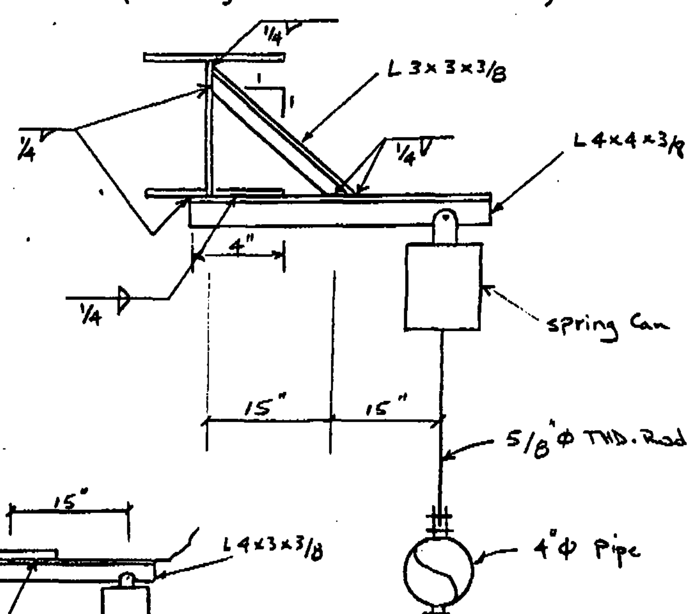
Type 1
(Ref. Hanger Mark No. MDH-12, 13, 18)



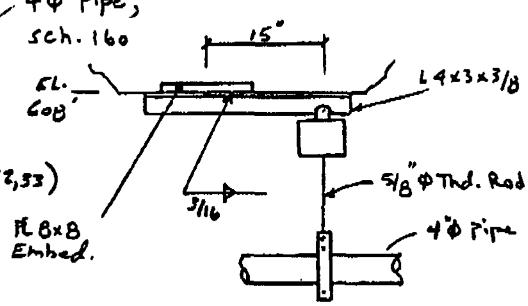
Type 2
(Ref. Hanger Mark No. MDH-15, 16, 17)



Type 3
(Ref. Hanger Mark No. MDH-19 TO 25, 32, 33)



Type 4
(Ref. MDH-26 supplemented by walkdown notes)



Type 5 (Ref. MDH-31)

EQE INTERNATIONAL

SHEET NO. 7

JOB NO. 200918 JOB BFN MSIV BY 7Beigi DATE 8-19-99
CALC. NO. C-001 SUBJECT Support EVALuations CHK'D JOD DATE 8/30/99

Support Assessment (cont'd)

- For conservatism and bounding purposes, in order to calculate the lower bound margin of safety for each support type shown, consider that all piping are insulated by 2" thick calcium silicate and the attachment point of the support is at EL-608 of the TB building. Also, all pipe sizes will be considered to be 3"φ & 4"φ. Note that the wt. of steam in these lines is negligible.

- Applicable vertical acceleration is based on the BFN DBE spectra.

The Horizontal Peak accel corresponding to 1.6x Housner Design Spectrum @ EL. 519' (or TB ground response spectrum) is: $a_{h\,ground}^{Peak} = 0.5g$ (see fig. 1, p. 27)

Therefore the vertical peak accel. @ ground is calculated as: $a_{v\,ground}^{Peak} = 0.5g \times 2/3 \times \frac{1.1}{1.6} = 0.23\,g$ (Refs. 8 + 9)

The above vertical accel. needs to be amplified for consideration of the support location within the building. Conservatively, use an amplification factor of 1.5 (very conservative for vertical direction)

$$a_v^{Peak} = 0.23\,g \times 1.5 = 0.35\,g$$

- other relevant inputs are:

$\omega_{4"\phi}$ = weight of 4"φ pipe + 2" CaSi Insulation

$$= 22.51\ \text{lb/ft} + \left(\frac{\pi}{4}(8.5^2 - 4.5^2)\frac{1}{12^2}\right) 11\ \text{lb/ft}^3$$

$$= 25.6\ \text{lb/ft}$$

$$\omega_{3"\phi} = 14.32\ \text{lb/ft} + \left(\frac{\pi}{4}(7.5^2 - 3.5^2)\frac{1}{12^2}\right) 11\ \text{lb/ft}^3$$

$$= 17\ \text{lb/ft}$$

EQE INTERNATIONAL

SHEET NO. 8

JOB NO. 200918 JOB BEN MSIV BY 7Beji DATE 8-19-99

CALC. NO. C-001 SUBJECT Support Evaluations CHK'D VBD DATE 8/30/99

Support Assessment (cont'd)

- Per References 3 & 4 MSIV ALT piping spans correspond to ANSI B31.1 (Ref. 7)

$$\ell_{4''\phi} = 14'$$

$$\ell_{3''\phi} = 12'$$

- Therefore the DL + Seismic load to be considered for the support evaluations are:

$$P_{4''\phi} = (\omega_{4''\phi} \times \ell_{4''\phi})(1 + a_V^{Peak})$$

$$= (25.6 \times 14')(1 + 0.35g)$$

$$= 484^{\#}$$

$$P_{3''\phi} = (\omega_{3''\phi} \times \ell_{3''\phi})(1 + a_V^{Peak})$$

$$= (17 \times 12')(1 + 0.35g)$$

$$= 275^{\#}$$

EQE INTERNATIONAL

SHEET NO. 9

JOB NO. 200918 JOB BFN MSIV BY 7Beigi DATE 8-19-99
CALC. NO. C-001 SUBJECT Support Evaluations CHK'D [illegible] DATE 8/30/99

Support Assessment (Cont'd)

Type 1

Only the compression in the $1\frac{1}{2}"\phi$ support pipe needs to be checked.

Area of $1\frac{1}{2}"\phi$ sch. 40 pipe = 0.799 in^2

length of $1\frac{1}{2}"\phi$ support pipe $\cong 6"$

$\frac{Kl}{r} = \frac{2.0 \times 6"}{0.623} = 19.3 \Rightarrow F_a = 20.66$ ksi $\times 1.33 = 27.5$ ksi (Ref. 6)

$f_a = \frac{P_{y'0}}{A} = \frac{275}{.799} = 344$ psi

$\frac{f_a}{F_a} = \frac{.344}{27.5} = 0.01 \ll 1.0$ ok

Type 2

The critical components in the load path for this support are the weld @ the welding lug to embed plate, the $5/8"\phi$ pin and the $\frac{1}{2}"\phi$ threaded rod.

- weld

$l_w = 2 \times 2\frac{1}{2}" = 5"$

$F_W = 0.3 \times 60 \times 0.707 \times \frac{1}{4}" \times 1.33 = 4.23$ K/in (weld material)
$= 0.4 \times 36 \times \frac{1}{4} \times 1.33 = 4.79$ K/in (Base Material)

$f_w = \frac{275}{5"} = 55$ lb/in

$\frac{f_w}{F_w} = \frac{0.055}{4.23} = 0.01 \ll 1.0$ ok

EQE INTERNATIONAL

SHEET NO. 10

JOB NO. 200918 JOB BFN MSIV BY 7Beig DATE 8-20-99
CALC. NO. C-001 SUBJECT Support Evaluations CHK'D JCD DATE 8/30/99

Support Assessment (cont'd)

- 1/2"ϕ A36 Threaded rod

Root Area = .126 in^2

$f_t = \frac{275^{\#}}{.126} = 2.2$ ksi

$F_t = 19.1 \times 1.33 = 25.4$ ksi
(per Ref. 6)

$\frac{f_t}{F_t} = \frac{2.2}{25.4} = 0.09 \ll 1.0$ ok

- 5/8"ϕ pin

$Area = \frac{\pi}{4}(5/8)^2 = 0.31$ in^2

$f_v = \frac{275}{.31} = .89$ ksi

$F_v = 10 \times 1.33 = 13.3$ ksi
(Ref. 6)

$\frac{f_v}{F_v} = \frac{.89}{13.3} = 0.07 \ll 1.0$ ok

Type 3

- Check member bending

$M_{max} = 484^{\#} \times 22'' = 10648$ lb-in

$S_{min} = 0.866$ in^3 (L4x3x3/8)

EQE INTERNATIONAL

SHEET NO. 11

JOB NO. 200918 JOB BFN MSIV BY FBeji DATE 8-20-99

CALC. NO. C-001 SUBJECT Support Evaluations CHK'D JOD DATE 8/30/99

Support Assessment (cont'd)

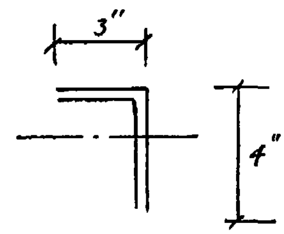
$$f_b = \frac{M}{S} = \frac{10648}{.866} = 12.3 \text{ ksi}$$

$F_b = 0.6\ F_y = 21.6$ ksi (Conservative, i.e., no 1.33 factor used)

$$\frac{f_b}{F_b} = \frac{12.3}{21.6} = 0.57 < 1.0 \quad \underline{ok}$$

- Check weld @ member – base plate

$$S_{W_{min.}} = \frac{4^2(4\times3'' + 4'')}{6(2\times3'' + 4'')} \times 2 = 8.53 \text{ IN}^2$$



$$l_w = (4+3)\,2 = 14''$$

$$f_w = \left[\left(\frac{10648}{8.53}\right)^2 + \left(\frac{484^{\#}}{14''}\right)^2\right]^{1/2} = 1.25 \text{ K/IN}$$

$F_{W_1} = 60 \times 0.3 \times 0.707 \times 3/16 \times 1.33 \doteq 3.17$ K/IN governs (Weld Mat.)

OR

$F_{W_2} = 0.4 \times 36 \times 3/16 \times 1.33 = 3.6$ K/IN (Base Mat.)

$$\frac{f_w}{F_{W_1}} = \frac{1.25}{3.17} = 0.39 < 1.0 \quad \underline{ok}$$

- Anchor bolt

$$T = \text{tension per A.B.} = \frac{10648}{8''} = 1331^{\#}$$

$$V = \text{shear per A.B.} = \frac{484}{2} = 242^{\#}$$

EQE INTERNATIONAL

SHEET NO. 12

JOB NO. 200918 JOB BFN MSIV BY [illegible] DATE 8-20-99
CALC. NO. C-001 SUBJECT Support Evaluations CHK'D JED DATE 8/30/99

Support Assessment (cont'd)

Reduction factor for unknown anchorage type, Ref. 5

$$T_{all} = 4.69^k \times \frac{3000}{4000} \times 0.6 = 2.11^k$$

Reduction for concrete strength
(conservatively assumed $f'_c = 3000$ psi)

Allowable Tensile load for 3/4" φ
Expansion anchor per Ref. 5, App. C

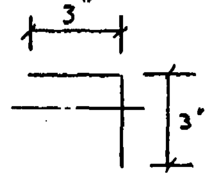
$$V_{all} = 5.48^k \times \frac{3000}{4000} \times 0.6 = 2.47^k$$

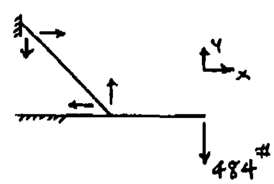
$$\frac{T}{T_{all}} + \frac{V}{V_{all}} = \frac{1.331}{2.11} + \frac{.242}{2.47} = 0.73 \quad < 1.0 \quad \underline{ok}$$

- 1/2" φ Rod and 5/8" φ Pin not critical by comparison to Calc. performed for type 2 support.

Type 4

Member bending stress ok by comparison to Type 3 (15" lever arm compared to 22" for type 3).
- Check brace welded connection





$$M = 484^{\#} \times 15'' = 7260^{\#''}$$

$$S_W = \frac{3^2(4 \times 3 + 3)}{6(2 \times 3 + 3)} = 2.5 \ in^2$$

$$l_W = 3 + 3 = 6''$$

axial force in brace $= \frac{7260}{15''}\sqrt{2} = 684^{\#}$
Vertical component of the axial force in brace $= 684 \times \frac{1}{\sqrt{2}} = 484^{\#}$
Horizontal — " — " — " — $= 684 \times \frac{1}{\sqrt{2}} = 484^{\#}$

EQE INTERNATIONAL

SHEET NO. 13

JOB NO. 200918 JOB BFN MSIV BY 7Beigi DATE 8-20-99

CALC. NO. C-001 SUBJECT support Evaluations CHK'D JOD DATE 8/30/99

Support Assessment (cont'd)

$f_{w_{1y}} = \frac{M}{S_w} = \frac{7260}{2.5} = 2.9$ K/IN

$f_{w_{2y}} = \frac{484}{6''} = .08$ K/IN

$f_{w_{3x}} = \frac{484}{6'} = .08$ K/IN

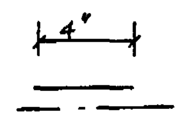
$f_w = ((2.9+.08)^2 + (.08)^2)^{1/2} = 2.98$ K/IN

$F_W = 4.23$ K/IN (see Type 2 support calc.)

$\frac{f_w}{F_W} = \frac{2.98}{4.23} = 0.70 < 1.0$ ok

- check weld @ L4x4 to the flange of the I-beam

$l_w = 2 \times 4'' = 8''$



$f_{w_1} = \frac{484}{8''} = 60.5$ lb/IN

$f_{w_2} = \frac{484}{8''} = 60.5$ lb/IN

$f_w = (.061^2 + .061^2)^{1/2} = .09$ K/IN $\ll F_W$ ok

- 5/8"φ Rod and 5/8"φ pin are not critical by comparison to calc. performed for Type 2 support.

EQE INTERNATIONAL

SHEET NO. 14

JOB NO. 200918 JOB DFN MSIV BY 7Beg DATE 8-20-99

CALC. NO. C-001 SUBJECT Support Evaluations CHK'D JSD DATE 8/30/99

Support Assessment (cont'd)

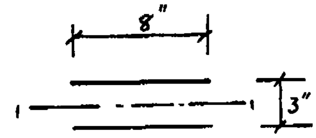
Type 5

- Check weld @ L4x3 to embed Pl.

$M = 484^{\#} \times 15'' = 7260^{\#''}$

$S_{W_{1-1}} = 3'' \times 8'' = 24 \ in^2$

$\ell_W = 2 \times 8'' = 16''$



$f_{W_1} = \frac{M}{S_{W_{1-1}}} = \frac{7260}{24} = .3 \ K/IN$

$f_{W_2} = \frac{484}{16} = .03 \ K/IN$

$f_W = f_{W_1} + f_{W_2} = .3 + .03 = .33 \ K/IN$

$F_W = 3.17 \ K/IN$ (see Type 3 support Calc.)

$\frac{f_W}{F_W} = \frac{.33}{3.17} = 0.1 \ll 1.0$ ok

- Member bending stress is ok by comparison to Type 3 support member bending calculation (15" lever arm for type 5 vs. 22" for Type 3)

- 5/8"φ Rod and pin are not critical by comparison to calc. performed for Type 2 support.

EQE INTERNATIONAL

		SHEET NO.	15
JOB NO. 200918	JOB BFN MSIV	BY FBeji	DATE 8-20-99
CALC. NO. C-001	SUBJECT Support Evaluations	CHK'D JOD	DATE 8/30/99

Support Assessment (cont'd)

The following Table summarizes the maximum D/C ratios (Demand/Capacity) for the typical supports on the MSIV drain piping.

Support Type	critical stress component	D/C
Type 1	Axial compression in support member	.01
Type 2	Tension in A36 Threaded rod	.09
Type 3	Anchor bolts	0.73
Type 4	Weld stress	0.70
Type 5	Weld stress	0.10

Table 1

Design Basis for Browns Ferry ALT Related Piping and Supports

Piping Description	Design Temp. (°F)	Design Press. (psig)	Pipe Size (NPS)	Pipe Sch.	D / t	Piping Material	Typical Support Types	Piping Design Basis
MS Lines from outboard MSIV's to MS Header and to Turbine Stop Valves	562	1146	24 1	80 160	20 5	ASTM A-106 Grade B	Spring hangers Vertical struts	USAS B31.1- 1967
Main Steam Header	562	1146	24	80	20	ASTM A-155 Grade KC-70	Spring hangers	USAS B31.1- 1967
MS Stop Valve Above Seat Leak-off	562	1146	1	160	5	ASTM A-106 Grade B	Rod hangers	USAS B31.1- 1967
Turbine Bypass Valve Header	562	1146	18	80	19	ASTM A-106 Grade B	Rigid supports Rod and Spring hangers	USAS B31.1- 1967
MS Steam Supply to RFP Turbine Stop Valves	562	1146	6 4	80 80	15 13	ASTM A-106 Grade B	Rod and Spring hangers Stanchion supports	USAS B31.1- 1967
MS Steam Supply from MS Header to SJAE's to the Condenser	562	1146	3 2 1-1/2 1	160 160 160 160	8 7 7 5	ASTM A-106 Grade B	Rod and Spring hangers	USAS B31.1- 1967

Table 1 (cont.)

Design Basis for Browns Ferry ALT Related Piping and Supports

Piping Description	Design Temp. (°F)	Design Press. (psig)	Pipe Size (NPS)	Pipe Sch.	D / t	Piping Material	Typical Support Types	Piping Design Basis
MS Steam Supply to Steam Seal Regulators	562	1146	4	80	13	ASTM A-106 Grade B	Rod hangers	USAS B31.1- 1967
MS Steam Supply from MS Header to the Off-Gas Preheaters A & B	562	1146	2	160	7	ASTM A-106 Grade B	Rod hangers	USAS B31.1- 1967
			2	160	7	ASTM A-335 Grade P11	New piping associated with the proposed installation of new boundary valves to Preheaters A & B	
MS Outboard Drains from MS Lines to the Main Drain Line	562	1146	3 2 1	160 160 160	8 7 5	ASTM A-106 Grade B	Stanchion supports	USAS B31.1- 1967
			3 2	160 160	8 7	ASTM A-333 Grade 1		
Main Drain Line to the Condenser	562 / 450	1146 / 400	4 3 1	80 160 160	13 8 5	ASTM A-106 Grade B	Rod and Spring hangers Stanchion supports	USAS B31.1- 1967

Table 1 (cont.)

Design Basis for Browns Ferry ALT Related Piping and Supports

Piping Description	Design Temp. (°F)	Design Press. (psig)	Pipe Size (NPS)	Pipe Sch.	D/t	Piping Material	Typical Support Types	Piping Design Basis
HPCI Drain to MS Drain; RCIC Drain to HPCI Drain; Aux. Boiler Drains to HPCI/RCIC/ Reactor Building Drain Line	450	400	2 1	160 160	7 5	ASTM A-106 Grade B	Rigid supports	USAS B31.1- 1967
	270	415	1	160	5			
Misc. PT Instrument Lines Sample Lines to Sample Station	562	1146	1	160	5	ASTM A-106 Grade B	Rigid supports	USAS B31.1- 1967
			¼" tubing	.049" (wall t)	–	ASTM A-213 SS Gr. TP-304	Rigid supports (tube clamps)	–

EQE INTERNATIONAL

SHEET NO. 19

JOB NO.	200918	JOB	BFN MSIV TECH SPEC CHANGE	BY	TBaig	DATE	8-23-99
CALC. NO.	C-001	SUBJECT	SEISMIC VERIFICATION OF THE MSIV ALT PIPING AND SUPPORTS	CHK	JDD	DATE	8/30/99

Table 2

Seismic Experience Database Piping Data

Facility	Pipe Size (NPS)	Pipe O.D. (inch)	Schedule	Wall Thickness (inch)	D/t
Valley Steam Plant Units 1 & 2	24	24.0	20	0.375	64
	20	20.0	20	0.375	53
	18	18.0	30	0.437	41
	16	16.0	30	0.375	43
	14	14.0	30	0.375	37
	12	12.75	40	0.406	31
	12	12.75	30	0.330	39
	10	10.75	160	1.125	10
	8	8.625	160	0.906	10
	6	6.625	40	0.280	24
	4	4.50	160	0.531	8
	4	4.50	40	0.237	19
	3	3.50	160	0.437	8
	3	3.50	80	0.300	12
	3	3.50	40	0.216	16
	2	2.375	160	0.343	7
	2	2.375	40	0.154	15
	1½	1.90	160	0.281	7
	1½	1.90	40	0.145	13
	1	1.315	40	0.133	10
	¾	1.05	160	0.218	5
	¾	1.05	40	0.113	9

Table 2 (cont.)

Seismic Experience Database Piping Data

Facility	Pipe Size (NPS)	Pipe O.D. (inch)	Schedule	Wall Thickness (inch)	D/t
El Centro Steam Plant	20	20.0	STD	0.375	53
	18	18.0	160	1.781	10
	18	18.0	XS	0.500	36
	18	18.0	STD	0.375	48
	14	14.0	40	0.437	32
	14	14.0	STD	0.375	37
	12	12.75	160	1.312	10
	12	12.75	STD	0.375	34
	10	10.75	40	0.365	29
	8	8.625	160	0.906	10
	8	8.625	120	0.718	12
	8	8.625	40	0.322	27
	6	6.625	120	0.562	12
	6	6.625	40	0.280	24
	4	4.50	80	0.337	13
	4	4.50	40	0.237	19
	3	3.50	160	0.437	8
	3	3.50	80	0.300	12
	3	3.50	40	0.216	16
	2	2.375	160	0.343	7
	2	2.375	80	0.218	11
	2	2.375	40	0.154	15
	1½	1.90	160	0.281	7
	1½	1.90	80	0.200	10
	1½	1.90	40	0.145	13
	1	1.315	80	0.179	7
	1	1.315	40	0.133	10
	¾	1.05	80	0.154	7
	¾	1.05	40	0.113	9

Table 2 (cont.)

Seismic Experience Database Piping Data

Facility	Pipe Size (NPS)	Pipe O.D. (inch)	Schedule	Wall Thickness (inch)	D/t
Moss Landing Units 1, 2 & 3	16	16.0	--	1.394	11
	12	12.75	--	1.148	11
	8	8.625	160	0.906	10
	8	8.625	30	0.277	31
	6	6.625	160	0.562	12
	6	6.625	40	0.280	24
	4	4.50	160	0.531	8
	4	4.50	80	0.337	13
	4	4.50	40	0.237	19
	3	3.50	160	0.437	8
	3	3.50	80	0.300	12
	3	3.50	40	0.216	16
	2	2.375	160	0.343	7
	2	2.375	80	0.218	11
	2	2.375	40	0.154	15
	1½	1.90	160	0.281	7
	1½	1.90	80	0.200	10
	1	1.315	160	0.250	5
	1	1.315	80	0.179	7
	¾	1.05	160	0.218	5
	¾	1.05	80	0.154	7

Table 2 (cont.)

Seismic Experience Database Piping Data

Facility	Pipe Size (NPS)	Pipe O.D. (inch)	Schedule	Wall Thickness (inch)	D/t
Moss Landing Units 4 & 5	24	24.0	40	0.687	35
	24	24.0	--	1.066	23
	--	18.8	--	2.287	8
	16	16.0	40	0.500	32
	16	16.0	--	0.902	18
	--	13.2	--	1.668	8
	8	8.625	160	0.906	10
	8	8.625	40	0.322	27
	6	6.625	160	0.562	12
	6	6.625	40	0.280	24
	4	4.50	160	0.531	8
	4	4.50	80	0.337	13
	4	4.50	40	0.237	19
	3	3.50	160	0.437	8
	3	3.50	80	0.300	12
	3	3.50	40	0.216	16
	2	2.375	160	0.343	7
	2	2.375	80	0.218	11
	2	2.375	40	0.154	15
	1½	1.90	160	0.281	7
	1½	1.90	80	0.200	10
	1½	1.90	40	0.145	13
	1	1.315	160	0.250	5
	1	1.315	80	0.179	7
	1	1.315	40	0.133	10
	¾	1.05	160	0.218	5
	¾	1.05	80	0.154	7
	¾	1.05	40	0.113	9

Table 2 (cont.)

Seismic Experience Database Piping Data

Facility	Pipe Size (NPS)	Pipe O.D. (inch)	Schedule	Wall Thickness (inch)	D/t
Moss Landing Units 6 & 7	30	30.0	--	0.632	47
	26	26.0	--	1.128	23
	18	18.0	--	3.444	5
	12	12.75	--	2.444	5
	12	12.75	--	0.601	21
	8	8.625	--	1.650	5
	8	8.625	40	0.322	27
	6	6.625	--	1.268	5
	6	6.625	40	0.280	24
	4	4.50	--	0.861	5
	4	4.50	80	0.337	13
	4	4.50	40	0.237	19
	3	3.50	80	0.300	12
	3	3.50	40	0.216	16
	2½	2.875	--	0.550	5
	2½	2.875	80	0.276	10
	2½	2.875	40	0.178	16
	2	2.375	--	0.519	5
	2	2.375	80	0.218	11
	2	2.375	40	0.154	15
	1½	1.90	--	0.428	4
	1½	1.90	80	0.200	10
	1½	1.90	40	0.145	13
	1	1.315	--	0.301	4
	1	1.315	80	0.179	7
	1	1.315	40	0.133	10
	¾	1.05	160	0.218	5
	¾	1.05	80	0.154	7
	¾	1.05	40	0.113	9
	½	1.05	--	0.210	4
	¼	0.54	--	0.153	4

Table 2 (cont.)

Seismic Experience Database Piping Data

Facility	Pipe Size (NPS)	Pipe O.D. (inch)	Schedule	Wall Thickness (inch)	D/t
Ormond Beach Units 1 & 2	30	30.0	-	1.298	23
	30	30.0	-	0.719	42
	21	21.0		3.793	6
Humboldt Bay Unit 3	12	12.75	80	0.687	19
	10	10.75	80	0.593	18
	6	6.625	80	0.432	15

Table 3

Comparison of Browns Ferry and Selected Database Piping Parameters

Piping Parameter	Browns Ferry	Database Sites
Pipe Diameter (inch)	1.315 – 24.0	1.05 – 30.0
Wall Thickness (inch)	0.25 – 1.218	0.113 – 3.793
Diameter-to-Thickness Ratio (D/t)	5 - 20	4 – 64

Table 4

Bounding Evaluations of Typical Support Configurations

Support Type	Critical Component	Stress Ratio
Cantilever bracket	Anchor bolts	.73
Rod hanger	Overhead weld attachment	.70

JOB NO.	200913	JOB	BFN MSIV TECH SPEC CHANGE	BY	TBaj	DATE	8-23-99
CALC. NO.	C-001	SUBJECT	SEISMIC VERIFICATION OF THE MSIV ALT PIPING AND SUPPORTS	CHK	JRD	DATE	8/30/99

SHEET NO. 27

Figure 1
Comparison of Database Site Spectra to Browns Ferry DBE Ground Spectra

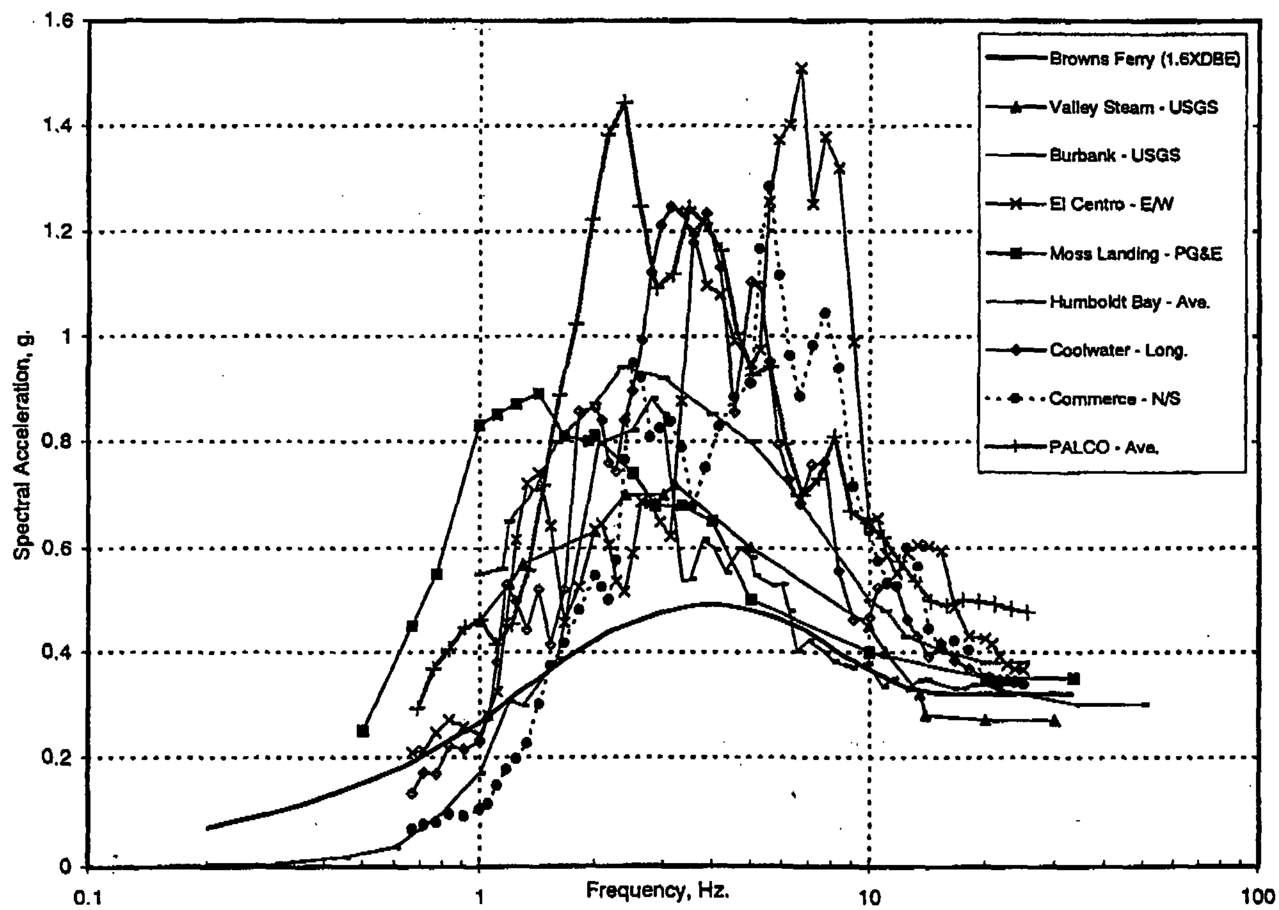
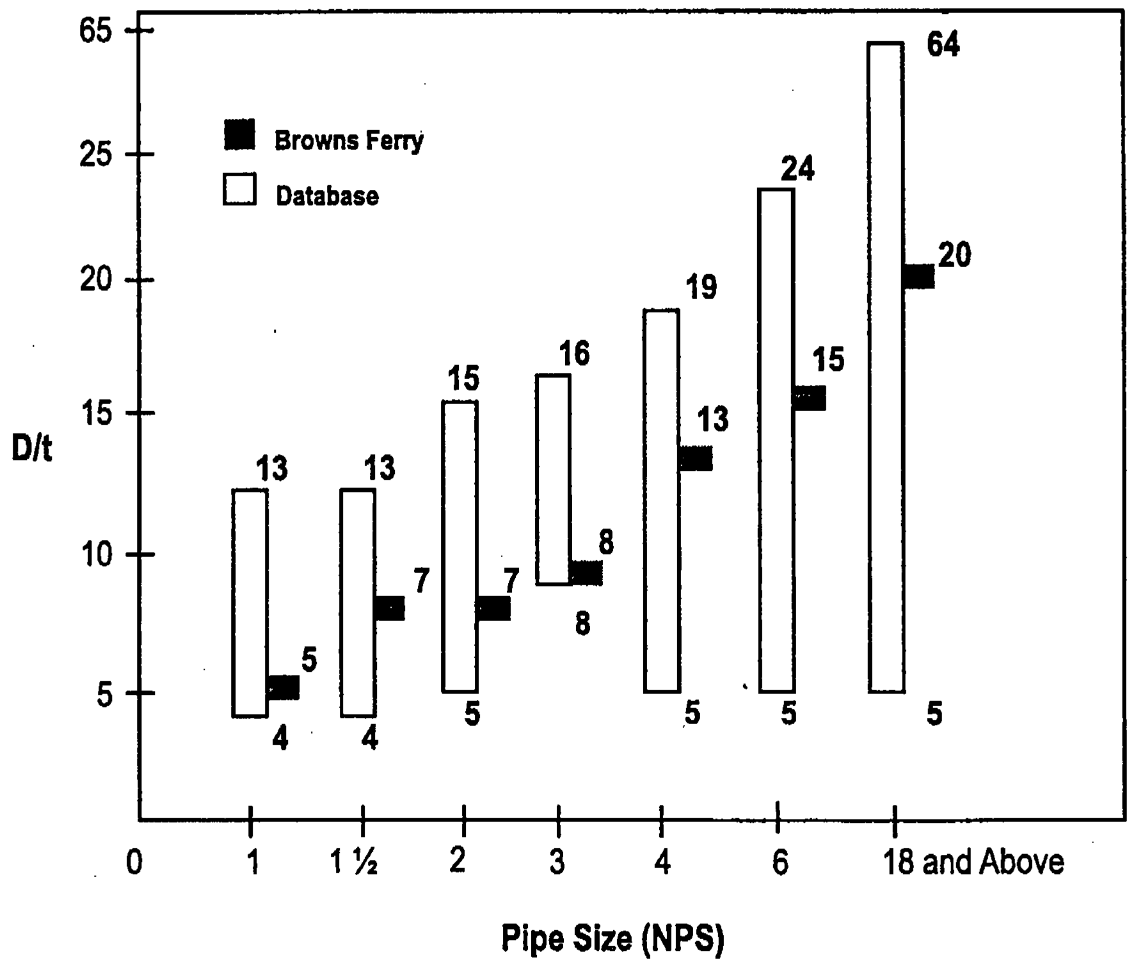


Figure 2
Comparison of Browns Ferry and Selected Database Piping D/t Ratios



5.0 CONCLUSIONS

Based on the results of the seismic verification walkdowns and bounding support evaluations, and upon the resolution of the identified walkdown outliers, it is reasonable to assume that the ALT piping, related supports and components have adequate seismic capacity in the event of a Design Basis Earthquake (DBE) at Browns Ferry.

ATTACHMENT D

MSIV SEISMIC EVALUATION REPORT

APPLICATION TO BFN UNIT 1

MSIV SEISMIC RUGGEDNESS VERIFICATION PROGRAM

PREPARER SIGNATURE	DATE	CHECKER SIGNATURE	DATE
	6/02/04		6/02/04
John O. Dizon (Facility Risk Consultants, Inc.)		Stephen J. Eder (Facility Risk Consultants, Inc.)	

D.1 PURPOSE

The purpose of this Attachment is to map the applicable sections of Attachments A, B and C of this calculation for use in the BFN Unit 1 Increased MSIV Leakage Tech Spec Change Submittal.

D.2 APPLICATION TO BFN UNIT 1

The following table presents a map purpose

Attachment	Section	Direct Application	Equivalent Section in Reference D-1	Additional References
A	1	Yes	- - -	N/A
	2.1	Yes	- - -	N/A
	2.2	Yes	- - -	N/A
	3.1	Yes	- - -	N/A
	3.2	No	2.1	- - -
	3.3	No	4.1 to 4.16	- - -
	4.1	No	5.1 to 5.2	- - -
	4.2	Yes	- - -	N/A
	4.3	Yes	- - -	N/A
	4.4	Yes *	- - -	Ref. D-2 of Attachment D
	5	Yes *	- - -	References in Attachment D
B	1	Yes	- - -	N/A
	2	Yes	- - -	N/A
	3	Yes *	- - -	References in Attachment D
	4	Yes *	- - -	Ref. D-2 of Attachment D
	5	Yes	- - -	N/A
C	1	Yes	- - -	N/A
	2	Yes	- - -	N/A
	3	Yes *	- - -	Ref. D-1 of Attachment D
	4	Yes *	- - -	Ref. D-1 of Attachment D
	5	Yes	- - -	N/A

* Supplemented by the additional reference(s) listed.

D.3 REFERENCES

D-1 Facility Risk Consultants, Inc., Report No. TVA/BFN-01-R-003, "*MSIV Seismic Ruggedness Verification at Browns Ferry Nuclear Plant Unit 1*", Revision 0, May 13, 2004. **RIMS No. W87040520002**.

D-2 TVA Calculation No. **CDN1-000-2004-0041**, "Seismic Verification of Condenser and its Anchorage, MSIV Ruggedness Seismic Analysis – Resolution of POS 15-1", Revision 000.

ATTACHMENT 10

Proposed Updated Final Safety Analysis Report Page Markups

d. The core inventory release fractions, timing, and chemical form are those specified in Regulatory Guide 1.183. Table 14.6-7 gives the bounding core inventory of each isotope .

14.6.3.5 Fission Product Release From Primary Containment

Fission products are released from the primary containment to the secondary containment via primary containment penetration leakage at the Technical Specification leakage limit. Primary containment atmosphere is released via main steam isolation valve leakage to the high and low pressure turbines and the condenser. Primary containment atmosphere is released directly to the Standby Gas Treatment System during operation of the Containment Atmospheric Dilution (CAD) System. Primary containment atmosphere is released to the top of the stack via leakage of the hardened wetwell vent isolation valves. The Emergency Core Cooling Systems (ECCS) leak into the secondary containment. The following assumptions were used in calculating the amounts of fission products released from the primary containment:

a. The primary containment minimum free volume (drywell and wetwell) is 278,400 ft^3. The drywell volume is 159,000 ft^3 and the torus gas space volume is 119,400 ft^3. The drywell torus gas space volumes are treated as separate volumes until after the activity release to the containment is complete and then these volumes are assumed to be well mixed. The activity release is entirely to the drywell.

b. The primary to secondary containment leak rate was taken as two percent volume per day (232 cfh).

c. The four main steam lines are assumed to leak a total of ~~150~~ 85 scfh which is the Technical Specification limit.

d. CAD system flow rate is 139 cfm for 24 hours at 10 days, 20 days, and 29 days.

e. The hardened wetwell vent isolation valves leak a total of 10 scfh to the top of the offgas stack. This leakage is assumed to begin at 8 hours.

f. Twenty gpm ECCS leakage into secondary containment in accordance with NUREG-0800, Section 15.6.5, Appendix B.

g. No credit is taken for spray removal in the containment.

h. Natural removal rates for particulates in the drywell are based on the correlations of NUREG-CR-6604. For elemental iodine, the natural removal coefficients for removal of plateout are based on the expressions of SRP 6.5.2.

values applicable to the time periods, distances, and geometric relationships (offsite and control room) are shown in Table 14.6-8. Control room X/Q values for the base of the stack releases are calculated using the computer code ARCON96. For sites, such as BFN, with control room ventilation intakes that are close to the base of tall stacks, ARCON96 underpredicts the X/Q values for top of stack releases; therefore, top of stack releases to the control room intakes are evaluated using the methods of Regulatory Guides 1.145 and 1.111.

j. The maximum control room X/Q for the top and bottom of the stack releases is used for each time period. Note that the effective X/Q is a factor of two less than the values listed because of the dual air intake configuration of the control bay ventilation.

<u>Main Steam Isolation Valve Leakage Releases</u>

The leakage from primary containment via the MSIVs is transferred 1) to the main turbine (high pressure and low pressure) via the four steam lines and 2) to the condenser via the alternate leakage treatment (ALT) flow path formed by the steam line drain. The leakage from the turbine and condenser migrates to the turbine deck and subsequently is exhausted to the atmosphere via the turbine building roof vents with no credit for hold-up or removal in the Turbine Building. The path takes advantage of the large volume of the main steam lines and the condenser to hold up and plate out fission products in the MSIV leakage effluent. The following assumptions were used to calculate the fission product activity released to the environment from the turbine building:

a. The four main steam lines are assumed to leak a total of ~~150~~ 85 scfh which is the Technical Specification limit. The direct leakage path to the turbines processes ~~only 0.5~~ 51.1% of the total leakage. The remainder goes to the condenser via the credited ALT flow path. The main steam piping from the outermost isolation valve up to the turbine stop valve, the bypass/drain piping to the main condenser and the main condenser will retain their structural integrity during and following a safe-shutdown earthquake (SSE).

b. Aerosol and elemental iodine removal due to sedimentation is credited in the main steam lines and in the main condenser. Aerosol settling velocities for sedimentation are determined for the steam lines and the main condenser per the AEB 98-03 distribution. Settling velocities are based on removal coefficients for the different volumes considering prior volume sedimentation removal. Elemental iodine removal in the steam lines utilizes the Bixler model of NUREG/CR-6604. The elemental iodine removal rate in the condenser is conservatively assumed to be the same as that for particulate.

ATTACHMENT 11

Affidavit

WorleyParsons Polestar, Inc.

AFFIDAVIT

I, Ronald W. Bailey, being duly sworn, depose and state as follows:

1. I am the General Manager of WorleyParsons Polestar, Inc. a wholly owned subsidiary of WorleyParsons Group Inc. and am responsible for the function of reviewing the information described in paragraph 2 which is sought to be withheld, and have been authorized to apply for its withholding.

2. The information sought to be withheld is contained in the WorleyParsons calculation NDQ099920010019 Revision 3, Ex-Containment Removal Coefficients for Alternate Source Term Analyses. This calculation was prepared for the Tennessee Valley Authority Browns Ferry Nuclear Plant to determine the aerosol and elemental iodine coefficients in the steam lines and main condenser.

3. In making this application for withholding of proprietary information of which it is the owner, WorleyParsons Polestar relies upon the exemption from disclosure set forth in the NRC regulations 10 CFR 9.17(a) 4), 2.390(a) (4), and 2.390(d) (1) for "trade secrets and commercial or financial information obtained from a person and privileged or confidential" (Exemption 2.390(a) 4)). The material for which exemption from disclosure is here sought is all "confidential commercial information".

4. Some examples of categories of information which fit into the definition of proprietary information are:

   a. Information that discloses a process or method, including supporting data and analysis, where prevention of its use by WorleyParsons Polestar's competitors without license from WorleyParsons Polestar constitutes a competitive economic advantage over other companies.

   b. Information which, if used by a competitor, would significantly reduce his expenditure of resources or improve his competitive position in the analysis, design, assurance of quality, of licensing of a similar product;

   c. Information which reveals cost or price information, production capacities, budget levels, or commercial strategies of WorleyParsons Polestar, its customers, or its suppliers;

   d. Information which reveals aspects of past, present, or future WorleyParsons Polestar customer-funded development plans and programs, of potential customers, or its suppliers;

   e. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

   The information sought to be withheld is considered to be proprietary for the reasons set forth in both paragraphs 4(a) and 4(b) above.

5. The information sought to be withheld is being submitted to the Tennessee Valley Authority in confidence. The information is of a sort customarily held in confidence by WorleyParsons Polestar, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by WorleyParsons Polestar, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to NRC have been made, or must be made, pursuant to regulatory provisions

or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

6. Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge. Distribution of such documents within WorleyParsons Polestar is limited to those with a need to know.

7. The approval of external release of such a document typically requires review by the Project Manager, and the WorleyParsons Polestar Officer closest to the work, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside WorleyParsons Polestar are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and only in accordance with appropriate regulatory provisions or proprietary agreements.

8. The information identified in paragraph (2), above, is classified as proprietary because it contains detailed information on and results from methodologies developed by WorleyParsons Polestar and applied under the WorleyParsons 10 CFR 50, Appendix B Quality Assurance Program. The methodologies used in this TVA work are several of a number of WorleyParsons Polestar developed methods, models and codes. Development of these methods, models, and codes was archived at a significant cost to WorleyParsons Polestar.

   The development of the methods, models, and codes, along with the interpretation and application of the results, is derived from the extensive experience database that constitutes a major WorleyParsons Polestar asset.

9. Public disclosure of the information sought to be withheld is likely to cause substantial harm to WorleyParsons Polestar's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of WorleyParsons Polestar's comprehensive technology base and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analysis done with methods which have been developed and are being maintained in accordance with 10 CFR 50, Appendix B requirements.

   The research, development, engineering, analytical and review costs comprise a substantial investment of time and money by WorleyParsons Polestar.

   The precise value of expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

   WorleyParsons Polestar's competitive advantage will be lost if its competitors are able to use the results of WorleyParsons Polestar's experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

   The value of this information to WorleyParsons Polestar would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive WorleyParsons Polestar of the opportunity to exercise its competitive advantage to seek an adequate return on its relatively large investment in developing these very valuable analytical tools.

State of Washington

County of Benton

Ronald W Bailey is being duly sworn deposes and says:

That he has read the foregoing affidavit and the matters stated therein are true and correct to the best of his knowledge, information and belief.

Executed at Richland WA this 6th day of November 2013

Ronald W Bailey

General Manager, WorleyParsons Polestar

Subscribed and sworn to me this 6th day of November 2013

JOSEPH BENASUTTI
COMMISSION EXPIRES
NOTARY
PUBLIC
07-31-17
STATE OF WASHINGTON

Notary Public, State of Washington

ENCLOSURE 2

List of Regulatory Commitments

List of Regulatory Commitments

1. Prior to implementation, BFN, Units 1, 2, and 3, will revise procedures to verify that the power is removed from valve FCV-1-57 after the valve has been verified as being in the open position.

2. To ensure the flow through the 0.1875-inch orifice is not obstructed, periodic radiography inspection of the 0.1875-inch orifice will be performed during refueling outages. These inspections will first be performed during the spring outage of 2014 for Unit 3, during the fall outage of 2014 for Unit 1, and during the spring outage of 2015 for Unit 2.