RG&E
Always at Your Service

Robert C. Mecredy
Vice President
Nuclear Operations

December 1, 2003

Mr. Robert L. Clark
Office of Nuclear Regulatory Regulation
U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

Subject: Reply to Information Requested at Public Meeting between RG&E and NRC Staff Held on August 19, 2003.
R.E. Ginna Nuclear Power Plant
Docket No. 50-244

References: 1. Letter from Robert C. Mecredy (RG&E) to Robert L. Clark (NRC) dated May 21, 2003, License Amendment Request Regarding Revision of Ginna Technical Specification Sections 1.1, 3.3.6, 3.4.16, 3.6.6, 3.7.9, 5.5.10, 5.5.16, and 5.6.7 Resulting From Modification of the Control Room Emergency Air Treatment System and Change in Dose Calculation Methodology to Alternate Source Term.

2. Letter from Robert C. Mecredy (RG&E) to Robert L. Clark (NRC) dated September 30, 2003, Summary of Public Meeting Between RG&E and NRC Staff Held on August 19, 2003.

Dear Mr. Clark:

On August 19, 2003 representatives of Rochester Gas and Electric Corporation (RG&E) met with members of the NRC Staff at your offices in White Flint. The purpose of the meeting was to brief the Staff and provide an overview of our Control Room Emergency Air Treatment System (CREATS) License Amendment Request (Ref. 1). Subsequent to the above meeting, RG&E summarized that meeting in a letter (Ref. 2), and committed to re-perform certain analysis and provide additional information. The attachments to this letter verify that those commitments are satisfied and should be docketed as an addendum to Reference 1.

I declare under penalty of perjury under the laws of the United States of America that I am authorized by Rochester Gas and Electric Corporation to submit this documentation and that the foregoing is true and correct.

If you have questions regarding the content of this correspondence please contact Mr. Mike Ruby at (585) 771-3572.

Sincerely

Executed on December 1, 2003

Robert C. Mecredy

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A003

Attachments:

1. Verification of Commitment Resolution
2. Summary of Radiological Analysis, Revision 1
3. Particulate Removed by Sprays
4. MSLB/Locked Rotor Two Hour Steam Release
5. Clarification of SGTR Steam Releases
6. PWR Natural Deposition Coefficients
7. UFSAR Excerpt

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Attachment 1

Verification of Commitment Resolution

Attachment 1
Verification of Commitment Resolution

1. NRC would prefer that RG&E use 2% versus 1% iodine partitioning for beyond 18 hours of Emergency Core Cooling System (ECCS) leakage.

   Initial Response: Agree. RG&E will revise the appropriate dose calculations.

   Resolution: The Loss of Coolant Accident (LOCA) dose analysis was revised to reflect the above and to incorporate the new X/Q values for the Exclusion Area Boundary (EAB) and Low Population Zone (LPZ). The Summary of Radiological Analysis (Attachment 2) was revised to reflect the new analysis.

2. Table 5.2 of the Summary of Radiological Analysis in the LAR submittal (page 38) shows that RG&E assumed certain efficiencies of the Containment (CNMT) post accident charcoal filters, when RG&E is planning to remove these filters.

   Initial Response: This is incorrect and will be revised.

   Resolution: Summary of Radiological Analysis (Attachment 2) has been revised to correct the indicated omission.

3. The NRC needs the calculation for spray removal coefficient for particulate as described in the Summary of Radiological Analysis attachment to the LAR.

   Initial Response: RG&E will provide the calculation.

   Resolution: See Attachment 3.

4. For Main Steam Line Break (MSLB) and Locked Rotor accidents, what is the steam release assumed for the intact SG at 2 hours?

   Initial Response: RG&E agreed to provide the requested information.

   Resolution: See Attachment 4.

5. Please clarify LAR Attachment 1, Table 8.2 and what the mass flows actually mean, including the partitioning factors for Steam Generator Tube Ruptures (SGTR)

   Initial Response: RG&E will clarify the information in a future submittal.

   Resolution: The Summary of Radiological Analysis (Attachment 2) was revised to clarify table values. See Attachment 5 for further explanation.

Attachment 1

6. In LAR Attachment 1, Table 10.1, what is the basis for the natural deposition coefficient value?

   Initial Response: RG&E agreed to provide this information.

   Resolution: See Attachment 6.

7. On LAR Attachment 1 page 77, the second paragraph under 12.2, what is meant by "Section 7.1.6".

   Initial Response: This is apparently a typographical error which RG&E agreed to correct, and provide the necessary information in a future submittal.

   Resolution: The Summary of Radiological Analysis (Attachment 2) was revised to correct the error.

8. Why did RG&E assume a 2-hour dispersion for Gas Decay Tank (GDT) rupture, especially since the previous analysis done for Ginna, related to TS Amendment 78, assumed a puff release?

   Initial Response: RG&E agreed to revise the analysis and do a puff release with no CR isolation, consistent with the analysis performed for Amendment 78.

   Resolution: The GDT dose analysis was revised to reflect the above comment and to incorporate the new atmospheric dispersion (X/Q) values for the EAB and LPZ. The control room doses were also calculated out to 30 days for consistency. The Summary of Radiological Analysis (Attachment 2) was revised to reflect the new analysis.

9. LAR Attachment 1 page 80, bottom of page has typo (renumbers).

   Initial Response: RG&E agreed and will correct the typo.

   Resolution: The Summary of Radiological Analysis (Attachment 2) was revised to correct numbering error.

10. What is the technical basis for lowering the required NaOH tank levels?

    Initial Response: RG&E agreed to provide the basis.

    Resolution: The basis for reducing the required NaOH tank level is described in the Ginna UFSAR, Section 6.1.2.1.4. See Attachment 7.

Attachment 2

Summary of Radiological Analysis

Rochester Gas and Electric Corporation
89 East Avenue
Rochester, New York 14649

R. E. Ginna Station

Docket Number 50-244

Summary of Radiological Analyses

Alternative Source Term and Control Room Emergency Ventilation System Submittal

Revision 1
November 2003

TABLE OF CONTENTS

1.0 Summary of Radiological Analysis

Each of the below accidents was analyzed for dose consequences using the Alternative Source Term Methodology per Regulatory Guide 1.183. All dose results are expressed in terms of TEDE for comparison with the appropriate limits. The accident consequences were calculated for both the Control Room Operator and the public at the Exclusion Area Boundary (EAB) and the Low Population Zone (LPZ). The following table summarizes the results of the analysis.

TABLE 1.1
ALTERNATE SOURCE TERM DOSE ANALYSIS SUMMARY

Accident	EAB Max. 2-hour		LPZ		Control Room	
	Limit	Dose	Limit	Dose	Limit	Dose
LOCA	25.0	3.70	25.0	0.92	5.0	3.51
FHA - CNMT	6.3	1.1	6.3	0.07	5.0	1.2
FHA-AUX	6.3	0.31	6.3	0.02	5.0	0.09
MSLB[1]	2.5	1.05	2.5	0.15	5.0	0.64
MSLB[2]	25.0	0.15	25.0	0.03	5.0	0.18
SGTR[1]	2.5	0.22	2.5	0.02	5.0	0.14
SGTR[2]	25.0	0.71	25.0	0.05	5.0	0.88
Locked Rotor	2.5	2.75[4]	2.5	0.55[4]	5.0	3.72
Rod Ejection	6.3	1.47	6.3	0.24	5.0	1.04
SFP- TMA	6.3	0.07[3]	-	-	5.0	0.06
GDT Rupture	0.5	0.172	0.5	0.013	5.0	0.067

[1] Accident Initiated Iodine Spike
[2] Pre-Accident Iodine Spike
[3] EAB X/Q = 1.74E-6 calculated as discussed in Section 2.7
[4] EAB and LPZ X/Q calculated by PAVAN, see Section 2.8

2.0 Atmospheric Dispersion (X/Q)

The atmospheric dispersion factors currently described within the UFSAR were reviewed as part of the control room ventilation system upgrade. As a result of this review, the atmospheric dispersion factors for the control room intake were recalculated as described below. The atmospheric dispersion factors for the EAB and LPZ are described in Section 2.8.

The atmospheric dispersion factors for each pathway from on-site source to control room intake were recalculated using the ARCON96 code (Reference 1) combined with the draft 2 Reg. Guide DG-1111 methodology (Reference 2).

The meteorological data collected by a Regulatory Guide 1.23 system for the years 1992, 1993, and 1994 was used in the calculations. This data is considered to be typical of any time period. This data was readily available and used in prior submittals. The data covered 26,304 hours, of which 512 hours were missing or invalid. This represents approximately 2% which is within the ARCON96's default setting of 10%.

The wind speed statistics for a typical year (1992) are:

Average wind speed:	4.16 m/sec
Maximum:	24.5 m/sec
Total hours (including invalid):	8572
Invalid hours:	212

The stability distribution for the same year (1992) was:

Stability Class	Duration (hr)
A	739
B	466
C	351
D	3132
E	2389
F	835
G	660

2.1 Containment Leakage

The containment shell is modeled as a diffuse vertical area source. This source is used in the dose calculations for LBLOCA, and the containment leakage portion of a control rod ejection accident. The source width is the containment O.D. and the source height is the distance from ground to the top of the containment dome. This is consistent with Reference 2, Figure 1. The diffuse source model is used because leakage is assumed to be distributed over the containment surface and all penetrations, not isolated to a specific point.

The source to receptor distance uses the shortest horizontal distance from the containment surface to the intake and assumes the source and receptor are at the same height. This results in the shortest source to receptor distance as illustrated by points C and B on Figure 2.1.B. The ARCON96 input parameters and resulting X/Qs are presented on Table 2.1 and Figures 2.1A and 2.1B.

TABLE 2.1 CONTAINMENT LEAKAGE INPUT AND RESULTS	
Distance to receptor, m	32
Intake height, m	13.8
Direction to source, degrees	247
Release type	ground level, diffuse vertical area
Release height, m	13.8
Building area, m^2	1071
Sector width constant	4.3
Surface roughness	0.2
Initial diffusion coefficients, m σ_{y0} σ_{z0}	 5.7 5.9
Lower measurement height, m	10
Upper measurement height, m	100
Elevation difference, m	0

TABLE 2.1 CONTAINMENT LEAKAGE INPUT AND RESULTS	
Resulting X/Q, sec/m^3	
0-2 hr	1.57 E-03
2-8 hr	1.12 E-03
8-24 hr	4.47 E-04
1-4 days	3.69 E-04
4-30 days	3.10 E-04

FIGURE 2.1A - CONTAINMENT AND CONTROL BUILDING ELEVATIONS

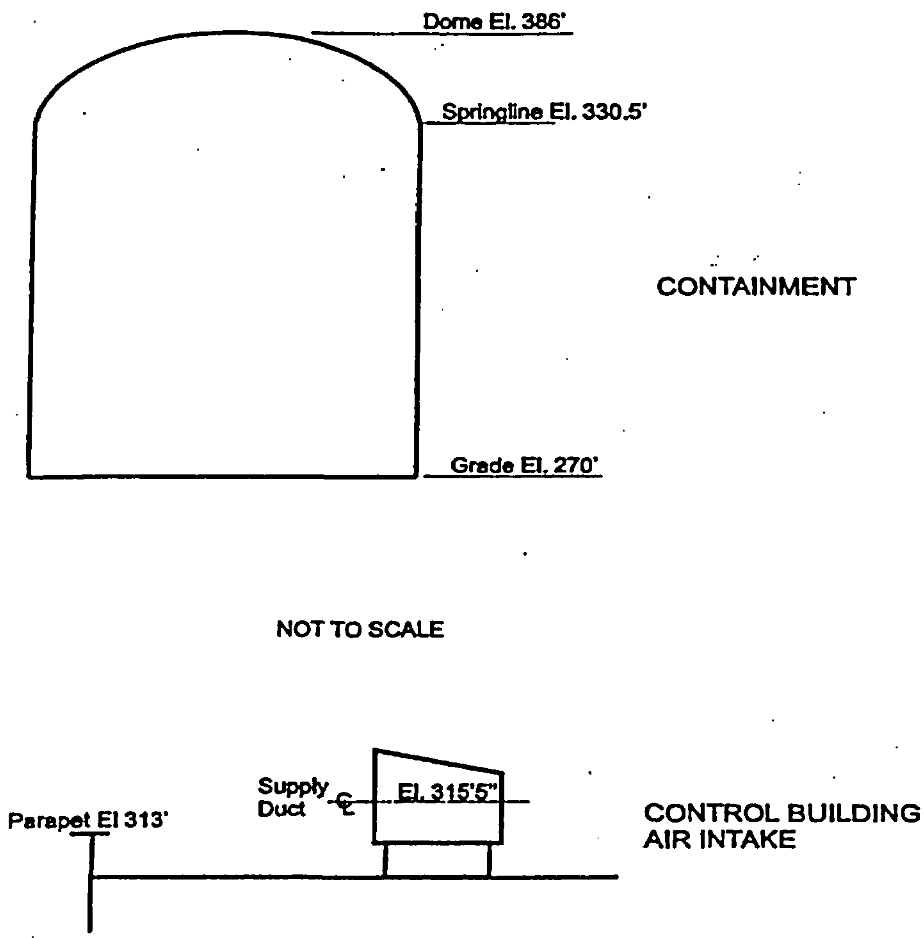
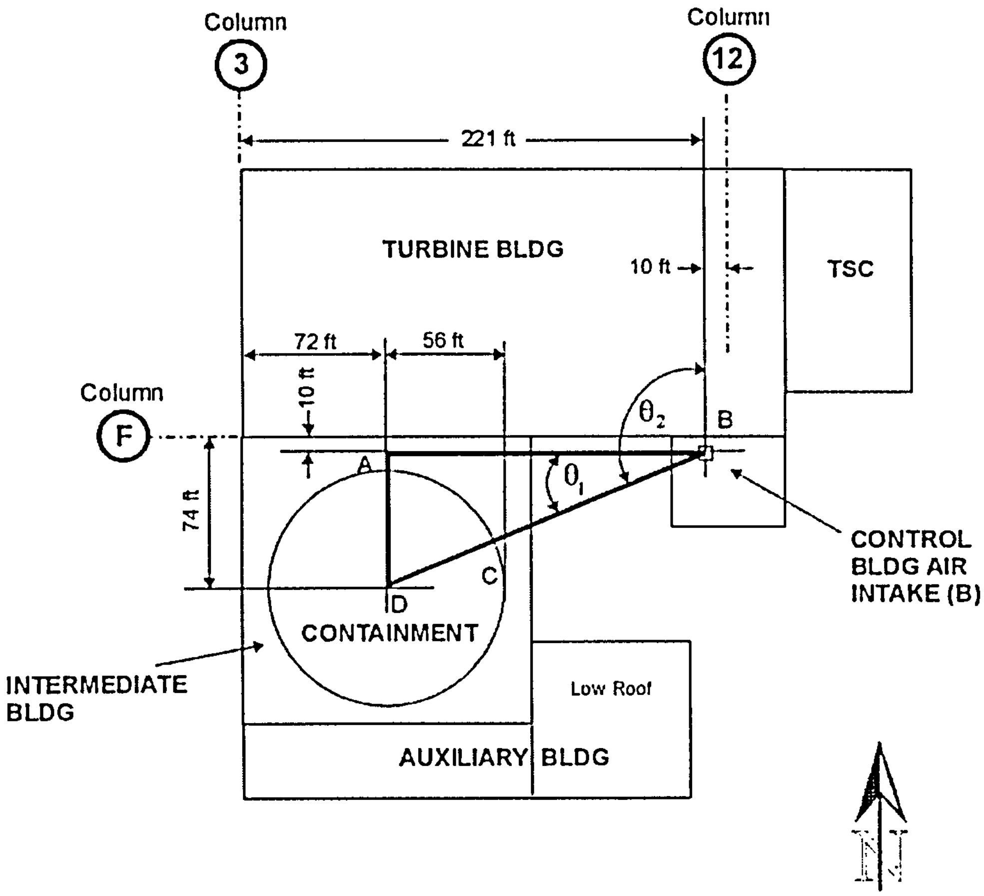


FIGURE 2.1B - CONTAINMENT LEAKAGE PLAN VIEW



2.2 Containment Equipment Hatch (Roll-Up Door)

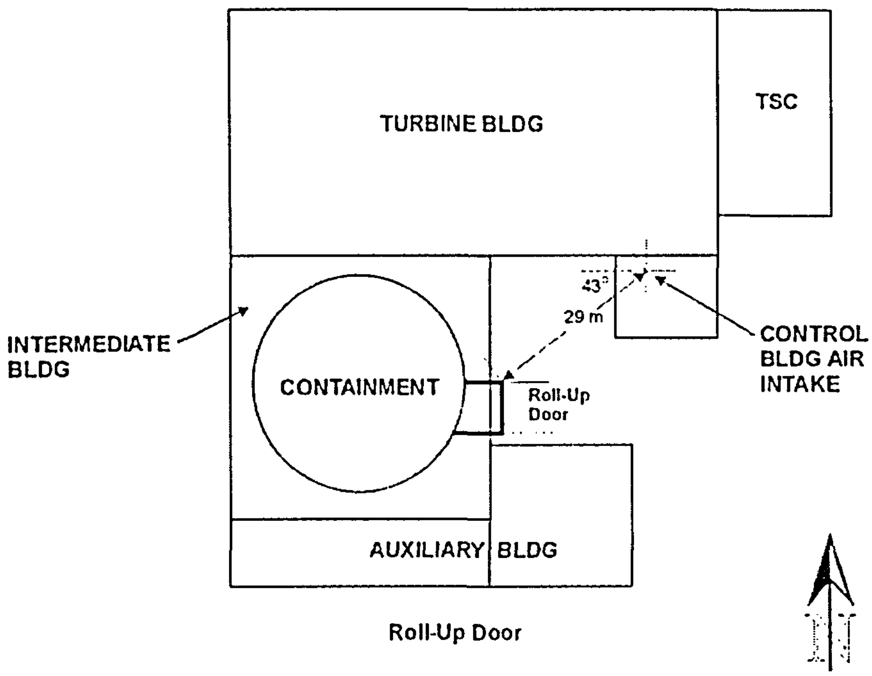
This vertical area source is used for the fuel handling accident in Containment. In this case, all Containment leakage is assumed to come from the equipment hatch, a large penetration located in the south-east sector of the Containment perimeter. During refueling, the hatch is removed, and the open penetration is covered by a roll-up door. The source dimensions are based on face area of the roll-up door. Radioactivity is postulated to leak through the open hatch, to the environment, through the perimeter seals of the roll-up door. The calculation uses:

1. The shortest horizontal distance between the door perimeter and the Control Room Intake
2. A diffuse vertical source is assumed. The dimensions being that of the roll-up door (23'6" wide, 22' high).
3. The assumed release height is equal to the distance from grade to the top of the roll-up door. This results in the shortest source - receptor distance.
4. The cross-section area of Containment was assumed for the building wake effect (1071 m^2). A sensitivity run was made where the wake area was doubled. There was an insignificant change in X/Q. The ARCON96 input parameters and resulting X /Q are presented on Table 2.2 and Figure 2.2.

TABLE 2.2 CONTAINMENT EQUIPMENT HATCH INPUT AND RESULTS	
Distance to receptor, m	29
Intake height, m	13.8
Direction to source, degrees	227
Release type	ground level, diffuse vertical area
Release height, m	6.7
Building area, m^2	1071
Sector width constant	4.3
Surface roughness	0.2
Initial diffusion coefficients, m σ_{y0} σ_{z0}	 1.2 1.1
Lower measurement height, m	10

TABLE 2.2 CONTAINMENT EQUIPMENT HATCH INPUT AND RESULTS	
Upper measurement height, m	100
Elevation difference, m	0
Resulting X/Q, sec/m^3 0-2 hr 2-8 hr 8-24 hr 1-4 days 4-30 days	 5.64 E-03 4.69 E-03 1.66 E-03 1.58 E-03 1.31 E-03

FIGURE 2.2 - ROLL-UP DOOR PLAN VIEW



Roll-Up Door

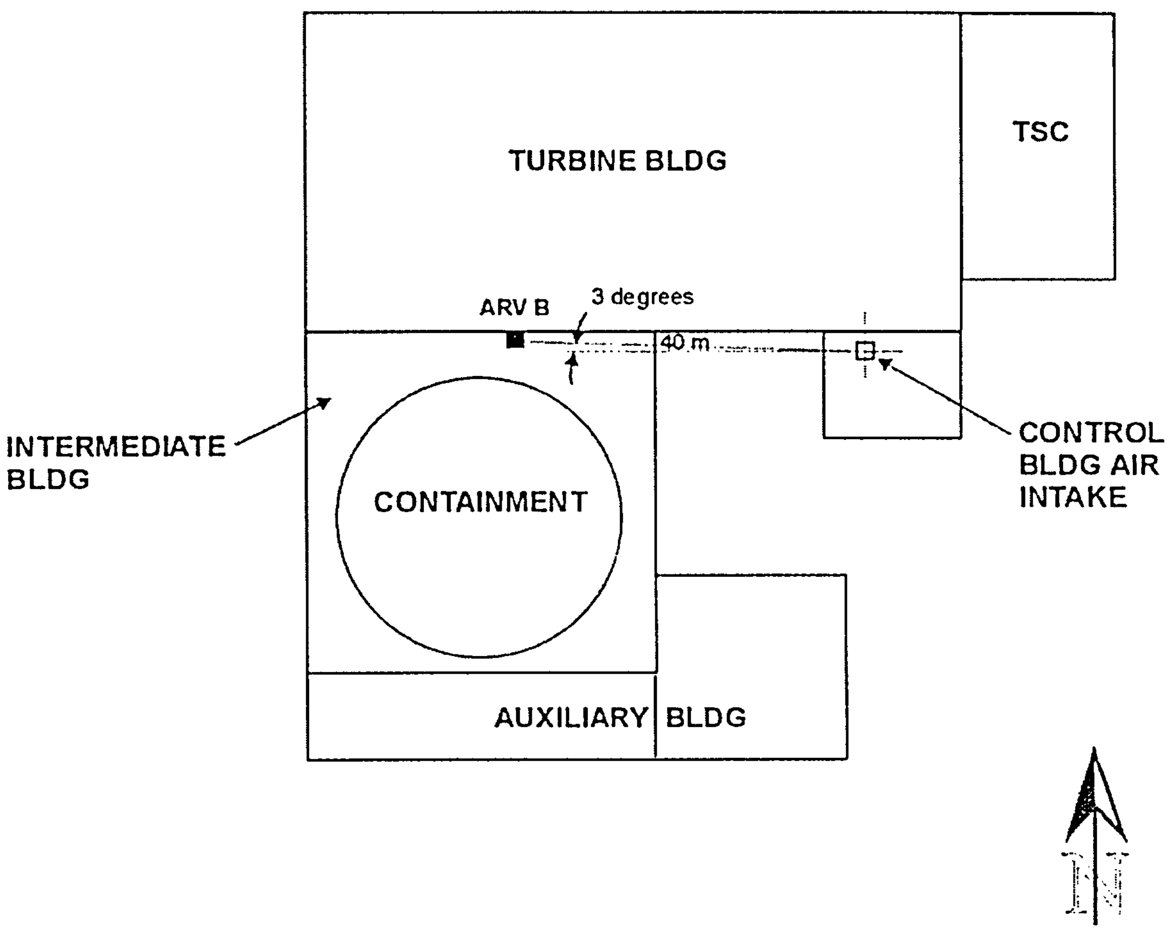
2.3 Atmospheric Relief Valves (ARVs)

This source is used for releases from the steam generators. The pathway is based on the ARV discharge that is closest to the Control Room Intake. This will result in larger X/Qs. The discharge of the ARV is modeled as a ground-level point source rather than an elevated vent since Reference 2 advises against using the vent release model, pending further NRC evaluation. The assumed release height is equal to the distance from grade to the vent point. The cross-section area of Containment was assumed for the wake area (1071 m^2). A sensitivity run was made where the wake area was doubled. There was an insignificant change in X/Q. The ARCON 96 input parameters and resulting X/Q are presented on Table 2.3 and Figure 2.3.

TABLE 2.3
ATMOSPHERIC RELIEF VALVES INPUT AND RESULTS

Distance to receptor, m	40
Intake height, m	13.8
Direction to source, degrees	273
Release type	ground level, point
Release height, m	22
Building area, m^2	1071
Sector width constant	4.3
Surface roughness	0.2
Initial diffusion coefficients, m	
σ_{y0}	0
σ_{z0}	0
Resulting X/Q, sec/m^3	
0-2 hr	3.66E-03
2-8 hr	2.49E-03
8-24 hr	1.07E-03
1-4 days	7.86E-04
4-30 days	7.17E-04

FIGURE 2.3 - ARV GROUP B PLAN VIEW

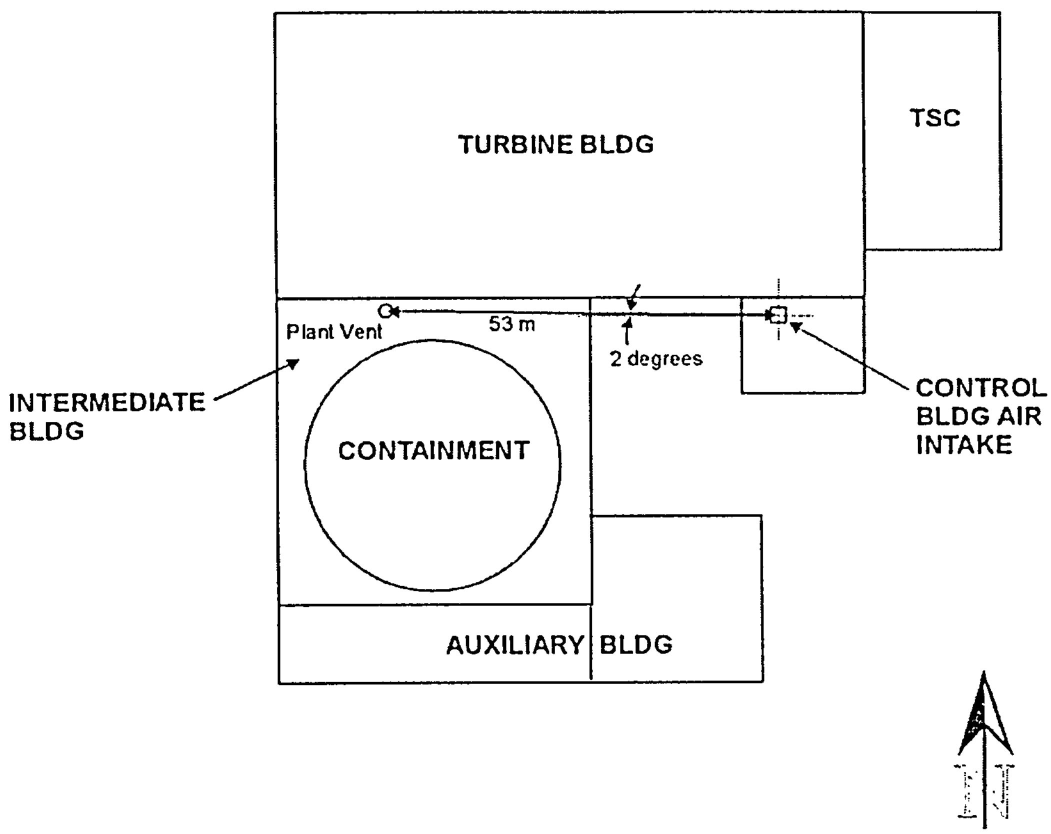


2.4 Plant Vent

This source is used for releases from a fuel handling accident in the spent fuel pool. The vent is modeled as a horizontal area source, rather than a vent source, based on guidance in Reference 2, which advises against using the vent release model pending further NRC evaluation. The assumption of an area source is considerably more conservative than the vent source assumption and only slightly less conservative than a point source. For the horizontal area source, the horizontal diffusion coefficient is based on the vent diameter (55") and the vertical coefficient is set to zero. The assumed release height is equal to the distance from grade to the vent point. The wake area of 1071 m^2 is again assumed. Doubling this value had an insignificant affect on X/Q. The ARCON96 input parameters and resulting X/Q are presented on Table 2.4 and Figure 2.4.

TABLE 2.4 PLANT VENT INPUT AND RESULTS	
Distance to receptor, m	53
Intake height, m	13.8
Direction to source, degrees	272
Release type	ground level, diffuse horizontal area
Release height, m	36
Building area, m^2	1071
Sector width constant	4.3
Surface roughness	0.2
Initial diffusion coefficients, m σ_{y0} σ_{z0}	 0.23 0
Resulting X/Q, sec/m^3 0-2 hr 2-8 hr 8-24 hr 1-4 days 4-30 days	 1.79E-03 1.15E-03 4.95E-04 3.71E-04 3.29E-04

FIGURE 2.4 - PLANT VENT PLAN VIEW

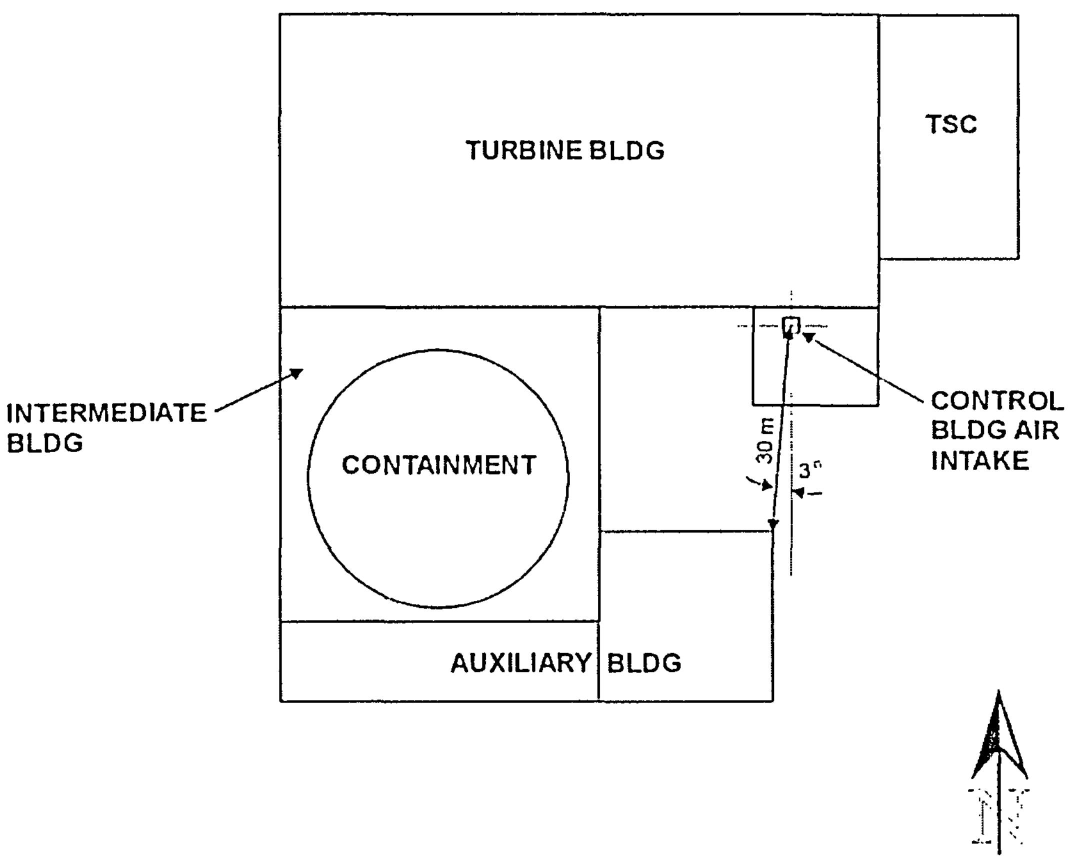


2.5 Auxiliary Building Leakage

This source is used when ECCS leakage is considered. The subgrade floors of this building contain ECCS equipment that is postulated to leak. The source is modeled as a vertical area source assumed to be the building wall closest to the Control Room Intake. The building north wall is modeled which approximates the cross-sectional area perpendicular to the line of site from the building surface to the control room intake. The assumed release height is the distance from grade to the top of the Auxiliary Building. The wake area equivalent to the Containment cross-section area is again assumed. The shortest source - receptor distance is calculated from the corner of the Auxiliary Building to the Control Room Intake. The ARCON96 input parameters and resulting X/Q are presented on Table 2.5 and Figure 2.5.

TABLE 2.5 AUXILIARY BUILDING LEAKAGE INPUT AND RESULTS	
Distance to receptor, m	30
Intake height, m	13.8
Direction to source, degrees	183
Release type	ground level, diffuse vertical area
Release height, m	13
Building area, m^2	1071
Sector width constant	4.3
Surface roughness	0.2
Initial diffusion coefficients, m σ_{y0} σ_{z0}	 3.9 2.1
Resulting X/Q, sec/m^3 0-2 hr 2-8 hr 8-24 hr 1-4 days 4-30 days	 3.89E-03 2.99E-03 9.63E-04 8.98E-04 8.23E-04

FIGURE 2.5 - AUXILIARY BUILDING LEAKAGE PLAN VIEW

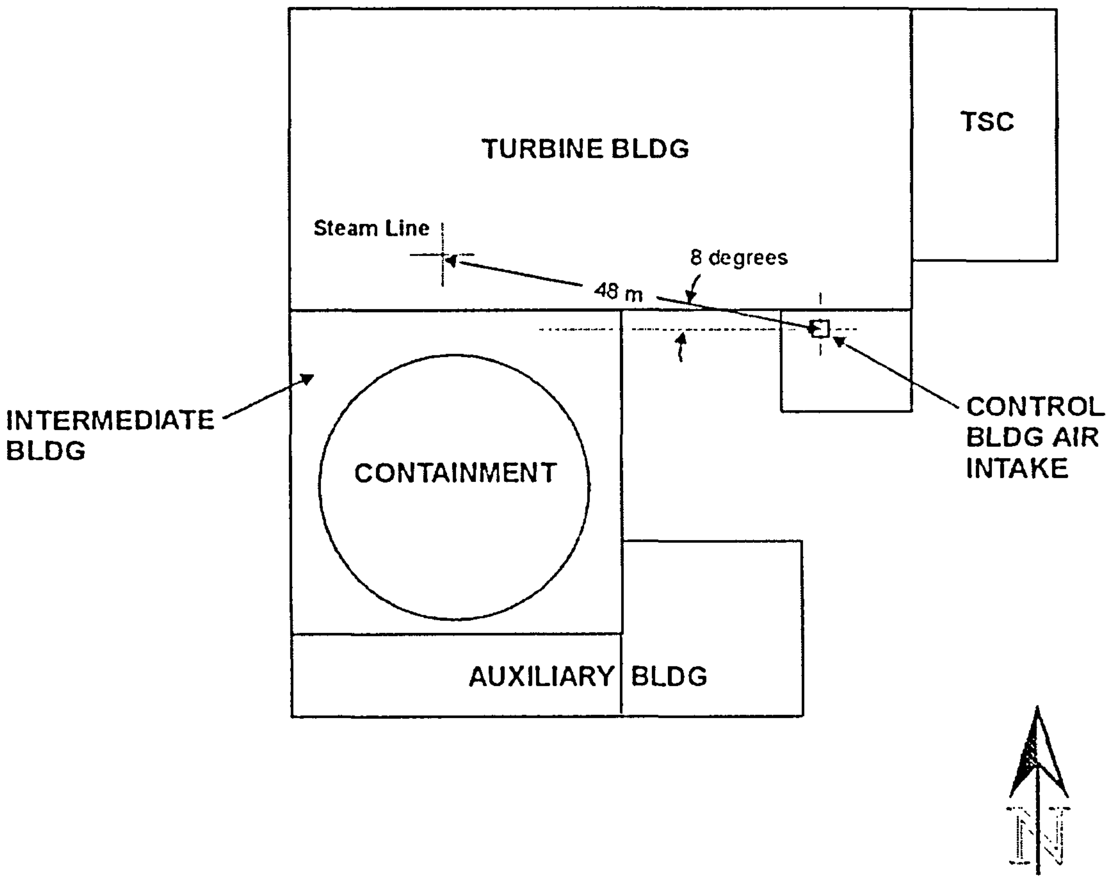


2.6 Main Steam Header Turbine Building

This source is used to model activity released from a main steamline break. The rupture site is assumed to be inside the Turbine Building on the mezzanine level. (See Section 7.1 for additional details.) Since the released steam is assumed to blow-out windows and metal siding of the Turbine Building, no confinement of the plume is assumed. The source is modeled as a ground level point source. The distance to the receptor is that from the header midpoint to the Control Room Intake. The release height is the distance from grade to the top of the header. The wake area equivalent to the Containment cross-section area is again assumed. The ARCON96 input parameters and resulting X/Q are presented on Table 2.6 and Figure 2.6.

TABLE 2.6 MAIN STEAM HEADER TURBINE BUILDING INPUTS AND RESULTS	
Distance to receptor, m	48
Intake height, m	13.8
Direction to source, degrees	278
Release type	ground level, point source
Release height, m	4
Building area, m^2	1071
Sector width constant	4.3
Surface roughness	0.2
Initial diffusion coefficients, m	
σ_{y0}	0
σ_{z0}	0
Resulting X/Q, sec/m^3	
0-2 hr	2.57E-03
2-8 hr	1.92E-03
8-24 hr	8.08E-04
1-4 days	5.77E-04
4-30 days	5.50E-04

FIGURE 2.6 - STEAM LINE PLAN VIEW



2.7 Tornado Missile

The tornado missile accident assumes that a utility pole, propelled by the wind, penetrates the Auxiliary Building roof and impacts fuel stored in the spent fuel pool. The specific location of the impact cannot be predicted. Thus, the shortest source-receptor distance is conservatively assumed. The source is modeled as a ground level point source. The release height is the distance from grade to the spent fuel pool surface. The wake area is again assumed equivalent to the cross-section area of Containment.

The calculation of atmospheric dispersion for tornado conditions is a unique task that cannot be performed with ARCON96. The primary reason that ARCON96 can't be used is the lack of meteorological data for a tornado. Further, if data were available, the duration of a tornado is too short for ARCON96 to provide a meaningful average. An ARCON96 calculation typically averages 1 to 5 years of hourly meteorological data. A tornado would provide two data points at most.

While the use of the ARCON96 code is not practicable for tornado conditions, the use of the dispersion models executed by ARCON96 may be used to conservatively estimate dispersion. The CONHAB module of the HABIT code calculates a single, direction and time-independent dispersion value using the basis dispersion models developed for ARCON96.

CONHAB is used to calculate dispersion factors for tornado wind speeds and to also show the sensitivity of the model to stability class. The input and results for these cases is summarized in Table 2.7. The basis for the selection of wind speed and stability class is as follows:

- wind speed

  The range is 24.5 to 60 meters/sec. 24.5 meters/sec is the maximum recorded hourly wind speed during normal atmospheric conditions. 132 miles/hour (about 60 meters/sec) is the wind speed for the design basis tornado.

- Pasquill stability class

  Stability class is a user input to the CONHAB dispersion model. There are 7 stability classes, A through G. "A" represents extremely unstable conditions, and "G" represents stable conditions. Unstable conditions enhance dispersion. Stable conditions diminish dispersion. However, the dispersion model predicts a diminishing effect with increasing wind speed. Test cases are run to show this effect and also to show that there are no discontinuities or instabilities in the model due to increasing wind speed. The cases show converging X/Qs with increasing wind speed (Figure 2.7). For the cases listed on Table 2.7, Pasquill F provides some conservatism over Pasquill A, even at wind speeds up to 60 meters/sec. Therefore, the tornado X/Q will be based on Pasquill F and a wind speed of 24.5 meters/sec., since this combination results in a larger X/Q.

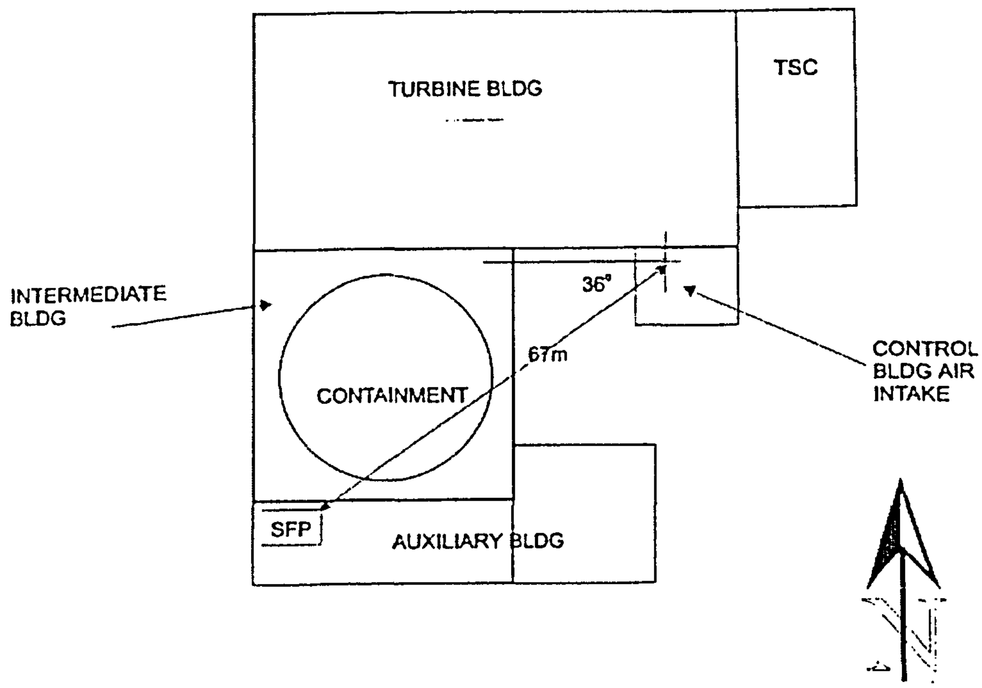
TABLE 2.7
CONHAB TORNADO MISSILE INPUT AND RESULTS

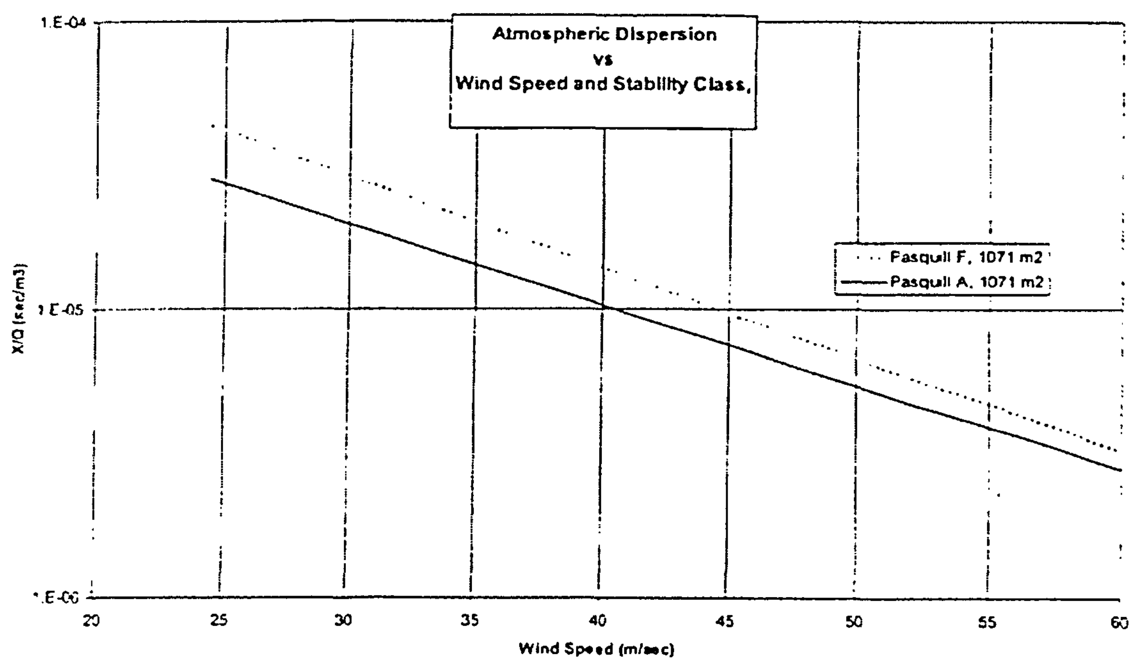
Parameter	CB1A	CB1F	CB2A	CB2F	CB3F
Distance to receptor, m	67				503
Intake height, m	13.8				
Release type	ground level, point source				
Release height, m	2.1				
Building area, m^2	1071				
Wind Speed, meters/sec	24.5	24.5	60	60	24.5
Stability Class	A	F	A	F	F
Resulting X/Q, sec/m^3	2.85E-5	4.36E-5	2.77E-6	3.03E-6	1.74E-6

Cases CB1A through CB2F are for the Control Room air intake.

Case CB3F is for the 503 meter EAB.

FIGURE 2.7 - SPENT FUEL POOL PLAN VIEW





2.8 EAB and LPZ Atmospheric Dispersion Factors

All the EAB and LPZ dose calculations used the current X/Qs presented in the Ginna UFSAR (Reference 3, Section 2.3.4.2.1) except for the tornado missile and locked rotor.

Due to the uniqueness of the tornado missile dose calculation and to maintain consistency between the control room calculation and the EAB calculation, the EAB calculation was done using the same methodology as used for the control room calculation. See Section 2.7 for a description of the methodology.

The ultra conservative assumptions used in the locked rotor dose calculation result in assuming 100% fuel failure. This assumption and the current UFSAR EAB X/Q results in an unrealistically high EAB dose. To obtain a more realistic dose, the EAB and LPZ X/Qs were recalculated using the PAVAN computer code. The recalculated values have only been used to calculate the locked rotor doses. The intent is to use these new values in any future calculations.

2.8.1 Current UFSAR Atmospheric Dilution Factors (Reference 3, Section 2.3.4.2.1)

Site boundary (0-2 hr)	4.8E-04
Low population zone	
0-8 hr	3.0E-05
8-24 hr	2.1E-05
1-4 days	8.6E-06
4-30 days	2.5E-06

2.8.2 Recalculated Atmospheric Dispersion Factors (PAVAN code)

The same meteorological data used to calculate the Control Room X/Q was used to recalculate the Exclusion Area Boundary (EAB) and Low Population Zone (LPZ) dispersion factors. The dispersion factors were calculated using KR PAVAN which is a PC-based version of the NRC's PAVAN code (Reference 9). Dispersion factors were calculated using the direction-dependent method and the direction-independent method. The direction-dependent method determined the 0.5 percent X/Q value for each of the 16 wind speed directions. The direction-independent method determined the 5 percent X/Q value for the overall site. The direction-dependent dispersion values were limiting, for both EAB and LPZ boundaries. The input assumptions are listed on Table 2.8.

The EAB dispersion factor calculated by the ENVLOP routine of PAVAN is a conservative bounding 0.5 percent X/Q value. Since the EAB dose can be limiting for certain accidents, such as locked rotor, a more accurate X/Q value is desired. Therefore, the output X/Q vs. percentile for the limiting sector is analyzed in a spreadsheet to obtain a more accurate value.

The results of the spreadsheet analysis are shown in Figures 2.8.1 and 2.8.2. A logarithmic trend line is fit to the data and the resulting 0.5% X/Q value (0-2 hours) is determined. The 0.5 percent code and spreadsheet values for the limiting sector (SW) are:

code value	3.32E-4
equation value using all data points	3.368E-4
equation value using only low percentage data	2.978E-4

Visual inspection of the data and trend line show good agreement. This is also confirmed by the R^2 values (0.9414 and 0.9388) which are close to 1.0. The EAB dispersion factor will be 2.98E-4.

The LPZ dispersion factor output was also evaluated using a spreadsheet. The equation value, using all data, was higher than the value generated by KR PAVAN and the equation value using only the low probability data was lower than the value generated by KR PAVAN. Since a high degree of accuracy is not needed for the LPZ values and the KR PAVAN value is reasonable, the code values will be used for the LPZ.

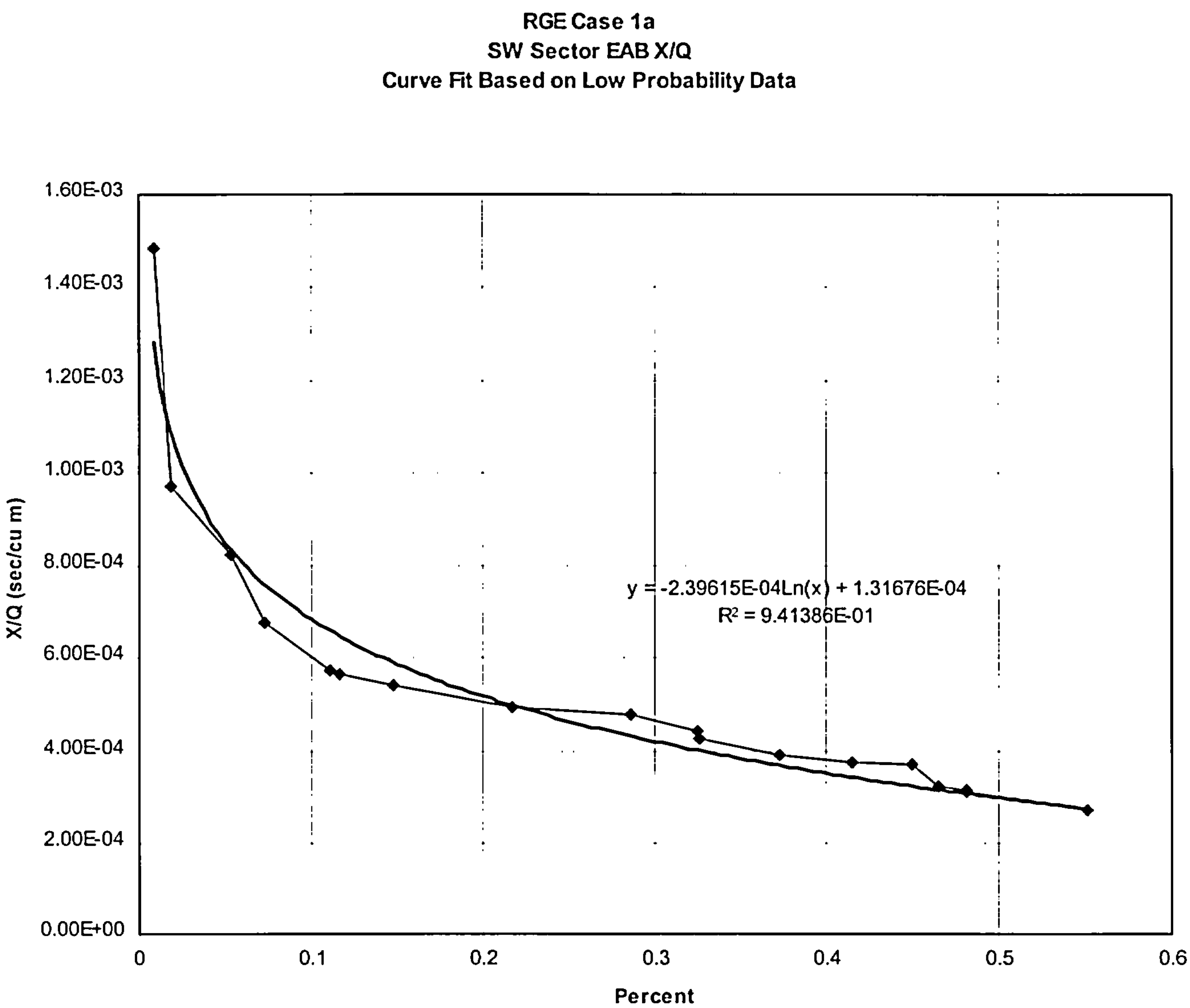
The X/Q values (sec/m^3) are:

Boundary	0-2 hr	0-8 hr	8-24 hr	24-96 hr	96-720 hr
EAB	2.98E-4	-	-	-	-
LPZ	-	2.29E-5	1.62E-5	7.59E-6	2.57E-6

TABLE 2.8	
KR PAVAN	INPUTS
Meteorological Data EAB distances, 16 wind speed directions (m)	Years 1992, 1993, 1994
S	450
SSW	450
SW	503
WSW	915
W	945
WNW	701
NW	1000
NNW	1000
N	1000
NNE	1000
NE	1000
ENE	1000
E	747
ESE	640
SE	503
SSE	450
LPZ distances (m)	4827
Wind speed considered to be calm (m/sec)	≤0.5
Activity releases	ground level
Height of wind speed measurement (m)	10
Calm hours	input separately from joint frequency distribution

Building - wake (m^2)	1071
Wind speed categories	14
Terrain adjustment factors	default

Figure 2.8.1 - Spreadsheet Analysis of Low Probability EAB X/Q Data



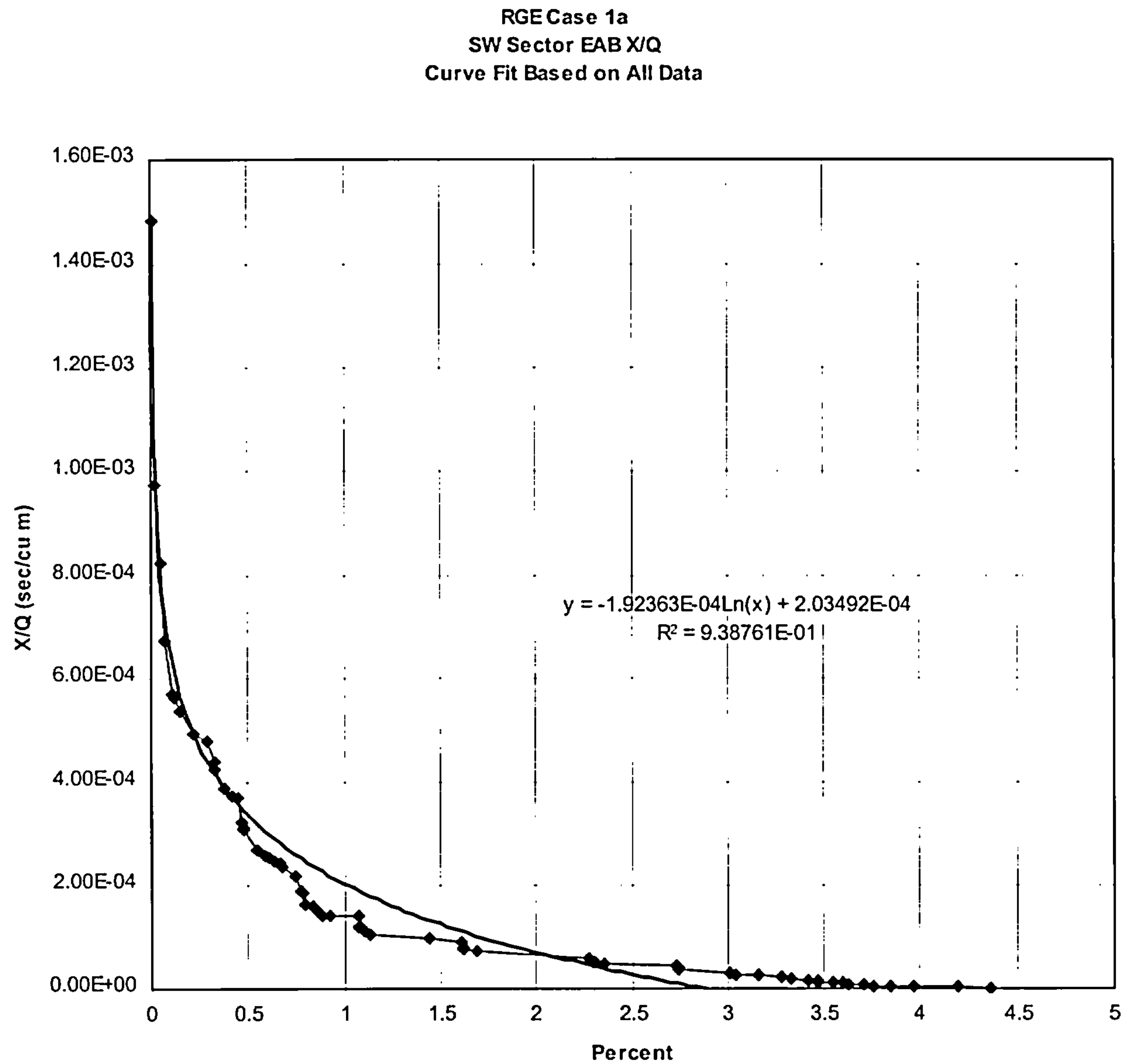
The 0.5 percent EAB value:

$$y := \left(-2.39615\cdot10^{-4}\right)\cdot\ln(x) + 1.31676\cdot10^{-4}$$

$$y = 2.97764 \times 10^{-4}$$

The resulting X/Q is rounded to 2.98E-4 sec/m^3.

Figure 2.8.2 - Spreadsheet Analysis of All EAB X/Q Data



The 0.5 percent EAB value:

$y := -1.92363 \cdot 10^{-4} \cdot \ln(x) + 2.03492 \cdot 10^{-4}$

$y = 3.36828 \times 10^{-4}$

The resulting X/Q is rounded to 3.37E-4 sec/m^3

3.0 Iodine Spiking

For events where no fuel failure is postulated, iodine spiking is assumed. Two cases of iodine spiking are considered.

1. Accident Initiated Spike
2. Pre-Accident Spike

3.1 Accident Initiated Spike

The primary system transient causes an iodine spike in the primary system. The appearance rate is based on an equilibrium concentration of 1.0 μCi/gm Dose Equivalent I-131. The rate of increase and duration of the spike is event dependent. The following inputs are used in the calculation of the appearance rate.

TABLE 3.1 ACCIDENT INITIATED SPIKE INPUTS AND RESULTS	
Reactor coolant system volume, ft^3 rcs pzr (nominal minus 5% uncertainty)	 5506 436
Letdown purification flow rate, gpm	60 + 10%
Reactor coolant iodine concentrations @1 μCi/gram of DE I-131, μCi/gram	I131 0.786 I132 4.54 E-3 I133 0.192 I134 1.55 E-4 I135 0.018
Mixed-bed demineralizer DF	100
Identified primary coolant leak rate, gpm	10
Unidentified primary coolant leak rate, gpm	1
Primary-to-secondary leak rate, gpd per SG	150
Letdown conditions Pressure, psia Temperature, °F	 15 127
Reactor coolant conditions Pressure, psia Temperature, °F	 2250 559
Appearance rates, Ci/hr I-131 I-132 I-133 I-134 I-135	 1.39E+1 2.49E-1 4.10E+0 1.79E-2 5.39E-1

3.2 Pre-Accident Spike - This assumes a transient has occurred prior to the event and has raised the primary coolant iodine concentration to the maximum full power value. This analysis assumes a value of 60 μCi/gm DE I-131. The resulting concentrations and inventories are:

I-131	4.71 E+1 μCi/gm	5.88 E+3Ci
I-132	2.72 E-1	3.39 E+1
I-133	1.15 E+1	1.43 E+3
I-134	9.32 E-3	1.16 E+0
I-135	1.07 E+0	1.33 E+2

4.0 General Discussion

4.1 The control room dose calculations use the same X/Q for both pre-isolated outside air and unfiltered inleakage. Pre-isolated outside air is all from the control room intake. Ginna does not have dual air intakes. Unfiltered inleakage may come from doors, penetrations into the control room envelope, air recirculation/filtration equipment, etc. The source to leakage location for all possible leak points is through other structures first (resulting in torturous paths) or longer source-to-receptor distances. Thus, the leakage point specific X/Q would be greater than that for the control room intake. The control room intake X/Q is assumed to be bounding for all control room dose calculations.

4.2 The nuclide data base used for all calculations is from ORIGEN2 (Reference 12). The nuclides are for a plant-specific representative 18 Month Fuel Cycle at end of life. The dose significant nuclide concentrations have been slightly increased to produce bounding doses.

4.3 All dose calculations assume the FGR11 and FGR12 dose conversion factors (References 10 and 11).

4.4 No credit is taken for elemental or methyl iodine removal inside containment by charcoal filters. This is indicated by assuming 0% efficiency as an input parameter. Credit is taken for particulate removal. Particulate removal is done by the inside containment HFPA filters.

4.5 Filter Loading - The RADTRAD code was used to calculate the inside containment HEPA filter particulate loading. The calculation was done for the conditions associated with a LBLOCA. The calculation assumed the filters operate for the duration of the calculation (720 hr.) which essentially removed all particulates from containment. The filter loading was approximately 1 oz/ft^2 which is judged to be well within the holding capability of the filters.

5.0 Loss-of-Coolant-Accident

5.1 Analysis

The analysis uses the alternate source term (AST) as defined in Reg. Guide 1.183 (Reference 5). The AST assumptions are listed on Table 5.1 and are consistent with Reg. Guide 1.183. The analysis is performed with the HABIT code version 1.1 (Reference 6) and the nuclide data base discussed in Section 4.2. The LBLOCA analysis consists of two parts: 1) Containment Leakage and 2) ECCS continuous leakage outside Containment. The resulting doses are summarized on Table 5.4

The airborne fraction (flashing fraction) used in the analysis is piece-wise time dependent and bounds the values based on sump (ECCS leakage) temperature from a Ginna-specific calculation. The values used in the analysis are illustrated on Figure 5.1.

The flashing fraction is estimated as follows:

$$FF = \frac{H_{exit} - H_l}{H_v - H_l}$$

Where:

FF = flashing fraction
H_{exit} = enthalpy of the relieved fluid (sump conditions)
H_l = enthalpy of liquid at 15 psia, saturated
H_v = enthalpy of vapor at 15 psia, 212°F.

Sump water temperature varies from 260°F at 1 hr. into the LOCA to 170°F at 50 hr. Sump pH is maintained greater than 7.0 on recirculation.

To determine the airborne fraction, a number of points were selected along the flashing curve, and then the curve was converted into a conservative step function. The value of each step is approximately 0.01 above the calculated flashed fraction. Even though the curve predicts that the flashed fraction goes to 0 at about 15 hours, the minimum airborne fraction is maintained at 0.01 out to 720 hours (only 25 hours shown in Fig 5.1). This is done to account for some droplet atomization. However, due to NRC comments during the review of the analysis, the flashing fraction was increased to 0.02 for T >18 hours.

Although these values are not as conservative as the fixed value of 10% suggested in the SRP, they are consistent with the intent of the SRP which is to use a conservative approximation.

5.2 Assumptions

A Large Break Loss of Coolant Accident (LBLOCA) occurs inside Containment.

One train of emergency power is assumed to fail. This results in only one train of Containment Recirculation Fan Coolers (CRFCs) operating and one train of Containment Spray.

At 52 minutes Containment Spray is stopped and sump recirculation is started and continues for the duration of the calculation.

At 4 hours the CRFCs are arbitrarily stopped, terminating particulate removal by filtration.

The Control Room parameters are listed on Table 5.3.

The Control Room is assumed isolated at 60 seconds and CREATS is up and operating at 70 seconds. Isolation from the radiation monitors and/or safety injection would occur well before the 60 seconds assumed in the analysis.

A passive ECCS failure of 50 gpm as identified in the Ginna UFSAR is not assumed in this analysis. However, the ECCS leakage has been increased to 4 gph.

The analysis uses the source term parameters in Table 5.1 and the Containment leakage parameters on Table 5.2.

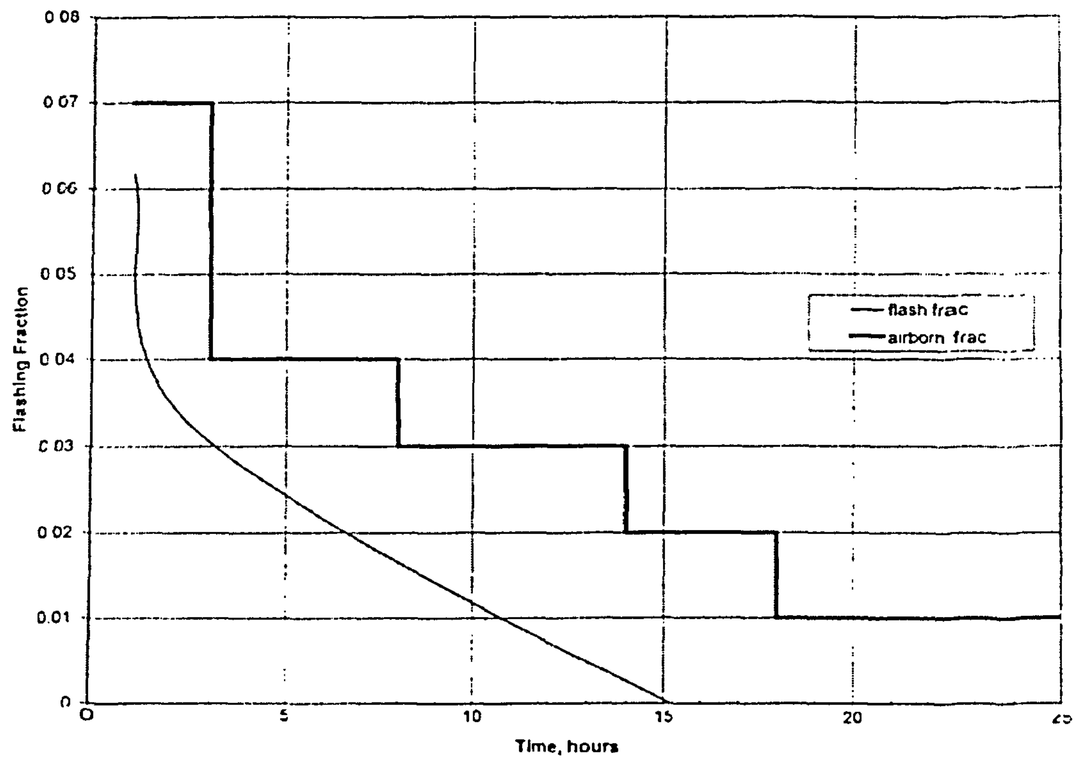
Control room parameters are shown in Table 5.3 and 5.4.

ECCS Leakage - The analysis assumes a continuous leakage of 4 gph.

5.3 Results

The results are provided in Table 5.5.

FIGURE 5.1 - AIRBORNE FRACTION



Note: Due to NRC comments during the review process, the assumed flashing fraction was increased to 0.02 for T > 18 hours.

TABLE 5.1 ALTERNATE SOURCE TERM (REFERENCE 5) Core Inventory Fraction Released Into Containment			
Nuclide Group	**Gap Release Phase**	**Early In-Vessel Phase**	**Total[4]**
Halogens	0.05	0.35	0.4
Noble Gases	0.05	0.95	1.0
Alkali Metals	0.05	0.25	0.3
Tellurium	0	0.05	0.05
Ba, Sr	0	0.02	0.02
Noble Metals	0	0.0025	0.0025
Cerium	0	0.0005	0.0005
Lanthanides	0	0.0002	0.0002

TABLE 5.1 ALTERNATE SOURCE TERM (REFERENCE 5) Timing of LOCA Core Inventory Release Phases		
Release Phase	**Onset**	**Duration**
Gap Release	30 sec	0.5 hr[5]
Early In-Vessel	0.5 hr	1.3 hr

TABLE 5.1 ALTERNATE SOURCE TERM (REFERENCE 5) Nuclide Groups	
Halogens	I
Noble Gases	Kr, Xe

[4]Fractions apply to both containment and ECCS leakage

[5]The duration of the gap release, specified in Reference 5, is 0.5 hr. The specified start of the gap release is 30 seconds and the end of the release is 0.5 hr. Thus, the duration of the gap release is modeled as 0.5 hr - 30 sec = 0.492 hr, rather than 0.5 hr.

TABLE 5.1 ALTERNATE SOURCE TERM (REFERENCE 5) Nuclide Groups	
Alkali Metals	Cs, Rb
Tellurium Group	Te, Sb, Se, Ba, Sr
Noble Metals	Ru, Rh, Pd, Mo, Tc. Co
Lanthanides	La, Zr, Nd, Eu, Nb, Pm, Pr, Sm, Y, Cm, Am
Cerium	Ce, Pu, Np

TABLE 5.1 ALTERNATE SOURCE TERM (REFERENCE 5) Nuclide Composition, fraction		
Form	In Containment Atmosphere	In ECC Solution
Iodine elemental methyl particulate	 0.0485 0.0015 0.95	 0.97 0.03 0
All other nuclides particulate	 1.0	 1.0

TABLE 5.2 CONTAINMENT/ECCS LEAKAGE PARAMETERS	
Parameter	**Value**
Reactor power, Mwt(including 2% uncertainty)	1550
Containment net free volume, ft3	1.0E6
Containment sprayed fraction	0.78
Containment leak rate, %/day 0-24 hours > 24 hours	 0.2 0.1
Containment fan cooler flow and operation number of operating units (per train) flow rate per unit, cfm total filtered flow rate, cfm HEPA (2 units) initiation delay, sec. termination of iodine removal, hours	 2 30,000 60,000 50 4
Containment fan cooler iodine removal efficiency, % Elemental Methyl Particulate	 90[2] 50[2] 95
Containment injection spray flow rate, gpm (per train) initiation delay, sec termination (end of spray injection), min	 1300 80 52
Iodine and particulate removal by spray, hr-1 elemental particulate	 20 3.5[1]
Containment sump volume, ft^3	264,700

[2]Case without iodine removal by carbon assumes 0% efficiency.

[1]Represents the 10th percentile value from the Powers model (Reference 7).

TABLE 5.2 CONTAINMENT/ECCS LEAKAGE PARAMETERS	
Parameter	**Value**
ECCS leakage	
Continuous leakage rate, gal/hr	4
Start time, hr	1
Termination time, hr	720
Airborne fraction	
0-3 hr	0.07
3-8 hr	0.04
8-14 hr	0.03
14-18 hr	0.02
>18 hr	0.02
Atmospheric dispersion X/Q, sec/m^3	
EAB 0-2 hr	2.98E-4
LPZ 0-8 hr	2.29E-5
8-24 hr	1.62E-5
24-96 hr	7.59E-6
96-720 hr	2.57E-6
Breathing rates, m^3/sec	
EAB & LPZ 0-8 hr	3.47E-4
8-24 hr	1.75E-4
24-720 hr	2.32E-4

TABLE 5.3 CONTROL ROOM PARAMETERS		
Parameter	**Value**	
Habitable volume, ft^3	36,211	
Normal Operating Mode make-up air flow rate, cfm	2000+10%	
Accident Operating Mode Recirculating air iodine removal efficiency, % elemental methyl particulate flow rate, cfm Unfiltered in-leakage, cfm	 90 70 98 6000-10% 300	
Breathing rate, m^3/sec	3.47E-4	
Occupancy factors 0-24 hr 24-96 hr 96-720 hr	 1 0.6 0.4	
Atmospheric dispersion X/Q sec/m^3	Containment Leakage	ECCS Leakage
0-2 hr 2-8 hr 8-24 hr 24-96 hr 96-720 hr	1.57E-3 1.12E-3 4.47E-4 3.69E-4 3.10E-4	3.89E-3 2.99E-3 9.63E-4 8.98E-4 8.23E-4

Table 5.4 Flow Rate and Iodine Removal Schedule				
	Inleakage		Recirculation	
Time, hours	cfm	iodine removal efficiency, %[1]	cfm	iodine removal efficiency, %[1]
0-0.0167[2]	2200	0/0/0	0	0/0/0
[3]0.0167-0.0194	300	0/0/0	0	0/0/0
>0.0194	300	0/0/0	5400	90/70/98

TABLE 5.5 LBLOCA DOSE SUMMARY, REM TEDE			
	EAB Max. 2-hour	LPZ 720 hour	Control Room 720 hour
Containment Leakage	3.403	0.741	2.063
ECCS Leakage	0.295	0.178	1.447
Total	3.70	0.919	3.51
Acceptance Criteria	25	25	5

[1]Elemental/Methyl/Particulate

[2]0 to 60 seconds

[3]60 to 70 seconds

6.0 Fuel Handling Accident

6.1 Analysis

This calculation determines the offsite and Control Room doses (TEDE) for a fuel handling accident (FHA). The analysis uses the alternate source term and accompanying TEDE methodology and conservative control room X/Q values that are calculated with the ARCON96 code. Two cases will be evaluated:

- FHA inside Containment
- FHA in the Spent Fuel Pool

The AST defined in Reference 5 is used. The HABIT code (Reference 6) and HABIT nuclide data base as discussed in Section 4.2 are used. Since the release from the FHA is assumed to end after 2 hours, the dose calculations are terminated after all contributions are accounted for; 2 hours for LPZ and 24 hours for the Control Room. The resulting doses are presented on Table 6.4.

6.2 Assumptions

Both cases assume the fuel rods in one fuel assembly fail.

Activity from the damaged fuel rods is assumed to be instantaneously released to the pool water.

There is a minimum of 23 feet of water above the fuel.

The activity release rate is independent of the actual ventilation flow rate. The activity release rate is adjusted to ensure all radioactive material that escapes from the reactor cavity or spent fuel pool is released to the environment over a two hour period.

The activity from a FHA in Containment is assumed to be released from Containment to the environment via the perimeter seals of the Equipment Hatch roll-up door. No filtration or absorption of iodine is assumed.

The activity from a FHA in the spent fuel pool is assumed to be released from the pool area to the environment via the plant vent. The dose conversion factors from FGR11 and 12 are used (References 10 and 11).

Note that the charcoal filter system for the spent fuel pool area is not ESF or safety-related and the charcoal filter system would be unavailable if a coincident loss of offsite power were to occur. The Technical Specifications require use of the system during irradiated fuel movement within the Auxiliary Building to minimize doses. Therefore, the system is credited in the dose analysis.

The FHA dose analysis assumptions are listed on Table 6.1. The Control Room assumptions are listed on Table 6.2.

The Control Room is assumed to be isolated within 60 seconds via the radiation monitors. A comparison of the nuclide concentration in the Control Room intake for the FHA to the radiation monitor response showed a Control Room isolation signal would occur before the 60 seconds assumed in the calculation.

Fission product inventories and activities released from the SFP are shown in Table 6.3.

TABLE 6.1 FHA DOSE ANALYSIS ASSUMPTIONS	
Parameter	**Value**
Reactor power, Mwt(including 2% uncertainty)	1550
Power Peaking Factor	1.75
Number of damaged fuel assemblies	1
Fission product inventory in damaged assemblies after decay	Values shown in Table 6.3
Time after reactor shutdown, hr	100
Fuel rod gap fractions I-131 other halogens Kr-85 other noble gases alkali metals	 0.08 0.05 0.1 0.05 0.12
Iodine species above water elemental iodine organic iodide	 0.57 0.43
Pool DF elemental iodine organic iodide particulate Overall Pool DF	 500 1 ∞ 200
Containment net free volume, ft^3	1E6
Exhaust flow rate, cfm	7.68E4
Duration of activity release, hr	2
Iodine removal efficiency Containment (all iodine forms) Fuel Pool elemental iodine organic iodide	 0 0.9 0.7

TABLE 6.1 FHA DOSE ANALYSIS ASSUMPTIONS	
Parameter	**Value**
Atmospheric dispersion, X/Q, sec/m^3 EAB 0-2 hr LPZ 0-8 hr	 4.8 E-4 3.0 E-5
Breathing rate, m^3/sec EAB & LPZ 0-8 hr	 3.47 E-4

TABLE 6.2 CONTROL ROOM PARAMETERS		
Habitable volume, ft^3		36,211
Normal Operating Mode make-up air flow rate, cfm		 2000+10%
Accident Operating Mode Recirculating air iodine removal efficiency, % elemental methyl particulate Flow rate, cfm Unfiltered in-leakage, cfm		 90 70 98 6000-10% 300
Breathing rate, m^3/sec		3.47 E-4
Occupancy factor 0-24 hr 24-96 hr 96-720 hr		 1 0.6 0.4
Atmospheric dispersion, X/Q, sec/m^3 0-2 hr 2-8 hr 8-24 hr	FHA Containment 5.64 E-3 4.69 E-3 1.66 E-3	FHA Spent Fuel Pool 1.79 E-3 1.15 E-3 4.95 E-4

Flow Rate and Iodine Removal Schedule				
Time, hours	Inleakage		Recirculation	
	cfm	iodine removal efficiency, %	cfm	iodine removal efficiency, %[1]
0 - 0.0167[2]	2200	0/0/0	0	0/0/0
[3]0.0167 - 0.0194	300	0/0/0	0	0/0/0
>0.0194	300	0/0/0	5400	90/70/98

[1]Elemental/Methyl/Particulate

[2]0 to 60 seconds

[3]60 to 70 seconds

TABLE 6.3 FISSION PRODUCT INVENTORY AND ACTIVITY RELEASED FROM POOL						
Nuclide	Total Core Activity - 100 hours decay, Ci(A)	Core Damage Fraction (F)	Gap Fraction (G)	Peaking Factor (P)	Overall Pool DF	Activity Released from Pool, Ci (A)
I-131	2.98E+07	0.008264	0.08	1.75	200	1.76E+02
I-132	2.52E+07	0.008264	0.05	1.75	200	9.29E+01
I-133	3.12E+06	0.008264	0.05	1.75	200	1.15E+01
I-134	0.00E+00	0.008264	0.05	1.75	200	0.00E+00
I-135	2.23E+03	0.008264	0.05	1.75	200	8.22E-03
Kr-85m	2.15E+00	0.008264	0.05	1.75	1	1.55E-03
Kr-85	4.98E+05	0.008264	0.1	1.75	1	7.20E+02
Kr-87	4.58E-17	0.008264	0.05	1.75	1	3.31E-20
Kr-88	7.48E-04	0.008264	0.05	1.75	1	5.41E-07
Xe-131m	4.42E+05	0.008264	0.05	1.75	1	3.20E+02
Xe-133m	1.10E+060	0.008264	0.05	1.75	1	7.95E+02
Xe-133	5.71E+07	0.008264	0.05	1.75	1	4.13E+04
Xe-135m	3.57E+02	0.008264	0.05	1.75	1	2.58E-01
Xe-135	1.09E+05	0.008264	0.05	1.75	1	7.88E+01

Core damage fraction is 1/121 = 0.008264. The total number of fuel assemblies in the core is 121.

The activity released from the pool (A) is calculated as follows: Note 2% added to iodine in Section 4.2.

$$A = \frac{A_c * F * G * P}{DF}$$

TABLE 6.4 FHA, DOSE, REM, TEDE			
	EAB Max - 2 hr	LPZ, 2 hr	Control Room, 24 hr
FHA - inside Containment via roll-up door	1.12	0.07	1.18
FHA - Spent Fuel Pool	0.31	0.019	0.089
Acceptance Criteria	6.3	6.3	5

7.0 Main Steam Line Break

7.1 Analysis

This calculation determines the offsite and Control Room doses (TEDE) for the Main Steam Line Break (MSLB) outside the Containment. The analysis uses the alternate source term and the accompanying TEDE methodology and conservative control room X/Q values that are calculated with the ARCON96 code. The MSLB analysis includes the following cases:

- MSLB with accident initiated iodine spike
- MSLB with pre-accident iodine spike

The AST defined in Reference 5 is used. The HABIT code (Reference 6) and HABIT nuclide data base as discussed in Section 4.2 are used. No fuel failures are postulated for the MSLB.

7.2 Assumptions

The purpose of this analysis is to calculate the steam releases from the faulted and intact Steam Generator (SG) during a steam line break to the atmosphere. Therefore, breaks inside Containment are non-applicable.

Because of an augmented inspection program, breaks between the Containment penetrations and inside the Intermediate Building are limited to connection pipes only with the largest pipe being 6" (UFSAR Section 3.6.2.4.5.2). Larger pipe breaks can only be postulated downstream of the Intermediate Building, i.e., inside the Turbine Building. Therefore, the break is assumed to occur in the 36" header inside the Turbine Building. This is the largest pipe break that can occur outside Containment. The break area is limited to 1.4 ft^2 because of a flow restrictor in the SG outlet nozzle.

The scenario consists of a header break. The single failure is assumed to be a failure of the main steam isolation valve on the faulted SG. Initially the break is fed by both SGs. Following steam line isolation, the break is fed only by the faulted SG. At approximately 10 minutes the faulted SG is isolated by operator action. The intact SG is then used for cooldown, where steam is released to the atmosphere through the intact SG Atmospheric Relief Valve (assumed to be 8 hr.) until the releases are stopped.

A primary to secondary leakage of one gpm to each SG is assumed for the duration of the event (8 hr). The faulted SG is assumed to be dry at 10 minutes. and remain dry for the event. The intact SG is isolated from the break within the first minute and auxiliary feedwater maintains SG level for the duration of the event.

All of the initial iodine inventory in the faulted SG is assumed released to the environment by 10 minutes. The iodine from the primary-to-secondary leakage into the faulted SG is released directly to the environment with no credit for retention. The initial iodine inventory in the intact SG is mixed with the primary-to-secondary leakage into the SG and released to the environment assuming an iodine partition of 100. The steam release from the intact SG is based on a LOFTRAN simulation of the MSLB followed by an energy balance to simulate the cooldown to RHR conditions. All noble gas activity carried over to the SGs is assumed to be immediately released to the environment.

Initially the Control Room HVAC is operating normally with a nominal 2000 cfm of makeup air. Isolation is assumed to occur at 60 sec and CREATS is operating at 70 sec assuming a nominal 6000 cfm recirculation flow. Since isolation is caused by a safety injection signal, the Control Room would be isolated well before the 60 sec. assumed in the analysis. Following isolation, 300 cfm of unfiltered inleakage is assumed for the duration of the calculation.

The releases from the steam break are assumed to stop at 8 hr. The Control Room calculation is continued until 24 hr to ensure all dose contributions are accounted for.

Accident - Initiated Iodine Spike: A spike factor of 500 with a duration of 8 hours is assumed. The initial appearance rates are listed on Table 3.1.

Pre-Accident Iodine Spike: The iodine concentrations are based on 60 μCi/gm DE I-131 and listed in Section 3.2.

Additional assumptions are listed in Table 7.1.

The Control Room parameters are listed on Table 7.2 and 7.3.

7.3 Results

The results for the MSLB are shown in Table 7.4.

TABLE 7.1 MSLB DOSE ANALYSIS ASSUMPTIONS	
Parameter	**Value**
Reactor power, Mwt(including 2% uncertainty)	1550
Initial reactor coolant activity, pre-accident iodine spike iodine μCi/gm of D.E. I-131 noble gas fuel defect level, %	 60 1.0
Initial reactor coolant activity, accident initiated iodine spike iodine μCi/gm of D.E. I-131 noble gas fuel defect level, %	 1.0 1.0
Concurrent iodine spike factor	500
Duration of concurrent iodine spike, hours	8
Initial secondary coolant iodine activity iodine μCi/gm of D.E. I-131 Concentration Ci	 0.1 I-131 4.57 E+0 I-132 2.64 E-2 I-133 1.12 E+0 I-134 9.04 E-4 I-135 1.03 E-1
Primary-to-secondary leakage (post accident) to SGs leak rate (cold conditions) per SG, gpm duration of leakage, hours	 1 8
Mass of primary coolant, gm	1.247 E+8
Initial mass of secondary coolant, gm faulted SG intact SG	 5.817 E+7 5.817 E+7

TABLE 7.1 MSLB DOSE ANALYSIS ASSUMPTIONS	
Parameter	**Value**
Steam Releases	
faulted SG	
0 - 610 sec	128,237 lb
610 sec - 8 hr	0 lb
intact SG	
0 - 610 sec	37,780 lb
610 sec - 8 hr	755,097 lb
Primary to Secondary Leakage	1 gpm per SG
Steam generator iodine partition coefficients (mass-based)	
Activity release from faulted SG	
elemental	1
methyl	1
Activity release from intact SG	
elemental	100
methyl	1
Noble gas, all SG	1
Iodine fractions assumed in the reactor coolant and SG water	
elemental iodine	0.97
organic iodide	0.03
Atmospheric dispersion X/Q sec/m^3	
EAB 0-2 hr	4.8E-4
LPZ 0-8 hr	3.0E-5
Breathing rate m^3/sec	
EAB & LPZ	
0-8 hr	3.47 E-4
8-24 hr	1.75 E-4
24-720 hr	2.32 E-4

TABLE 7.2 CONTROL ROOM PARAMETERS	
Parameter	**Value**
Habitable volume, ft^3	36,211
Normal Operating Mode make-up air flow rate, cfm	 2000+10%
Accident Operating Mode Recirculating air iodine removal efficiency, % elemental methyl particulate flow rate, cfm Unfiltered in-leakage, cfm	 90 70 98 6000-10% 300
Breathing rate, m^3/sec	3.47 E-4
Occupancy factor 0-24 hr 24-96 hr 96-720 hr	 1 0.6 0.4
Atmospheric dispersion, X/Q, sec/m^3 0-2 hr 2-8 hr 8-24 hr	 2.57 E-3 1.92 E-3 8.08 E-4

Table 7.3 **Flow Rate and Iodine Removal Schedule**				
	Inleakage		Recirculation	
Time, hours	cfm	iodine removal efficiency, %	cfm	iodine removal efficiency, %[1]
0 - 0.0167[2]	2200	0/0/0	0	0/0/0
[3]0.0167 - 0.0194	300	0/0/0	0	0/0/0
>0.0194	300	0/0/0	5400	90/70/98

TABLE 7.4 **RESULTS FOR MAIN STEAM LINE BREAK**			
	EAB Max - 2 hr TEDE	LPZ, 8 hr TEDE	Control Room 24 hr TEDE
Accident Initiated Iodine Spike	1.05	0.15	0.64
Acceptance Criteria	2.5	2.5	5
Pre-Accident Iodine Spike	0.15	0.03	0.18
Acceptance Criteria	25	25	5

[1]Elemental/Methyl/particulate

[2]0 to 60 seconds

[3]60 to 70 seconds

8.0 Steam Generator Tube Rupture (SGTR)

8.1 Analysis

This calculation determines the offsite and Control Room doses for the SGTR accident. The analysis uses alternate source term and accompanying TEDE methodology and conservative Control Room X/Q values, that are calculated with the ARCON96 code. The SGTR analysis includes the following cases:

- SGTR with accident-initiated spike
- SGTR with pre-accident iodine spike

The AST defined in Reference 5 is used. The HABIT code (Reference 6) and HABIT nuclide data base discussed in Section 4.2 are used.

8.2 Assumptions

Input parameters are listed in Table 8.1 below.

The break flow and steam release data for the ruptured SG, and steam release data for the intact SG is taken from the analysis discussed in Section 15.6 of Reference 3 and listed on Table 8.2.

The Control Room parameters are listed on Table 8.3.

Control Room isolation is assumed at 6 minutes which bounds the safety injection signal generation time for the Reference 3, Section 15.6 SGTR. The ARV is the source point for the Control Room X/Q.

Accident-Initiated Iodine Spike:

The initial appearance rates are listed on Table 3.1. The input parameters are listed on Table 8.1 and the results are presented on Table 8.5. The dose calculations are terminated after all dose contributions are accounted for.

Pre-Accident Iodine Spike:

The iodine concentrations are based on 60 μCi/gm DE I-131 and listed in Section 3.2. The input parameters are listed on Table 8.1 and results are presented on Table 8.5. The dose calculations are terminated after all dose contributions are accounted for.

TABLE 8.1 SGTR DOSE ANALYSIS ASSUMPTIONS	
Parameter	**Value**
Reactor power, MwT(including 2% uncertainty)	1550
Initial reactor coolant activity, pre-accident iodine spike iodine, µCi/gm of DE I-131 noble gas fuel defect level, %	 60 1.0
Initial reactor coolant activity, accident initiated iodine spike iodine, ci/gm of DE I-131 noble gas fuel defect level, %	 1.0 1.0
Concurrent iodine spike factor	335
Duration of concurrent iodine spike, hours	8
Initial secondary coolant iodine activity, µCi/gm of DE I-131	0.1
Primary-to-secondary leakage to intact SG leak rate (cold conditions) duration of leakage, hours	 150 gal/day 8
Mass of primary coolant, gm	1.247×10^8
Initial mass of secondary coolant, gm faulted SG intact SG	 3.27×10^7 3.27×10^7
Steam generator elemental iodine partition coefficients (mass-based) Activity release from faulted SG via boiling of bulk water via flashed break flow Activity release from intact SG	 100 1.0 100
Steam generator partition coefficient for organic iodide and noble gas release	1.0
Iodine species assumed in the reactor coolant and SG water elemental iodine organic iodide	 0.97 0.03

TABLE 8.1 SGTR DOSE ANALYSIS ASSUMPTIONS	
Parameter	**Value**
Atmospheric dispersion, X/Q, sec/m^3 EAB 0-2 hr LPZ 0-8 hr	 4.8 E-4 3.0 E-5
Breathing Rates, m^3/sec EAB & LPZ 0-8 hr 8-24 hr	 3.47E-4 1.75E-5

Table 8.2 Steam Releases and Rupture Flow				
	Time periods, seconds			
Mass, 1000 lb_m	0-49 sec	49 sec-3492 sec	3492 sec- 2 hours	2 hrs - 8 hrs
Ruptured SG to: Condenser[1] Atmosphere	 45.5 -	 - 62.4	 - 0	 - 31.6
Intact SG to: Condenser Atmosphere	 45.2 -	 - 60.0	 - 147.5	 - 459.9
Rupture flow	2.9	107.4	-	-

49 sec: Reactor trip.
3492 sec: SG and RC pressures are equal, rupture flow is terminated.
8 hrs: RHR operating conditions are achieved, steaming to the environment is terminated.

[1]The analysis conservatively treats steam released to the condenser the same as a direct release to the atmosphere, i.e., elemental iodine partition is 100.

TABLE 8.3 CONTROL ROOM PARAMETERS	
Parameter	**Value**
Habitable volume, ft^3	36,211
Normal Operating Mode make-up air flow rate, cfm	 2000+10%
Accident Operating Mode recirculating air iodine removal efficiency, % elemental methyl particulate flow rate, cfm unfiltered in-leakage, cfm	 90 70 98 6000-10% 300
Breathing rate, m^3/sec	3.47E-4
Occupancy factor 0-24 hr 24-96 hr 96-720 hr	 1 0.6 0.4
Atmospheric dispersion, X/Q, sec/m^3 0-2 hr 2-8 hr 8-24 hr	 3.66E-3 2.49E-3 1.07E-3

Table 8.4 **Flow Rate and Iodine Removal Schedule**				
Time, hours	Inleakage		Recirculation	
	cfm	iodine removal efficiency, %	cfm	iodine removal efficiency, %[1]
0-0.1[2]	2200	0/0/0	0	0/0/0
[3]0.1-0.103	300	0/0/0	0	0/0/0
>0.103	300	0/0/0	5400	90/70/98

TABLE 8.5 RESULTS FOR SGTR			
	EAB Max 2 hr	LPZ, 8 hr	Control Room 24 hr
Accident Initiated Iodine Spike (TEDE)	0.22	0.017	0.14
Acceptance Criteria	2.5	2.5	5
Pre-Accident Iodine Spike (TEDE)	0.71	0.051	0.88
Acceptance Criteria	25	25	5

[1]Elemental/Methyl/Particulate

[2]0 to 360 seconds

[3]360 to 370 seconds

9.0 Locked Rotor Accident

This calculation determines the offsite and Control Room doses for the LR accident. The analysis uses alternate source term and accompanying TEDE methodology and conservative Control Room X/Q values, that are calculated with the ARCON96 code. The LR analysis includes the following case:

- Primary-to-secondary leakage with SG activity releases

The AST defined in Reference 5 is used. The HABIT code (Reference 6) and HABIT nuclide data base discussed in Section 4.2 are used.

9.1 Assumptions

Input parameters are listed in Table 9.1 and 9.2 below.

It is conservatively assumed 100% of the fuel rods experience DNB and are therefore assumed to release their gap activity into the reactor coolant system.

The initial reactor coolant iodine activity is based on a pre-accident spike discussed in Section 3.2. The concentrations are based on 60 uCi/gm of DE I-131. The noble gas activity is based on 1% fuel defects.

The initial secondary coolant iodine activity is based on 0.1 uCi of DE I-131.

The assumed post-accident primary-to-secondary leak rate is 500 gal/day per SG. This bounds the current limit of 144 gpd/SG and a future Technical Specification limit of 150 gpd/SG.

A partition coefficient of 100 is assumed for elemental iodine in the secondary coolant. No partitioning is assumed for organic iodine or noble gas. No particulates are assumed to be released to the atmosphere with the secondary side steam.

The steam release from the SGs is based on a LOFTRAN simulation of the LR followed by an energy balance to simulate the cooldown to RHR conditions. RHR System is assumed to be placed into service for heat removal 8 hours after the initiation of the LR.

Initially the Control Room HVAC is operating normally with a nominal 2000 cfm of makeup air. Isolation is assumed to occur at 60 sec. via the radiation monitors. A comparison of the nuclide concentration in the Control Room intake for the LR to the radiation monitor response showed a Control Room isolation signal would occur before the 60 sec. assumed in the calculations. CREATS is assumed operating at 70 sec. assuming a nominal 6000 cfm recirculation flow.

The EAB and LPZ X/Qs are the new values calculated by K R PAVAN as discussed in Section 2.8.2.

TABLE 9.1 **LR Dose Analysis Assumptions**	
Parameter	**Value**
Reactor power, Mwt(including 2% uncertainty)	1550
Failed Fuel, %	100
Initial reactor coolant activity, pre-accident iodine spike iodine, uCi/gm of DE I-131 noble gas fuel defect level, %	 60 1.0
Initial secondary coolant iodine activity, uCi/gm of DE I-131	0.1
Primary-to-secondary leakage (post accident) to SGs leak rate (cold conditions per SG, gpd duration of leakage, hours	 500 8
Mass of primary coolant, gm	1.247×10^8
Initial mass of secondary coolant in 2 SGs, gm	8.501E+7
Steam Releases (2 SGs), lb 0-10 min. 10-30 min. 0.5-8 hr.	 54,620 14,446 685,229
Steam generator iodine partition coefficients (mass-based) elemental methyl (organic)	 100 1
Iodine fractions in the reactor coolant and SG water elemental iodine methyl (organic) iodide	 0.97 0.03
Atmospheric dispersion X/Q sec/m^3 EAB 0-2 hr LPZ 0-8 hr	 2.98E-4 2.29E-5

TABLE 9.1 LR Dose Analysis Assumptions	
Parameter	**Value**
Breathing rate m^3/sec EAB & LPZ 0-8 hr 8-24 hr	 3.47E-4 1.75E-4

TABLE 9.2 CONTROL ROOM PARAMETERS	
Parameter	**Value**
Habitable volume, ft^3	36,211
Normal Operating Mode make-up air flow rate, cfm	 2000+10%
Accident Operating Mode Recirculating air iodine removal efficiency, % elemental methyl particulate flow rate, cfm Unfiltered in-leakage, cfm	 90 70 98 6000-10% 300
Breathing rate, m^3/sec	3.47 E-4
Occupancy factor 0-24 hr 24-96 hr 96-720 hr	 1 0.6 0.4
Atmospheric dispersion, X/Q, sec/m^3 0-2 hr 2-8 hr 8-24 hr	 3.66 E-3 2.49 E-3 1.07 E-3

Table 9.3 Flow Rate and Iodine Removal Schedule				
Time, hours	Inleakage		Recirculation	
	cfm	iodine removal efficiency, %	cfm	iodine removal efficiency, %[1]
0 - 0.0167[2]	2200	0/0/0	0	0/0/0
[3]0.0167 - 0.0194	300	0/0/0	0	0/0/0
>0.0194	300	0/0/0	5400	90/70/98

TABLE 9.4 RESULTS FOR LOCKED ROTOR			
	EAB Max - 2 hr TEDE	LPZ, 8 hr TEDE	Control Room 24 hr TEDE
Elemental iodide	1.150	0.209	1.370
Methyl iodide	1.022	0.254	2.115
Noble gas	0.578	0.090	0.232
Total	2.750	0.553	3.717
Acceptance criteria	2.5	2.5	5

[1]Elemental/Methyl/particulate

[2]0 to 60 seconds

[3]60 to 70 seconds

10.0 Rod Ejection Accident

This calculation determines the offsite and Control Room doses (TEDE) for Rod Ejection Accident (REA). The analysis uses the alternate source term and the accompanying TEDE methodology and conservative control room X/Q values that are calculated with the ARCON96 code. The REA analysis includes the following cases:

- Containment leakage
- Primary-to-secondary leakage with SG activity release.

Doses are calculated for the following receptors:

- Exclusion Area Boundary (EAB), maximum 2 hour dose
- Outer boundary of the Low Population Zone (LPZ), 30 day dose (8 hr for secondary side transport)
- Control Room, 30 day dose (24 hr for secondary side transport)

The AST defined in Reference 5 is used. The HABIT code (Reference 6) and HABIT nuclide data base described in Section 4.2 are used. Ten percent of the core is assumed to fail. This is based on a Ginna specific calculation (Reference 3, Section 15.4.5.3.5). The release fraction used in the analysis is the product of the core damage, the peaking factor, and the gap fraction. The input parameters are listed on Table 10.1.

10.1 Containment Leakage

The containment leakage calculation assumes the gas activity is instantaneously released from the core to containment atmosphere. No credit is taken for removal of elemental or methyl iodine by the CRFC charcoal filters. The CRFCs only remove particulate iodine by the associated HEPA filters. The CRFCs are assumed to be operating at 53 seconds based on a 3 inch SBLOCA. The CRFCs are arbitrarily terminated after four hours since there is no longer a significant particulate concentration.

Containment spray is assumed not to actuate for the REA. Particulate removal is assumed by natural deposition. The removal coefficient is based on the correlations provided in Reference 8, Table 2.2.2.1-1. The first is for the time period 0 to 0.5 hr and the second is for 0.5 to 1.8 hr. The 10th percentile is the most conservative (smallest removal rate) and is used in this calculation. Only the smallest value is used and is held constant for the duration of the calculation.

10.2 Primary-to-Secondary Leakage

The initial reactor coolant iodine activity is based on a pre-accident spike discussed in Section 3.2. The concentrations are based on 60µCi/gm of DE I-131. The noble gas activity is based on 1% fuel defects. Gap (10% failed fuel rods) activity is released instantaneously and homogeneously mixed in the reactor coolant. The activity release fraction is the product of core damage, the peaking factor, and gap fraction.

The initial secondary coolant iodine activity is based on 0.1μi of DE I-131.

The assumed post-accident primary-to-secondary leak rate is 500 gal/day per SG. This bounds the current limit of 144 gpd/SG and a future Technical Specification limit of 150 gpd/SG.

A partition coefficient of 100 is assumed for elemental iodine in the secondary coolant. No partitioning is assumed for organic iodine or noble gas. No particulates are assumed to be released to the atmosphere with the secondary side steam.

The steam release from the SGs is based on a LOFTRAN simulation of the REA followed by an energy balance to simulate the cooldown to RHR conditions. RHR system is assumed to be placed into service for heat removal 8 hours after the initiation of the REA.

Initially the Control Room HVAC is operating normally with a nominal 2000 cfm of makeup air. Isolation is assumed to occur at 60 sec. via the radiation monitors. A comparison of the nuclide concentration in the Control Room intake for the REA to the radiation monitor response showed a Control Room isolation signal would occur before the 60 sec. assumed in the calculations. CREATS is assumed operating at 70 sec. assuming a nominal 6000 cfm recirculation flow.

TABLE 10.1 REA CONTAINMENT PARAMETERS	
Parameter	**Value**
Reactor power, MwT(including 2% uncertainty)	1550
Failed Fuel, % of core Gap fraction Peaking factor, fraction	10 0.10 1.75
Initial primary coolant activity iodine noble gas	 60µCi/gm of DE I-131 1% fuel defects
Iodine forms particulate elemental organic	 0.95 0.0485 0.0015
Containment net free volume, ft^3	10E6
Containment leak rate, %/day 0-24 hr >24 hr	 0.2 0.1
Containment fan cooler flow and operation number of operating units flow rate per unit, cfm total filtered flow rate, cfm HEPA (2 units) initiation delay CRFCs (HEPA) termination of particulate iodine removal, hours	 2 30,000 60,000 53 sec 4
Containment fan cooler iodine removal efficiency, % elemental methyl particulate	 0 0 95
Natural deposition coefficient, 1/hr	0.023

TABLE 10.1 REA CONTAINMENT PARAMETERS	
Parameter	**Value**
Atmospheric dispersion, X/Q, sec/m^3	
EAB 0-2 hr	4.8 E-4
LPZ 0-8 hr	3.0 E-5
8-24 hr	2.1 E-5
24-96 hr	8.6 E-6
96-720 hr	2.5 E-6
Breathing rate, m^3/sec	
EAB & LPZ	
0-8 hr	3.47 E-4
8-24 hr	1.75 E-4
24-720 hr	2.32 E-4

TABLE 10.2 PARAMETERS FOR REA SECONDARY SIDE ACTIVITY RELEASE	
Parameter	**Value**
Reactor power, MwT(including 2% uncertainty)	1550
Failed fuel, % of core	10
gap fraction	0.10
peaking factor, fraction	1.75
Initial secondary coolant iodine activity, ci/gm of DE I-131	0.1
Primary-to-secondary leakage	
leak rate, gpd per SG	500
duration, hr	8
Mass of primary coolant, gm	1.247E8
Initial mass of secondary coolant, gm per 2 SGs	8.5E7
Steam released from S.S. to environment, gm/min	
0-10 min	2.478E6
10-30 min	3.276E5
30 min - 8 hr	6.907E5

TABLE 10.2 PARAMETERS FOR REA SECONDARY SIDE ACTIVITY RELEASE	
Steam generator iodine partition coefficient (mass-based) elemental methyl	 100 1
Iodine species assumed in the SG water elemental iodine methyl iodide	 0.97 0.03

TABLE 10.3 CONTROL ROOM PARAMETERS		
Habitable volume, ft^3		36,211
Normal operating Mode make-0up air flow rate, cfm		 2000+10%
Accident Operating Mode Recirculating air iodine removal efficiency, % elemental methyl particulate flow rate, cfm Unfiltered in-leakage,cfm		 90 70 98 6000-10% 300
Breathing rate, m^3/sec		3.47E-4
Occupancy factors 0-24 hr 24-96 hr 96-720 hr		 1 0.6 0.4
Atmospheric dispersion X/Q, sec/m^3		
	Containment Leakage	ARV
0-2 hr	1.57E-3	3.66E-3
2-8 hr	1.12E-3	2.49E-3
8-24 hr	4.47E-4	1.07E-3
24-96 hr	3.69E-4	
96-720 hr	3.10E-4	

Table 10.4 Control Room Flow Rate and Iodine Removal Schedule for REA				
Time, hours	Inleakage		Recirculation	
	cfm	iodine removal efficiency, %	cfm	iodine removal efficiency, %[1]
0-0.0167[2]	2200	0/0/0	0	0/0/0
0.0167-0.0194[3]	300	0/0/0	0	0/0/0
>0.0194	300	0/0/0	5400	90/70/98

TABLE 10.5 REA DOSE SUMMATION, rem, TEDE			
	EAB, max -2 hour	LPZ, 720 hours (CNMT), 8 hours (secondary side)	Control Room, 720 hours (CNMT), 24 hours (secondary side)
Containment Leakage	2.859E-01	4.825E-02	1.311E-01
Secondary Side, Elemental Iodine	4.539E-01	6.759E-02	3.196E-01
Secondary Side, Noble Gas	3.263E-01	4.125E-02	8.132E-02
Secondary Side, Methyl Iodide	4.032E-01	8.244E-02	5.043E-01
TOTAL	1.47E+00	2.40E-01	1.04E+00

[1]Elemental/Methyl/Particulate

[2]0 to 60 seconds

[3]60 to 70 seconds

11.0 Tornado Missile in Spent Fuel Pool

11.1 This calculation determines the offsite and Control Room doses (TEDE) for a tornado missile accident (TMA). The analysis uses the alternate source term and accompanying TEDE methodology and conservative Control Room X/Q values calculated as discussed in Section 2.7.

The AST defined in Reference 5 is used. The HABIT code (Reference 6) and HABIT nuclide data base as discussed in Section 4.2 are used. The analysis assumes 9 fuel assemblies are damaged (5 fuel assemblies decayed for 100 hours and four fuel assemblies decayed for 60 days) based on the size of a telephone pole missile. The nuclide inventory in the damaged assemblies is estimated by applying a power peaking factor of 1.75 to the average assembly inventory. Activity from the damaged assemblies is assumed to be instantaneously released to the pool water. After applying decontamination factors of the pool water, the resulting elemental and organic fractions above the water are 0.57 and 0.43. The activity above the pool is assumed to be released to the environment. No iodine removal is assumed. Reference 5 suggests using a two-hour activity release. Since the duration of the tornado is uncertain, and may be less than two hours, two cases were run.

Case 1) All activity was released over two hours. The activity released over the first hour was at tornado conditions. The activity released over the second hour was at normal atmospheric conditions.

Case 2) All activity was released over one hour at tornado conditions. Case 2 resulted in slightly higher Control Room doses.

The TMA dose analysis assumptions are listed on Table 11.1. The activity released from the pool is listed on Table 11.5. The Control Room assumptions are listed on Table 11.2. The Control Room is assumed to be isolated within 60 seconds via the radiation monitors. A comparison of the nuclide concentration in the Control Room intake for the TMA to the radiation monitor response showed a Control Room isolation signal would occur before the 60 seconds assumed in the calculation. The resulting doses are presented on Table 11.4. Since the release from the TMA is assumed to end after one or two hours, the dose calculations are terminated after all contributions are accounted for; 2 hours for EAB and 24 hours for the Control Room.

TABLE 11.1 TMA DOSE ANALYSIS ASSUMPTIONS	
Parameter	**Value**
Reactor power, MwT(including 2% uncertainty)	1550
Power Peaking Factor	1.75
Number of damaged fuel assemblies Hot Cold	 5 4
Fission product inventory in damaged assemblies after decay	Values calculated
Time after reactor shutdown hot assemblies cold assemblies	 100 hours 60 days
Fuel rod gap fractions I-131 other halogens Kr-85 other noble gases	 0.08 0.05 0.1 0.05
Iodine species above water elemental iodine organic iodine	 0.57 0.43
Pool DF elemental iodine organic iodide particulate Overall Pool DF	 500 1 ∞ 200
Exhaust flow rate, cfm 1-hour activity release 2 -hour activity release	 1.545E5 7.685E4
Iodine removal efficiency for all forms	0
Atmospheric dispersion, X/Q, sec/m^3 EA. Tornado conditions Normal conditions	 1.74E-6 4.8E-4

TABLE 11.1 TMA DOSE ANALYSIS ASSUMPTIONS	
Parameter	**Value**
Breathing rate, m^3/sec EA. 0-8 hr	3.47E-4

TABLE 11.2 CONTROL ROOM PARAMETERS		
Parameter	**Value**	
Habitable volume, ft^3	36,211	
Normal Operating Mode make-up air flow rate, cfm	2000+10%	
Accident Operating Mode Recirculating air iodine removal efficiency, % elemental methyl particulate flow rate, cfm Unfiltered in-leakage, cfm	 90 70 98 6000-10% 300	
Breathing rate, m^3/sec	3.47E-4	
Occupancy factor 0-24 hr 24-96 hr 96-720 hr	 1 0.6 0.4	
Atmospheric dispersion, X/Q, sec/m^3	1 hour release 4.36E-5 (Case 1)	2 hour release 4.36E-5 1.45E-3 (Case 2)

Table 11.3 Flow Rate and Iodine Removal Schedule				
Time, hours	Inleakage		Recirculation	
	cfm	iodine removal efficiency, %	cfm	iodine removal efficiency, %[1]
0-0.0167[2]	2200	0/0/0	0	0/0/0
0.0167-0.0194[3]	300	0/0/0	0	0/0/0
>0.0194	300	0/0/0	5400	90/70/98

TABLE 11.4 TMA DOSE, Rem, TEDE		
TMA	EAB, Max - 2 hours[4]	Control Room, 24 hours
1-hour release	2.01 E-2	5.87 E-2
2-hour release	7.41 E-2	5.44 E-2
Acceptance Criteria	6.3	5

[1]Elemental/Methyl/Particulate

[2]0 to 60 seconds

[3]60 to 70 seconds

[4]The 2 hour LPZ dose is bounded by the 2-hour dose at the EAB, as such, only the EAB dose is evaluated.

TABLE 11.5
Spent Fuel Pool Activity

	A_{100}	A_{60d}	n	Xgap	Xpeak	DF	$A_{released}$
1-131	2.98E+07	2.432E+05	121	0.08	1.75	200	8.676E+02
1-132	2.52E+07	0.000E+00	121	0.05	1.75	200	4.557E+02
1-133	3.12E+06	1.261E-13	121	0.05	1.75	200	5.640E+01
1-134	0.00E+00	0.00E-0	121	0.05	1.75	200	0.0
1-135	2.23E+03	0.00	121	0.05	1.75	200	4.028E-02
Kr-85m	2.15E+00	0.00	121	0.05	1.75	1	7.774E-03
Kr-85	4.98E+05	4.934E+05	121	0.1	1.75	1	6.456E+03
Kr-87	4.58E-17	0.0	121	0.05	1.75	1	1.656E-19
Kr-88	7.48E-04	0.0	121	0.05	1.75	1	2.705E-06
Xe-131m	4.42E+05	3.084E+04	121	0.05	1.75	1	1.687E+03
Xe-133m	1.10E+06	2.416E-02	121	0.05	1.75	1	3.977E+03
Xe-133	5.71E+07	3.662E+04	121	0.05	1.75	1	2.066+05
Xe-135m	3.57E+02	0.0	121	0.05	1.75	1	1.291E+00
Xe-135	1.09E+05	0.0	121	0.05	1.75	1	3.941E+02
Xe-138	0.00E+00	0.0	121	0.05	1.75	1	0.0

Total core activity @ 100 hours (A_{100}): Ci

Total core activity @ 60 days (A_{60d}): Ci

Core assemblies (n)

Gap Fraction (Xgap)

Peaking factor (Xpeak)

Overall pool DF

Activity released from the pool to the environment ($A_{released}$):

$$A_{hot}: \ A_{hot} = \frac{A_{100}}{n} * 5$$

$$A_{cold}: \ A_{cold} = \frac{A_{60d}}{n} * 13$$

$$A_{total}: \ A_{total} = A_{hot} + A_{cold}$$

$$A_{total}: = \frac{A_{total} * X_{gap} * X_{peak}}{DF}$$

12.0 Waste Gas Decay Tank Rupture

12.1 Analysis

This analysis calculates the Control Room and off-site doses for a release of a Gas Decay Tank (GDT) into the Auxiliary Building Atmosphere

12.2 Assumptions

The source term is 100,000 Ci of equivalent Xe-133. The assumed source will be 100,000 Ci of actual Xe-133.

Activity, from the ruptured tank, is released considering two different release rates

- Released to the environment over 2-hours. The flow rate corresponds to a 2-hour activity release.
- A puff release assuming a 5 second release duration.

The 2-hour activity release assumption is consistent with that of the Fuel Handling Accident.

Activity from the ruptured tank is released into the Auxiliary Building and assumed to diffuse from the building to the environment. The Control Room dose calculation will use χ/Qs for the Auxiliary Building area source.

The dose conversion factor for Xe-133, contained in HABIT library MLWRGE.1465.pwr, will be used. The DCF values in this library were derived from FGR 11 and 12.

Table 12.1
Atmospheric Dispersion (sec/m^3)

EAB	LPZ
2.98E-4	2.29E-5

Control Room

0-2 hours	2-8 hours	8-24 hours	24 - 96	96 - 720
3.89E-3	2.99E-3	9.63E-4	8.98E-4	8.23E-4

Table 12.2
Control Room Parameters

Parameter	Value
Habitable volume, ft^3	36,211
Normal Operating Mode make-up air flow rate, cfm	 2000+10%
Accident Operating Mode This analysis considers only noble gas, as such, iodine removal efficiencies and recirculation flow have no effect on the calculated doses. Unfiltered in-leakage, cfm	300

Table 12.3
Flow Rate and Iodine Removal Schedule

Time, hours	Inleakage		Recirculation	
	cfm	iodine removal efficiency, % [1]	cfm	iodine removal efficiency, % [1]
0 - 0.0167[2]	2200	0/0/0	0	0/0/0
0.0167 - 0.0194[3]	300	0/0/0	0	0/0/0
>0.0194	300	0/0/0	0	0/0/0

Note: The isolation and recirculation times, shown above, are consistent with those provided for other accidents (excluding SGTR).

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[1]Elemental/Methyl/Particulate

[2]0 to 60 seconds

[3]60 to 70 seconds

The iodine removal efficiencies and recirculation flow rates are not applicable to the GDT rupture, which assumes only Xe-133 in the source term (no iodine).

Table 12.4
Offsite and Control Room Doses

	rem, TEDE		
	EAB Max. 2-hour	LPZ 30 days	Control Room 30 days
2-hour release without CR isolation	1.718E-1	1.320E-2	6.632E-2
2-hour release with CR isolation	1.718E-1	1.320E-2	9.559E-2
Puff release without CR isolation	1.720E-1	1.332E-2	6.664E-2
Acceptance Criteria	0.5	0.5	5

13.0 References

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Attachment 3

Particulate Removal by Sprays

Attachment 3

PARTICULATE REMOVAL BY SPRAYS
NUREG/CR-5966

Input

$h := 89\text{ft}$ — Average spray nozzle elevation above the operating deck

$Diam := 105\text{ft}$ — Inside diameter of the containment

$Flow := 1300\frac{\text{gal}}{\text{min}}$ — Total spray flow rate

Calculation

$A := \pi \cdot \frac{Diam^2}{4}$ — Area of containment operating deck

$q := \frac{Flow}{A}$ — spray flux

$Q := q \cdot \left(\frac{\text{cm}^2\text{sec}}{\text{cm}^3}\right)$ $\quad H := h \cdot \frac{1}{\text{ft}}$ $\quad q = 0.02\frac{\frac{\text{ft}^3}{\text{min}}}{\text{ft}^2}$

1/2

Attachment 3

10th Percentile, 90% confidence

$$lam_{10} := 5.575 + 0.94362 \cdot \ln(Q) - 6.9821 \cdot 10^{-3} \cdot Q^2 \cdot H - 7.327 \cdot 10^{-7} \cdot Q \cdot H^2 + 3.555 \cdot 10^{-6} Q^2 \cdot H^2$$

$$\lambda_{10} := e^{lam_{10}} hr^{-1}$$

50th Percentile, 50% confidence

$$lam_{50} := 6.83707 + 1.0074 \ln(Q) - 4.1731 \cdot 10^{-3} \cdot Q^2 \cdot H - 1.2478 Q - 2.4045 \cdot 10^{-5} \cdot H + 9.006 \cdot 10^{-8} \cdot Q \cdot H^2$$

$$\lambda_{50} := e^{lam_{50}} hr^{-1}$$

90th Percentile, 90% Confidence

$$lam_{90} := 7.10927 - 8.0868 \cdot 10^{-4} \cdot Q^2 \cdot H + 0.92549 \ln(Q)$$

$$\lambda_{90} := e^{lam_{90}} hr^{-1}$$

Input Summary

$h = 89ft$ $\quad$ $Diam = 105ft$ $\quad$ $Flow = 1.3 \times 10^3 \dfrac{gal}{min}$

Output

$\lambda_{90} = 17.551 hr^{-1}$

$\lambda_{50} = 9.047 hr^{-1}$

$\lambda_{10} = 3.48 hr^{-1}$

Attachment 4

MSLB/Locked Rotor Two Hour Steam Release

Attachment 4

MSLB/Locked Rotor Two Hour Steam Release

1. Main Steam Line Break (MSLB)

From Attachment 2, Table 7.1:

Steam Release 0 - 610 seconds (intact SG) = 37,780 lb

From Reference 19 of Attachment 2, Section 7.1.6:

Steam Release Rate 610 seconds - 8 hours = 7.29E+5 gm/min

Calculation:

From 610 seconds to 2 hours adds an additional 6590 seconds, or 109.83 minutes.

Therefore: (7.29E+5 gm/min) x (109.83 min) = 8.007E+7 gm

Converted = 176,514 lb

Total steam release (0 - 2 hr, intact SG) = 37,780 + 176,514

= 214,294 lb

Attachment 4

2. <u>Locked Rotor</u>

From Attachment 2, Table 9.1:

Total Steam release   0 - 10 min = 54,620 lb
10 min - 30 min = 14,446 lb

From Reference 21 of Attachment 2:

Steam release rate 30 min - 8 hr = 6.907E+5 gm/min

Calculation:

From 30 min to 2 hours adds an additional 90 minutes

Therefore: (6.907E+5 gm/min) x (90 min) = 6.22E+7 gm

Converted = 137,045 lb

Total steam release (0 - 2hr, both SG) = 54,620 + 14,446 + 137,045

= <u>206,111 lb</u>

Attachment 5

Clarification of SGTR Steam Releases

Attachment 5

CLARIFICATION OF SGTR STEAM RELEASES

Steam releases (lb_m) and break flows (lb_m), for the affected and unaffected SGs, are shown in the table below. Westinghouse calculated these mass values and time intervals, with LOFTRAN.

Table 1

Steam Releases and Rupture Flow

	Time Periods, seconds			
Mass, 1000 lb_m	0-trip	trip -break	Break - 2 hours	2hrs - RHR
Affected SG to:				
Condenser	45.5	-	-	-
Atmosphere	-	62.4	0	31.6
Unaffected SG to:				
Condenser	45.2	-	-	-
Atmosphere	-	60.0	147.5	459.9
Rupture flow	2.9	107.4	-	-

trip: reactor trip (49 sec.)
break: SG and RC pressures are equal, rupture flow is terminated (3492 sec)
RHR: RHR operating conditions are achieved, steaming to the environment is terminated (8 hours)

The steam releases, from the affected SG, represent the total mass released to the environment. The components of the total steam release are:

- steam produced by boiling of the bulk SG water
- steam produced by flashing rupture flow

Attachment 6

The first part of the calculation is to convert the integrated steam and break flows (provided in the previous table) into flow rates.

Table 2

	SGTR STEAM RELEASE FROM AFFECTED SG AND RUPTURE FLOW							
	LOFTRAN Time Steps for Steam Release and Break Flow							
Start time, hr	Start time, sec	End of time step, sec	duration, min	Steam Flow, lbm	Steam flow rate, gm/min	Break flow, lbm	Break flow rate, lbm/min	Break flow rate, gm/min
0	0	49	0.82	4.550E+04	2.53E+07	2.900E+03	3.55E+03	1.61E+06
0.014	49	3492	57.38	6.240E+04	4.93E+05	1.074E+05	1.87E+03	8.49E+05
0.970	3492	7200	61.80	0.000E+00	0.00E+00	0.000E+00	0	0.00E+00
2	7200	2.88E+04	360.00	3.160E+04	3.98E+04	0.000E+00	0.00E+00	0.00E+00

The flow rates are shown in both lb/min and grams/min. The analysis uses the gm/min values. Interval time is converted to hours (TACT5 time step unit is hours. TACT5 flow unit is gm/min).

The second part of the calculation is to split the rupture flow into flashed (steam) flow and non-flashed (liquid) flow and calculate the net boil-off steam release.

The total break flow is taken from Table 2. The integrated flashed flow is provided by Westinghouse.

The TACT5 input (start time in hours, flashing break flow rate, non-flashing break flow rate, and net steam flow rate) are calculated in Table 3.

Table 3

	Start time, sec	End time, sec	duration, min	Flashing break flow at start time, lbm	Flashing break flow at end time, lbm	Flashing break flow for time step, lbm	Flashing break flow rate, gm/min	Non-Flashing break flow rate, gm/min	Net steam flow rate, gm/min
0	0	49	0.82	0.00E+00	4.24E+02	4.24E+02	2.35E+05	1.38E+06	2.50E+07
0.014	49	2004	32.58	4.24E+02	4.58E+03	4.16E+03	5.79E+04	7.91E+05	4.35E+05
0.557	2004	3492	24.80	4.58E+03	4.58E+03	0.00E+00	0.00E+00	8.49E+05	4.93E+05
0.970	3492	7200	61.80	4.58E+03	4.58E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.000	7200	2.88E+04	360	4.58E+03	4.58E+03	0.00E+00	0.00E+00	0.00E+00	3.98E+04

The following times are represented:

49 sec	reactor trip
2004	break flashing stops
3492	break flow is stopped
7200	2 hours: end of dose interval
2.88E4	8 hours: RHR operation begins, steam release is terminated

The flashing break flow for the time interval t (integrated mass in lb), is calculated as follows:

$$FF_T = FF_{t2} - FF_{t1}$$

Where:

FF_T = integrated flashing break flow for time interval T
FF_{t2} = integrated flashing break flow at time t2
FF_{t1} = integrated flashing break flow at time t1

The flashing break flow rate (steaming rate in grams/min) is calculated as follows:

$$FF_{TR} = \frac{FF_T}{Dur_T}$$

Where:

FF_{TR} = flashing break flow rate for time interval T
Dur_T = duration of time interval T

This steam is released directly to the environment without mixing with the SG water or partition (partition =1).

The non-flashing break flow rate (gm/min) is calculated as follows:

$$NF_{TR} = W_{break} - FF_{TR}$$

Where:

NF_{TR} = non-flashing break flow rate for time interval T
W_{break} = total break flow rate for time interval T

Attachment 5

This water is assumed to homogeneously mix with the bulk SG water.

The net steam flow rate (gm/min) is calculated as follows:

$$W_{net} = W_{gross} - FF_{TR}$$

Where:

W_{net} = net steam flow rate to environment due to SG boiling
W_{gross} = gross steam flow rate to environment (total due to boiling and flashing)

A partition of 100 is applied to the net steam elemental iodine activity release. A partition os 1 is applied to the methyl iodide activity release.

The steam released from and break flow to the affected SG are summarized as follows:

The last time interval is 7200 sec to 8 hours.

The rate of activity release from the SG to the environment is proportional to the activity concentration is the SG water, the steaming rate and the iodine partition coefficient.

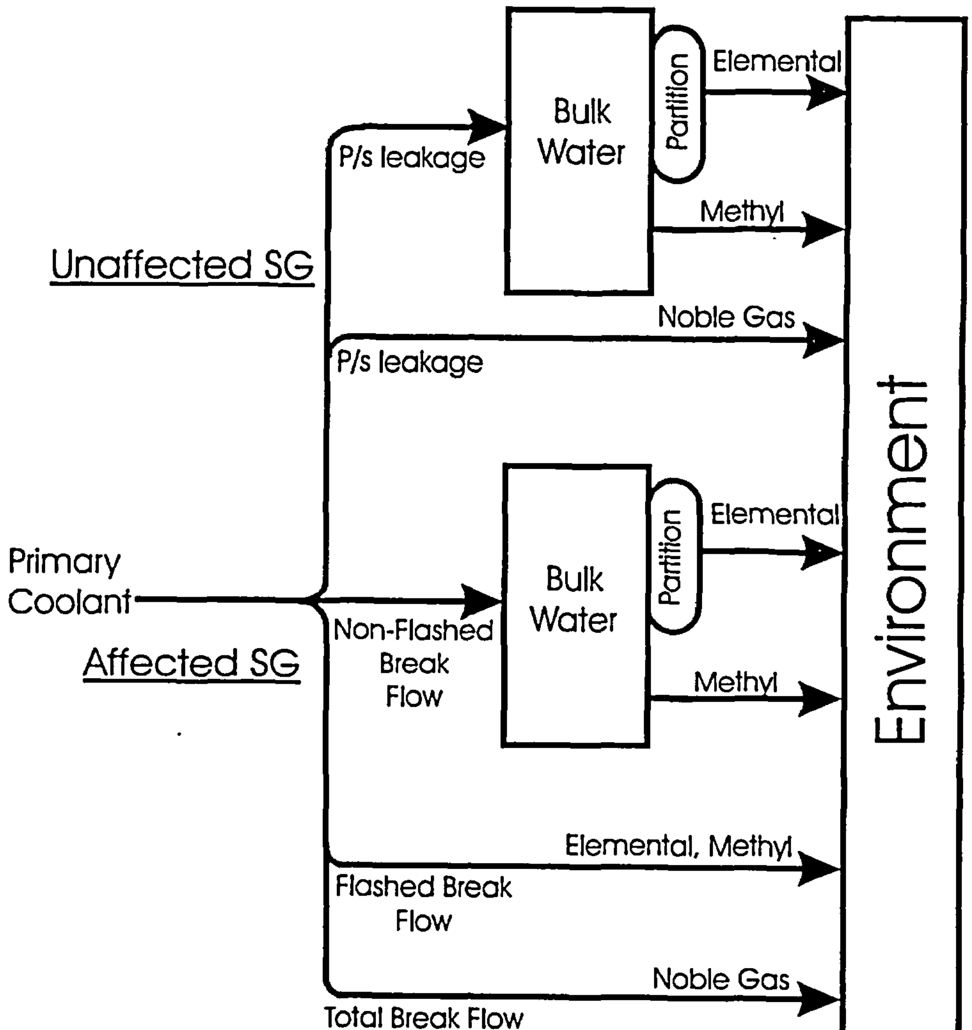
	Steam Release			
Start time, sec	Flash Steam, lb	Boil-Off, lb	Total Steam, lb	Break Flow (not-flashed) lb
0	4.24E+02	4.51E+04	4.55E+04	2.48E+03
49	4.16E+03	3.13E+04	3.54E+04	5.68E+04
2004	0.00E+00	2.70E+04	2.70E+04	4.64E+04
3492	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7200	0.00E+00	3.16E+04	3.16E+04	0.00E+00
			1.40E+05	**1.06E+05**

Attachment 5

The following iodine partition coefficients are used:

Elemental iodine: boil-off from bulk SG water flashing activity release	 100 1
Methyl iodide - all releases	1

The TACT5 activity transport model, for the affected and unaffected SGs, is shown below.



TACT5, SGTR Transport Model

Attachment 6

PWR Natural Deposition Coefficients