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## CALCULATION TITLE PAGE

# CALCULATION NUMBER: PSAT 3019CF.QA.08

CALCULATION TITLE: Radiological Evaluation of a DBA-Loss of Coolant Accident

		ORIGINATOR Print/Sign/Date	CHECKER Print/Sign/Date	IND REVIEWER Print/Sign/Date
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Appendix A, Rev 0, "Determination of Volumetric Flows and Removal Efficiencies/DFsFor Alternative Leakage Treatment (ALT)"18 pages (no attachments)

Appendix B, Rev 0, "Check Calculation with STARDOSE" 49 pages (with 4 attachments)

#### Purpose

This calculation is prepared by Polestar Applied Technology, Inc. for Vermont Yankee (VY) to determine the offsite and control room doses following a DBA Loss of Coolant Accident (LOCA). It evaluates the radiological impact at the Exclusion Area Boundary (EAB), Low Population Zone (LPZ) and control room (CR). The analysis includes three release pathways (or cases) as follows:

Case 1: Leakage from Primary Containment (PC) directly to the environment (Secondary Containment (SC) or Reactor Building (RB) bypass);

Case 2: Leakage from the PC into the RB and subsequent release to the environment via the Standby Gas Treatment System (SGTS) and the plant stack;

Case 3: Leakage from the PC via the Main Steam Isolation Valves (MSIVs) to the Main Condenser (MC) and subsequent release to the environment.

All of these pathways are analyzed for two accident scenarios: one in which the failure of an SGTS train delays drawdown of the SC (affecting Cases 1 and 2) and one in which an MSIV fails to close (affecting Case 3). Summaries of the results are presented in Table 1.

## **Summary of Results**

Location	Dose (rem)						
	Thyroid	Whole Body/DDE	<b>Total Effective Dose</b>				
	Inhalation Pathway* External Radiation*		Equivalent (TEDE)				
Case 1A: Primary Containment Leakage Direct to Environment - No SGTS Failure							
EAB	1.1E+01	2.8E-01	1.1E+00				
LPZ	4.6E-01	2.2E-02	5.3E-02				
CR	2.0E+01	2.4E-02	1.4E+00				
Case 1B: Primary	Containment Leakage D	Direct to Environment -	With SGTS Failure				
EAB (@ 0.0 hours)	2.4E+01	3.4E-01	1.8E+00				
LPZ	9.3E-01	2.4E-02	8.0E-02				
CR	4.8E+01	2.9E-02	2.8E+00				
Case 2/	A: Release Via RB and	Plant Stack - No SGTS	Failure				
EAB	2.0E+00	1.2E+00	1.3E+00				
LPZ	1.0E+00	3.7E-01	4.4E-01				
CR	4.2E-01	5.6E-03	3.6E-02				
Case 2B	: Release Via RB and P	lant Stack – With SGTS	S Failure				
EAB (@ 1.3 hours)	2.0E+00	1.2E+00	1.3E+00				
LPZ	1.0E+00	3.7E-01	4.4E-01				
CR	4.2E-01	5.6E-03	3.6E-02				
Case 3A: I	Release Via Main Steam	Lines and MC - No MS	SIV Failure				
EAB (@ 3.9 hours)	1.5E-01	2.6E-02	3.5E-02				
LPZ	1.1E-02	1.1E-03	1.6E-03				
CR	1.5E+01	2.6E-02	5.3E-01				
Case 3B: Ro	elease Via Main Steam I	Lines and MC - With M	SIV Failure				
EAB	1.9E-01	2.7E-02	<u>3.9E-02</u>				
LPZ	1.2E-02	1.2E-03	<u>1.7E-03</u>				
CR	1.5E+01	2.6E-02	5.6E-01				
DBA-LO	OCA with SGTS Failure	(Case 1B + Case 2B + Cas	Case 3A)				
EAB	2.6E+01	1.6E+00	3.1E+00				
LPZ	<u>1.9E+00</u>	4.0E-01	5.2E-01				
CR	6.3E+01	6.1E-02	3.4E+00				
DBA-LOCA with MSIV Failure (Case 1A + Case 2A + Case 3B)							
EAB	1.3E+01	1.5E+00	2.4E+00				
LPZ	<u>1.5E+00</u>	3.9E-01	4.9E-01				
CR	3.5E+01	5.6E-02	2.0E+00				
Acceptance Criteria (rem)							
EAB & LPZ	None*	None*	25				
CR	None*	None*	5				

\*These doses provided for information only – no limits apply

This table shows that all cases meet the applicable limits at all locations (Exclusion Area Boundary or EAB, the Low Population Zone outer boundary or LPZ, and the Control Room or CR).

## Methodology

This dose analysis was conducted to fully comply with NRC Regulatory Guide 1.183 (Reference 1). The calculation determines the offsite and control room doses due to a DBA-LOCA. The computer code RADTRAD 3.02a (Reference 2) was used to determine the activity releases, offsite dose and CR dose. Verification of the RADTRAD runs was performed using the STARDOSE 1.01 computer code (Reference 3) and is documented in Appendix B.

## Assumptions

- Assumption 1: The Case 1 and 3 releases are from either the RB (Case 1) or the MC/turbine stop valves (Case 3), both at ground level. The Case 2 releases are from the plant stack.
- Justification: The exact leak location for the release from the MC is not known, but it is assumed to be at the location of the turbine stop valves where the leakage bypassing the MC is also assumed to occur. The RB bypass is also treated as a ground-level release. It may occur from two locations: the RB siding on the refueling elevation during drawdown (i.e., the establishing of a stable negative pressure in the RB at the beginning of SGTS operation) or at the RB penetration for the nitrogen system.

## Assumption 2: Event timing is as follows:

- LOCA occurs at t = 0 minutes. Degraded core cooling leads to core damage.
- Release from core to PC begins at t = 2 minutes. A drainline pathway is established from the main steam lines to the MC.
- SGTS starts automatically and RB drawdown is achieved by t = 10 minutes.
- Drywell sprays are initiated at t = 15 minutes.
- Further core damage and associated activity releases are terminated at t = 122 minutes by assumed restoration of core cooling. Drywell and torus airspace become well-mixed at that time.
- Within several hours, Standby Liquid Control (SLC) is initiated and the contents of the SLC system have become mixed with the suppression pool water.
- By t = 24 hours, the containment pressure has decreased to less than 5.5 psig, and the PC leak rate has become a factor of two less than the maxium PC leak rate (except for Engineered Safety Feature (ESF) liquid leakage).
- By t = 720 hours, essentially all particulate activity has been leaked or deposited and gaseous I-131 (the principal dose contributor excluding particulate I-131) has gone through nearly four half-lives. The dose calculation is terminated in accordance with Reference 1.
- Justification: The timing of all of these events is based on Reference 1 except for establishing the drainline pathway, drawdown, drywell spray initiation, drywell and torus mixing, SLC injection, and containment leak rate reduction justification. These are covered in the following justification.
  - Establishing the DrainLine Pathway

The drainline pathway to the MC is expected to be established very early in the accident response. Even if such a response were delayed for half an hour, the dose impact would be minimal (less than two percent of the CR dose limit). Therefore, the exact timing of this action is not considered critical.

Drawdown Time

The time at which the SC pressure becomes sufficiently low to justify no further outleakage is an important parameter of the DBA-LOCA analysis. The value used is that specified in Reference 4, Item 8.11.

Drywell Spray Initiation

Drywell spray initiation is called for in the plant procedures. For an accident involving the degree of core damage postulated in Reference 1 for the DBA-LOCA (and used herein), the plant procedures would be called upon to guide operator actions. This guidance calls for drywell spray operation if the radiation level in the drywell exceeds 4000 rads/hour (Reference 4, Item 9.4) and, for conservatism, a minium 10-minute operator response time is provided for (Reference 4, Item 9.1).

Based on Reference 5, the release of the noble gas and iodine gap activity to the PC using shutdown core inventory (i.e., early in the accident) will yield an indication on the containment high-range monitor of nearly 6000 rads/hour in about five minutes. This can be determined by (1) noting that the high range monitor response would indicate 6.05E5 rads/hour for 100% noble gas release and 5.89E5 rads/hour for 100% halogen release and (2) recognizing that the gap release rate for both noble gas and halogens is assumed to be 0.1 core inventory per hour or 0.00167 per minute (Reference 1). Before sprays are started, natural removal is minimal (it is neglected in this analysis); and, therefore, the dose rate is accumulating at the rate of 0.00167(6.05E5 + 5.89E5) = 1994 rads/hour/minute once the release begins at t = 2 minutes. By t = 5 minutes, the indicated dose rate will be at least 5.98E3 rads/hour, well in excess of the 4000 rads/hour calling for spray operation and well before the assumed spray

actuation time of t = 15 minutes (accident time) or 13 minutes after the start of the gap activity release.

The VY sprays are designated Safety-Related and their availability is governed by the Technical Specifications.

Drywell and Torus Mixing

Reference 1 establishes that only the drywell volume should be credited for diluting the activity release from the core for a BWR. For Mark III containment designs, specific instructions are then provided as to how to subsequently treat mixing between the drywell and the remainder of the containment. For Mark I and Mark II plants, however, no specific guidance is provided. Instead, the general guidance is that the torus airspace "... may be included provided there is a mechanism to ensure mixing ...".

Polestar is aware that AST applications have been accepted by the NRC in which the full containment volume (drywell + torus airspace) has been credited from t = 0 with no apparent explanation or justification of the mixing credit (i.e., the justification for mixing does not appear to have been addressed in either the submittal or in the NRC Safety Evaluation; e.g., Reference 6). However,

Polestar believes that mixing will be limited between these two volumes during the fission product release phase because of the generally quiesent state of the drywell during core degradation; and, therefore, it is inappropriate to include the torus airspace volume initially (per NRC guidance) without actually analyzing the drywell-to-torus flow.

Following the restoration of core/core debris cooling, considerable thermalhydraulic activity in the PC will result, and the drywell and torus airspace volumes will become well-mixed. Beyond t = 122 minutes, therefore (the end of the release phase), a mechanism does exist to mix these two volumes; and that assumption has been made in this analysis.

SLC Injection

The injection of the SLC sodium pentaborate is justified by the plant procedures (as with drywell sprays). If core damage is expected or identified as a result of normal and emergency core cooling not being available or sufficient, the plant procedures provide guidance for injecting all available water sources into the reactor vessel. This would include SLC injection. Therefore, SLC injection is expected for this event.

The VY SLC system is designated Safety-Related and its availability is governed by the Technical Specifications.

Per Reference 6, SLC injection will maintain the suppression pool pH above 7.0 for 30 days, and radioiodine re-evolution does not need to be considered.

Containment Leak Rate Reduction Justification Reference 1 requires justification for implementing a factor of two reduction in PC leak rate at 24 hours after the start of the accident. No such justification is required for PWRs.

Typically, PWR containment pressures are reduced rapidly by the use of containment sprays, while BWRs have not credited containment sprays in accident analysis (although they are generally Safety-Related, and the impact of their use on containment pressure is generally described in the plant FSAR). The use of sprays for VY is already discussed above. With sprays in operation, the drywell pressure is reduced to ~20 psia (5.3 psig) at 24 hours (Reference 4, Item 8.10) from a peak value of 58.7 psia (44 psig), a ratio of 0.12 based on the gauge pressure.

Polestar has reviewed a number of PWR FSARs, and the containment pressure ratio at 24 hours (gauge pressure at 24 hours divided by the peak calculated gauge pressure) is typically about 0.3 or less. If the leak path is sufficiently restrictive so that choked flow is not occurring and the problem may be treated as incompressible flow (low Mach Number), a factor of 3.33 reduction in containment pressure will yield a reduction in volumetric flow of about 1.8 (approximately a factor of two) if the density is assumed constant. Since the containment is a closed system, the density of the non-condensables will not change during depressurization (the pressure decrease being the result of a temperature reduction) except for steam condensation. However, the steam condensation effect cannot be neglected, and the chart on the following page (Figure 1) shows the relationship of leakage fraction vs. gauge pressure for incompressible flow with the density effect taken into account.

The chart shows that for VY's peak pressure of about 44 psig (see Reference 4, Item 8.3), the factor of two reduction in volumetric leak rate is not achieved until a pressure of about 5.5 psig is attained, about a factor of eight reduction in containment pressure. Polestar believes that NRC has previously given credit for a factor of two reduction in containment leak rate at 24 hours in some BWR AST applications with apparently as little as a factor of two reduction in containment pressure (Reference 7); however, a factor of eight seems to be a more sound technical basis. VY meets this basis at approximately 24 hours since the pressure reduction for VY (with spray credit) is more than a factor of eight; i.e., it is a factor of 44/5.3 or 8.3.



Assumption 3: CAD operation is neglected. Operation of the CAD actually reduces the doses because activity is removed from the PC atmosphere (where it is vulnerable to release via RB bypass and MSIV leakage) and released via the plant stack with relatively little dose impact. CAD operation actually acts as a removal mechanism.
 Justification: This assumption was identified as a result of the independent review of this calculation and a further discussion of this point is provided in Appendix B.

Assumption 4: Iodine resuspension in the main steam lines is neglected. Justification:

## **Proprietary Material Removed**

#### **Proprietary Material Removed**

Assumption 5: Accident time = time after release + two minutes.

Justification: Unless otherwise stated, all times given in this calculation are accident times, beginning at t = 0 with the assumed DBA-LOCA leading to core damage. Even for the largest LOCA, there is a two-minute delay for BWRs between the start of the accident and the start of release.

#### References

- 1. "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors", US NRC Regulatory Guide 1.183, Revision 0, July 2000.
- 2. S. L. Humphries et al, "RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation", NUREG/CR-6604, Sandia National Laboratories, December 1997.
- 3. For calculation verification purposes only: "STARDOSE Model Report, Polestar Applied Technology, Inc., PSAT C109.03 January 1997.
- 4. PSAT 3019CF.QA.03, "Design Database for Application of the Revised DBA Source Term to Vermont Yankee", Revision 2.
- 5. VYC 2312, "VY Post-LOCA Drywell High Range Monitor Responses for Core Damage Assessment at 1912 MWt", Revision 0
- 6. PSAT 3019CF.QA.04, "DBA-LOCA pH Calculation for Vermont Yankee", Revision 0

- "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment No. 134 to Facility Operating License No. NPF-57", Docket No. 50-354, TAC No. MB1970
- 8. NUREG-0800, Standard Review Plan, Section 6.5.2

## **Design Inputs**

Design Input Data (Reference 4 for all inputs, Item numbers given in parentheses):

Power level = 1950 MWt			(Item 8.1)	
Core inventories - see Refere	(Item 1.1 – full core inver	[Item  1.1 - full core inventory at  t = 0]		
Release rates:				
Fraction of core inventory, 0	– 120 seconds:		(Item 2.1)	
No Release				
Fraction of core inventory, 12	20 – 1920 seconds:		(Item 2.2)	
Gases	Xe, Kr $- 0.1/hr$ (0.05 tot	al)		
	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)		
	$C_{s}, R_{b} - 0.1/hr$ (0.05 tot	al)		
Fraction of core inventory, 19	920 – 7320 seconds:		(Item 2.3)	
Gases	Xe, Kr $- 0.63$ /hr (0.95 to	otal)		
	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)		
	$C_{s}, R_{b} - 0.133/hr (0.2 to$	otal)		
	Te Group $- 0.033/hr (0.0)$	05 total)		
	Ba, Sr – 0.013/hr (0.02 t	otal)		
	Noble Metals – 1.7E-3/h	ur (2.5E-3 total)		
	La Group – 1.3E-4/hr (2	E-4 total)		
	Ce Group – 3.3E-4/hr (5	E-4 total)		
Volume of Drywell - 131.47	0 ft <sup>3</sup> (max), 128,370 ft <sup>3</sup> (r	nin)	(Item 3.1)	
Volume of Torus Airspace –	$103.932 \text{ ft}^3 \text{ (min)}$	)	(Item $3.2$ )	
Volume of Suppression Pool	-68.000 ft <sup>3</sup> (min), 70.00	$0 \text{ ft}^3 (\text{max})$	(Item 3.3)	
Volume of Main Condenser (	$(MC) - 107,000 \text{ ft}^3$		(Item 3.5)	
Volumetric Leak Rate from I	Drywell (not including MS	SIVs) – 0.713 cfm	(Item 3.6)	
This represents 0.8%	of the minimum DW volu	ume per day (Item 3.1).		
Volumetric Leak Rate from Torus Airspace – 0.577 cfm (Item				
This represents 0.8%	of the torus airspace volu	me per day (Item 3.2).		
Containment Leakage Bypass	sing Secondary Containm	ent – 5 scfh	(Item 3.16)	
No	t part of the 0.8% per day	containment leakage (Items	3.6 and 3.7)	
MSIV Allowable Leakage –	124 scfh total, 62 scfh ma	x for per steamline	(Item 3.17)	
3SF Leakage – 0.5 gpm analyzed as 1.0 gpm, assumed to start at t = 0 (Item 3.10)				

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Release Fraction of Radioiodine from ESF leakage – 10% DW Pressure at 24 Hours after DBA-LOCA, with Sprays – ~20 psia Secondary Containment Drawdown Time, 0 minutes with all SGTS 10 minutes with one SGTS train failed*				
*During the 10 minutes, the minutes (the Reactor Build beyond t = 10 minutes (ac	e Reactor Building pressure is actually negative for at le ding begins at a negative pressure). Positive pressure w cident time).	ast four ill not occur		
Drywell Spray Flow – 6650	gpm (one loop)	(Item 3.9)		
Drywell Radiation Level Ca	alling for Spray Initiation – 4000 R/hr	(Item 9.4)		
Spray (Drywell) Initiation 7	ime – 15 minutes, accident time*	(Item 9.1)		
*as lo	ng as drywell radiation level requiring sprays exceeded at least 10	minutes earlier		
Spray Header Characteristic	es: Header Elevation – 264'2" Header Diameter – 60.17'	(Item 9.2)		
Drywell Floor Elevation - 2	38'	(Item 10.3)		
Biological Shield Wall Dian	neter – 24'9½"	(Item 10.4)		
Nominal SGTS Single-Train	n Flow (with +/- 150 cfm) – 1500 cfm	(Item 3.14)		
Filter Efficiency – SGTS		(Item 4.2)		
For Particulate Iodin	e, Cesium and other Aerosols – 95%			
For Elemental and C	Organic Iodine – 95%			
For Noble Gases – 0	%			
MSIV Test Pressure - Great	ter than or equal to 24 psig	(Item 8.2)		
Accident Conditions to be u Pressure: 58.7 psia (	sed for SCFH to CFH conversion 44 psig)	(Item 8.3)		
Steam Line Temperature	50 E	(Itam 8 1)		
Steam Line ID 16 124"		(Item 7.2)		
Lengths of Steam Line –	All steamlines, horizontal from outboard MSIV to RB	(Item 7.2) TB		
	matchine = $20'7'' + 2'5'' - 24 1'$			
	207 + 30 = 24.1			
	$14^{\circ} - 6^{\circ} - 2^{\circ}6^{\circ} - 11^{\circ}$			
	"A" Steamline East from RB/TB matchline =			
	30' + 35' + 20' - 2'4'' - 4'8'' = 78'			
	"A" Steamline North from TB penetration =			
	3' + 3' + 3' + 21'6'' + 27'6'' + 27'6'' + 3'6'' = 89'			
	"A" Steamline South to Turbine Stops = $36$ " + $116$ " = $15$			
	Steamlines between MSIVs – estimated to be 18' (base location relative to 13' between FW isolation values)	ed on MSIV		
		(Item 7.3)		

Ratio: Main Condenser Bypass Area to Min Flow Area of Drainline Pathways – 0.008(Item 7.5) Elevation of LP Turbine/Main Condenser Bellows – 262' to 265'9" (Item 7.6)

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Elevation of Condenser Centerline – 237.47'	(Item 7.7)
Elevation of Bottom of Main Condenser Hotwell - ~223'	(Item 7.8)
Elevation of Drain Line Tap to Main Condenser – 237'1/2"	(Item 7.11)
Surface Area of Tubes in Main Condenser – 157,000 ft <sup>2</sup>	(Item 7.12)

Volume of Control Room (CR) -41,533.75 ft<sup>3</sup> (Item 3.4) Volumetric Flowrate, Environment to CR (Pre-isolation Fresh Air Intake, Unfiltered) - 3700 cfm Environment to CR (Post-Isolation, Unfiltered) – 3700 cfm (Items 3.8/3.18) Time to Isolate CR Ventilation for DBA-LOCA - N/A\*\* (Item 9.3)

X/Q values in sec/m <sup>3</sup> :							
Building	0-2 hr	0-1 hr	1-2 hr	2-8 hr	8-24 hr	1-4 day	4-30 day
Releases							
EAB ground	1.7 E-3 for TB			N/A	N/A	N/A	N/A
(Item 5.1)	1.476E-3 for RB						
EAB stack	Fumigation:			N/A	N/A	N/A	N/A
(Item 5.1)	2.03E-4 (0.5 hr)						
	Normal:						
	1.54E-4 (0.5 hr)						
	9.17E-5 (1.0 hr)						
LPZ ground		2.74E-5	1.75E-5	8.01E-6	1.00E-6	5.80E-7	3.37E-7
(Item 5.2)		TB↑RB↓	TB↑RB↓	TB↑RB↓	TB↑RB↓	TB↑RB↓	TB↑RB↓
		5.253E-5	5.253E-5	2.227E-5	1.469E-5	5.948E-6	1.625E-6
LPZ stack		2.55E-5	1.87E-5	1.01E-5	1.09E-6	6.90E-7	4.61E-7
(Item 5.2)							
Control		4.66E-3	4.66E-3	3.46E-3	1.45E-3	1.09E-3	9.92E-4
Room ground		TB↑RB↓	TB↑RB↓	TB↑RB↓	TB↑RB↓	TB↑RB↓	TB†RB↓
(Item 5.3)		2.25E-3 <sup>#</sup>	2.25E-3	8.18E-4	3.53E-4	2.77E-4	2.23E-4
Control	Fumigation:			8.28E-7	3.36E-7	3.08E-7	1.79E-7
Room stack	1.92E-5 (0.5 hr)						
(Item 5.3)	Normal:						
	1.92E-5 (0.5 hr)						
	1.92E-5 (1.0 hr)						

This is for the N<sub>2</sub> system sustained bypass. For short-term drawdown bypass, use 2.98E-3

Control Room breathing rates in  $m^3/s$  (Item 5.4): 0-30 days 3.5E-4 EAB & LPZ breathing rates in  $m^3/s$  (Item 5.4): 0-8 hr 3.5E-4 1-4 days 1.8E-4 4-30 days 2.3E-4 Control Room occupancy factors (Item 5.5): 0-24 hours 1.0 1-4 days 0.6 4-30 days 0.4

\*\*Transition to isolated condition not credited

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Dose Conversion Factors: Default FGR11&12.INP file from Reference 2

#### Calculation

As previously described, the three cases included in the overall RADTRAD model are the RB bypass (two releases directly from the PC to the environment), the RB releases via the SGTS and the plant stack (including ESF leakage), and MSIV leakage (via the main steam lines employing an Alternative Leakage Treatment or ALT scheme to collect MSIV leakage and direct it to the main condenser). The RADTRAD model is shown on Figure 2.



Figure 2 – RADTRAD Model

Case 1 – Leakage from Primary Containment Directly to the Environment (Bypass Pathway)

This is the first pathway that makes a significant contribution to the DBA-LOCA doses. There are two components of this pathway. The first is pre-drawdown PC leakage (0.8 %/day). This is leakage from the PC that occurs prior to establishing a sustained negative pressure in the SC; and, therefore, it is assumed to leak directly to the environment from the refueling elevation via sheet-metal siding.

The second component is the nitrogen supply which penetrates the PC and then penetrates the RB on the RB's south side. Leakage from the PC through this system's closed containment

isolation valves (CIVs) could bypass the SC and the SGTS filters and could also result in a ground-level release.

#### **Pathway Assumptions**

The drawdown bypass occurs during the first 10 minutes of the DBA-LOCA, accident time. Even though there is a period during this 10 minutes when the RB pressure is actually subatmospheric, the full 10 minutes is used.

The release from the core is assumed to enter the drywell only. Mixing within the entire PC is not assumed to occur until after the end of the release (see Assumption 2).

No credit is taken for natural deposition in the drywell during the drawdown period; credit for drywell deposition does not begin until drywell sprays start at t = 15 minutes. Nor is any credit for deposition taken in the unspecified leak path(s) that lead to this bypass.

The sustained bypass through the nitrogen system is treated very conservatively. No credit is taken for deposition in piping or components (either inside or outside the PC), and this includes the nitrogen heater. Both this release and the drawdown bypass are assumed to be released at ground level.

The drawdown bypass corresponds to the PC leak rate of 0.8 %/day. The sustained bypass via the nitrogen supply pathway has an assumed leak rate of 5 scfh which (using the same conversion as that of Appendix A for the maximum per line MSIV leak rate of 62 scfh) is 5 x (23/62) = 1.85 cfh = 0.031 cfm. For the minimum drywell volume of 1.284E5 ft<sup>3</sup>, this is 0.035 %/day. After the PC is assumed to become well-mixed at the end of the release (2.033 hours), this changes to 0.019 %/day. Finally, beyond 24 hours, this leak rate becomes 0.010 %/day (see Assumption 2).

For this case, the two parallel main steam line flowpaths to the ALT volume (see Appendix A for definition and discussion) are included in the model as well as the pathway to the RB. These are discussed in more detail for the MSIV leakage pathway RADTRAD model and the RB/SGTS/plant stack pathway RADTRAD model, respectively. They are included in this model only so that the associated leakage out of the PC is properly accounted for.

#### **RADTRAD Analysis**

The 60 radionuclides in the default RADTRAD .nif file are used; however, the file is modified to include the core inventories from Reference 4.

Nuclear Information File

Nuclide Inventory Name: VY general 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 0.0000E+00 none 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
 none 0.0000E+00 Nuclide 003: Kr-85 1 0.3382974720E+09 0.8500E+02 5.05E+02 none 0.0000E+00 0.0000E+00 none none 0.0000E+00 Nuclide 004: Kr-85m 1 0.1612800000E+05 0.8500E+02 9.71E+03 Kr-85 0.2100E+00 none 0.0000E+00 0.0000E+00 none Nuclide 005: Kr-87 1 0.457800000E+04 0.8700E+02 1.94E+04 Rb-87 0.1000E+01 none 0.0000E+00 none 0.0000E+00 Nuclide 006: Kr-88 1 0.1022400000E+05 0.8800E+02 2.75E+04 Rb-88 0.1000E+01 none 0.0000E+00 none 0.0000E+00 Nuclide 007: Rb-86 3 0.1612224000E+07 0.8600E+02

1.28E+02

```
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```

0.0000E+00 none none 0.0000E+00 none 0.0000E+00 Nuclide 008: Sr-89 5 0.4363200000E+07 0.8900E+02 3.45E+04 none 0.0000E+00 none 0.0000E+00 none 0.0000E+00 Nuclide 009: Sr-90 5 0.9189573120E+09 0.9000E+02 4.10E+03 Y-90 0.1000E+01 0.0000E+00 none none 0.0000E+00 Nuclide 010: Sr-91 5 0.342000000E+05 0.9100E+02 4.45E+04 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 4.61E+04 Y-92 0.1000E+01 none 0.0000E+00 none 0.0000E+00 Nuclide 012: Y-90 9 0.2304000000E+06 0.9000E+02 4.29E+03 0.0000E+00 none none 0.0000E+00 none 0.0000E+00 Nuclide 013: Y-91 9 0.5055264000E+07 0.9100E+02 4.24E+04 none 0.0000E+00 none 0.0000E+00 0.0000E+00 none Nuclide 014: Y-92 9 0.1274400000E+05

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0.9200E+02 4.62E+04 none 0.0000E+00 0.0000E+00 none 0.0000E+00 none Nuclide 015: **Y-93** 9 0.3636000000E+05 0.9300E+02 5.05E+04 Zr-93 0.1000E+01 none 0.0000E+00 none 0.0000E+00 Nuclide 016: Zr-95 9 0.5527872000E+07 0.9500E+02 4.95E+04 Nb-95m 0.7000E-02 Nb-95 0.9900E+00 0.0000E+00 none Nuclide 017: Zr-97 9 0.6084000000E+05 0.9700E+02 4.92E+04 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 4.96E+04 0.0000E+00 none none 0.0000E+00 none 0.0000E+00 Nuclide 019: Mo-99 7 0.2376000000E+06 0.9900E+02 5.30E+04 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 4.64E+04 Tc-99 0.1000E+01 none 0.0000E+00 none 0.0000E+00 Nuclide 021: Ru-103

7 0.3393792000E+07 0.1030E+03 5.07E+04 Rh-103m 0.1000E+01 none 0.0000E+00 none 0.0000E+00 Nuclide 022: Ru-105 7 0.1598400000E+05 0.1050E+03 4.02E+04 Rh-105 0.1000E+01 none 0.0000E+00 0.0000E+00 none Nuclide 023: Ru-106 7 0.3181248000E+08 0.1060E+03 2.85E+04 Rh-106 0.1000E+01 none 0.0000E+00 none 0.0000E+00 Nuclide 024: Rh-105 7 0.1272960000E+06 0.1050E+03 3.68E+04 none 0.0000E+00 0.0000E+00 0.0000E+00 none none Nuclide 025: Sb-127 4 0.3326400000E+06 0.1270E+03 3.69E+03 Te-127m 0.1800E+00 Te-127 0.8200E+00 0.0000E+00 none Nuclide 026: Sb-129 4 0.1555200000E+05 0.1290E+03 1.01E+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 3.67E+03 none 0.0000E+00 0.0000E+00 none

none 0.0000E+00 Nuclide 028: Te-127m 4 0.9417600000E+07 0.1270E+03 4.98E+02 Te-127 0.9800E+00 none 0.0000E+00 none 0.0000E+00 Nuclide 029: Te-129 4 0.417600000E+04 0.1290E+03 9.98E+03 I-129 0.1000E+01 none 0.0000E+00 none 0.0000E+00 Nuclide 030: Te-129m 4 0.2903040000E+07 0.1290E+03 1.48E+03 Te-129 0.6500E+00 0.3500E+00 I-129 none 0.0000E+00 Nuclide 031: Te-131m 4 0.108000000E+06 0.1310E+03 4.31E+03 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 3.97E+04 I-132 0.1000E+01 none 0.0000E+00 none 0.0000E+00 Nuclide 033: I-131 2 0.6946560000E+06 0.1310E+03 2.85E+04 Xe-131m 0.1100E-01 0.0000E+00 none none 0.0000E+00 Nuclide 034: I-132 2 0.828000000E+04 0.1320E+03

4.05E+04

none 0.0000E+00 none 0.0000E+00 0.0000E+00 none Nuclide 035: I-133 2 0.7488000000E+05 0.1330E+03 5.79E+04 Xe-133m 0.2900E-01 Xe-133 0.9700E+00 0.0000E+00 none Nuclide 036: I-134 2 0.315600000E+04 0.1340E+03 6.43E+04 none 0.0000E+00 0.0000E+00 none 0.0000E+00 none Nuclide 037: I-135 2 0.2379600000E+05 0.1350E+03 5.39E+04 Xe-135m 0.1500E+00 Xe-135 0.8500E+00 0.0000E+00 none Nuclide 038: Xe-133 1 0.4531680000E+06 0.1330E+03 5.78E+04 none 0.0000E+00 0.0000E+00 none 0.0000E+00 none Nuclide 039: Xe-135 1 0.3272400000E+05 0.1350E+03 2.33E+04 Cs-135 0.1000E+01 0.0000E+00 none 0.0000E+00 none Nuclide 040: Cs-134 3 0.6507177120E+08 0.1340E+03 1.52E+04 none 0.0000E+00 none 0.0000E+00 none 0.0000E+00 Nuclide 041: Cs-136 3

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0.1131840000E+07 0.1360E+03 3.90E+03 0.0000E+00 none 0.0000E+00 0.0000E+00 none none Nuclide 042: Cs-137 3 0.9467280000E+09 0.1370E+03 6.08E+03 Ba-137m 0.9500E+00 none 0.0000E+00 0.0000E+00 none Nuclide 043: Ba-139 6 0.496200000E+04 0.1390E+03 5.35E+04 none 0.0000E+00 none 0.0000E+00 0.0000E+00 none Nuclide 044: Ba-140 6 0.1100736000E+07 0.1400E+03 5.15E+04 La-140 0.1000E+01 none 0.0000E+00 none 0.0000E+00 Nuclide 045: La-140 9 0.1449792000E+06 0.1400E+03 5.17E+04 none 0.0000E+00 0.0000E+00 none 0.0000E+00 none Nuclide 046: La-141 9 0.1414800000E+05 0.1410E+03 4.91E+04 Ce-141 0.1000E+01 none 0.0000E+00 0.0000E+00 none Nuclide 047: La-142 9 0.555000000E+04 0.1420E+03 4.81E+04 none 0.0000E+00 none 0.0000E+00 0.0000E+00 none Nuclide 048:

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Ce-141 8 0.2808086400E+07 0.1410E+03 4.75E+04 none 0.0000E+00 none 0.0000E+00 none 0.0000E+00 Nuclide 049: Ce-143 8 0.1188000000E+06 0.1430E+03 4.73E+04 Pr-143 0.1000E+01 none 0.0000E+00 0.0000E+00 none Nuclide 050: Ce-144 8 0.2456352000E+08 0.1440E+03 3.73E+04 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 4.71B+04 none 0.0000E+00 0.0000E+00 none none 0.0000E+00 Nuclide 052: Nd-147 9 0.9486720000E+06 0.1470E+03 1.92E+04 Pm-147 0.1000E+01 none 0.0000E+00 none 0.0000E+00 Nuclide 053: Np-239 8 0.2034720000E+06 0.2390E+03 7.67E+05 Pu-239 0.1000E+01 none 0.0000E+00 0.0000E+00 none Nuclide 054: Pu-238 8 0.2768863824E+10 0.2380E+03 3.93E+02 U-234 0.1000E+01 none 0.0000E+00

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none 0.0000E+00 Nuclide 055: Pu-239 8 0.7594336440E+12 0.2390E+03 1.47E+01 U-235 0.1000E+01 none 0.0000E+00 none 0.0000E+00 Nuclide 056: Pu-240 8 0.2062920312E+12 0.2400E+03 3.11E+01 U-236 0.1000E+01 none 0.0000E+00 none 0.0000E+00 Nuclide 057: Pu-241 8 0.4544294400E+09 0.2410E+03 6.57E+03 U-237 0.2400E-04 Am-241 0.1000E+01 0.0000E+00 none Nuclide 058: Am-241 9 0.1363919472E+11 0.2410E+03 8.73E+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 3.42E+03 Pu-238 0.1000E+01 none 0.0000E+00 Nuclide 060: Cm-244 9 0.5715081360E+09 0.2440E+03 1.21E+03 Pu-240 0.1000E+01 0.0000E+00 none 0.0000E+00 none End of Nuclear Inventory File

The standard BWR DBA-LOCA release fraction and timing file is used.

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## **Release Fraction and Timing File**

Release Fract:	Release Fraction and Timing Name:					
BWR, NUREG-14	465, Tables	3.11 & 3.13,	June 1992			
Duration (h)	: Design Ba	asis Accident	t			
0.5000E+00	0.1500E+01	0.0000E+00	0.0000E+00			
Noble Gases:						
0.5000E-01	0.9500E+00	0.0000E+00	0.0000E+00			
Iodine:						
0.5000E-01	0.2500E+00	0.0000E+00	0.0000E+00			
Cesium:						
0.5000E-01	0.2000E+00	0.0000E+00	0.0000E+00			
Tellurium:						
0.0000E+00	0.0500E+00	0.0000E+00	0.0000E+00			
Strontium:						
0.0000E+00	0.2000E-01	0.0000E+00	0.0000E+00			
Barium: .						
0.0000E+00	0.2000E-01	0.0000E+00	0.0000E+00			
Ruthenium:						
0.0000E+00	0.2500E-02	0.0000E+00	0.0000E+00			
Cerium:						
0.0000E+00	0.5000E-03	0.0000E+00	0.0000E+00			
Lanthanum:						
0.0000E+00	0.2000E-03	0.0000E+00	0.0000E+00			
Non-Radioactive Aerosols (kg):						
0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00			
End of Release File						

The following description of the drywell spray removal rate development applies to both the MSIV leakage pathway and the RB/SGTS/plant stack pathway, as well as to the RB bypass leakage pathway described above.

## **Proprietary Material Removed**

# Proprietary Material Removed

The .psf file for the RB bypass pathways is shown below.

```
Plant and Scenario File
```

```
Radtrad 3.02 1/5/2000
Bypass
Nuclide Inventory File:
c:\polestar\vy\loca ast\vygeneral.nif
Plant Power Level:
  1.9500E+03
 Compartments:
   8
Compartment 1:
Drywell
  3
  1.2840E+05
  1
   0
   0
   0
   0
Compartment 2:
DWandWW
  3
 2.3230E+05
  1
  0
  0
  0
  0
Compartment 3:
RB
  3
 1.5000E+03
  0
  0
  0
  0
  0
Compartment 4:
ALT
  3
 1.3170E+03
  0
  0
  0
  0
  0
Compartment 5:
MC
  3
 1.0700E+05
  0
  0
  0
  0
  0
Compartment 6:
Pool
  3
```

```
PSAT 3019CF.QA.08
```

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```
6.8000E+04
  0
  0
  0
  0
  0
Compartment 7:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Compartment 8:
Control-Room
  1
 4.1530E+04
  0
  0
  0
  0
  0
Pathways:
 12
Pathway 1:
Drywell to Environment
  1
  7
  4
Pathway 2:
Drywell to RB
  1
  3
  4
Pathway 3:
Drywell to ALT - SL 1
  1
  4
  4
Pathway 4:
Drywell to ALT - SL 2
  1
  4
  4
Pathway 5:
Pool to RB
  6
  3
  2
Pathway 6:
ALT to MC
  4
  5
  1
Pathway 7:
DWandWW to Environment
 2
  7
  4
```

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```
Pathway 8:
DWandWW to RB
  2
  3
  4
Pathway 9:
DWandWW to ALT - SL 1
  2
  4
  4
Pathway 10:
DWandWW to ALT - SL 2
  2
  4
  4
Pathway 11:
Environment to Control-Room
  7
  8
  2
Pathway 12:
Control-Room to Environment
  8
  7
  4
End of Plant Model File
Scenario Description Name:
Plant Model Filename:
Source Term:
  3
      1.0000E+00
  1
  2
      1.0000E+00
  6
    1.0000E+00
c:\polestar\vy\loca ast\fgr11&12.inp
c:\polestar\vy\loca ast\bwr dba.rft
  3.3300E-02
 1
  9.5000E-01
              4.8500E-02 1.5000E-03
                                          1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  8
Compartment 1:
 0
 1
 1
 0.0000E+00
 3
 3.3300E-02
              0.0000E+00
 2.5000E-01
              2.0000E+01
 2.0333E+00
              0.0000E+00
 1
 0.0000E+00
 3
```

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```
3.3300E-02
                 0.0000E+00
   2.5000E-01
                 2.0000E+01
   2.0333E+00
                 0.0000E+00
   1
   0.0000E+00
   0
   0
   0
   0
   0
Compartment 2:
  0
  1
  1
  0.0000E+00
  5
  3.3300E-02
                0.0000E+00
  2.5000E-01
                2.0000E+01
  2.0333E+00
                1.1300E+01
  2.0677E+00
                1.1300E+00
  7.2000E+02
                0.0000E+00
  1
  0.0000E+00
  5
  3.3300E-02
                0.0000E+00
  2.5000E-01
                2.0000E+01
  2.0333E+00
                1.1300E+01
  2.0677E+00
                1.1300E+00
  7.2000E+02
                0.0000E+00
  1
  0.0000E+00
  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
```

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3.3300E-02 0.0000E+00 1.6700E-01 8.0000E-01 2.0333E+00 0.0000E+00 Pathway 3: 3.3300E-02 4.3300E-01 2.0333E+00 0.0000E+00 Pathway 4: 3.3300E-02 4.3300E-01 2.0333E+00 0.0000E+00 Pathway 5: 3.3300E-02 1.3400E-01 9.4740E+01 0.0000E+00 0.0000E+00 7.2000E+02 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 Pathway 6: 

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1		
3 33008-02	5 60008+00	2 91005.00
2.4000E+01	5.6000E+00	1.9600E+00
7.2000E+02	1.0000E+00	0.0000E+00
1		
3		
3.3300E-02	2.4000E+00	3.9100E+00
2.4000E+01	2.4000E+00	1.9600E+00
1.20006+02	1.00006+00	0.0000E+00
3		
3.3300E-02	1.0000E+00	3.9100E+00
2.4000E+01	1.0000E+00	1.9600E+00
7.2000E+02	1.0000E+00	0.0000E+00
0		
0		
U		
0		
0		•
õ		
Pathway 7:		
0		
0		
0		
0		
0		
0		
õ		
0		
0		
1		
4	0.00000.00	
2 0333F±00	1 9000E+00	
2.4000E+01	1.0000E~02	
7.2000E+02	0.0000E+00	
0		
Pathway 8:		
0		
0		
0		
0		
0		
0		
0		
0		
0		
1 A		
	0.00008+00	
2.0333E+00	8.0000E-01	
2.4000E+01	4.0000E-01	,
7.2000E+02	0.0000E+00	
0		
Pathway 9:		
U		
v		

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0 0 0				
0 0 0				
0 1 . 4				· · · 2
3.3300E-02 2.0333E+00 2.4000E+01 7.2000E+02	0.0000E+00 2.3900E-01 1.2000E-01 0.0000E+00			
0 Pathway 10: 0 0 0				
0 0 0 0				
0 0 1 4				
3.3300E-02 2.0333E+00 2.4000E+01 7.2000E+02	0.0000E+00 2.3900E-01 1.2000E-01 0.0000E+00			
0 Pathway 11: 0 0 0 0 1				
2 3.3300E-02 7.2000E+02 0 0 0 0	3.7000E+03 0.0000E+00	0.0000E+00 0.0000E+00	0.0000E+00 0.0000E+00	0.0000E+00 0.0000E+00
0 0 Pathway 12: 0 0				
0 0 0 0				
0 0 0 1				

1 3.3300E-02 1.2830E+04 0 Dose Locations: 3 Location 1: Control Room 8 0 1 2 3.3300E-02 3.5000E-04 7.2000E+02 0.0000E+00 1 4 3.3300E-02 1.0000E+00 6.0000E-01 2.4000E+01 9.6000E+01 4.0000E-01 7.2000E+02 0.0000E+00 Location 2: EAB 7 1 3 3.3300E-02 1.4760E-03 2.4000E+01 0.0000E+00 7.2000E+02 0.0000E+00 1 4 3.3300E-02 3.5000E-04 8.0333E+00 1.8000E-04 2.4000E+01 2.3000E-04 7.2000E+02 0.0000E+00 0 Location 3:  $\mathbf{LPZ}$ 7 1 6 3.3300E-02 5.2530E-05 2.0333E+00 2.2270E-05 8.0333E+00 1.4690E-05 2.4000E+01 5.9480E-06 9.6000E+01 1.6250E-06 7.2000E+02 0.0000E+00 1 4 3.3300E-02 3.5000E-04 8.0333E+00 1.8000E-04 2.4000E+01 2.3000E-04 7.2000E+02 0.0000E+00 0 Effective Volume Location: 1 7 3.3300E-02 2.9500E-03 1.6700E-01 2.2500E-03 2.0333E+00 8.1800E-04 8.0333E+00 3.5300E-04 2.4000E+01 2.7700E-04 9.6000E+01 2.2300E-04

```
7.2000E+02 0.0000E+00
Simulation Parameters:
1
3.3300E-02 0.0000E+00
Output Filename:
C:\Polestar\vy\loca ast\CaseLOCABypassOK.o0
1
1
1
0
0
0
End of Scenario File
```

Note that the CR X/Q from 0.0333 hours to the end of drawdown (0.167 hours) is a weighted average of 2.98 sec/m<sup>3</sup> for the RB siding release and 2.25E-03 sec/m<sup>3</sup> for the release through the N<sub>2</sub> supply. The worst two-hour EAB dose interval for this pathway begins at t = 0.00333 hours.

#### **Single-Failure Considerations**

If there is not a single-failure of a SGTS train, there will not be a positive pressure period for the RB and there will not be any drawdown bypass. There will continue to be a RB bypass associated with the nitrogen system. To analyze this event, it is only necessary to change the first two junctions as follows and to dispense with the weighted average CR X/Q for the bypass pathways during the drawdown period (i.e., to use only the X/Q for the N<sub>2</sub> supply):

```
Pathway 1:
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   1
   2
   3.3300E-02
                3.5000E-02
   2.0333E+00
                 0.0000E+00
 Pathway 2:
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   1
   2
   3.3300E-02 8.0000E-01
   2.0333E+00 0.0000E+00
   0
```

Case 2 – Leakage from Primary Containment to the Environment via the Reactor Building, SGTS, and Plant Stack (RB/SGTS/Plant Stack Pathway)

For this pathway, a single junction is provided from the "Drywell" control volume (before 2.033 hours) and a single junction is provided from the "DW and WW" control volume (after 2.033 hours) to represent the 0.8 %/day PC leakage to the RB. Added to this is the ESF leakage which is modeled as a continuous 1 gpm (0.134 cfm) volumentric flow from the "Pool" control volume to the RB.

## Pathway Assumptions

Airborne releases from the PC to the RB begin after the drawdown period. ESF leakage is assumed to begin immediately.

Since the "Pool" control volume receives the full release in parallel with the "Drywell" and the "DW and WW" control volumes, five percent of the iodine (total) is in elemental and organic form. If the particulate were filtered out entirely in the junction from the "Pool" to the RB, only 5% of the iodine would be released to the RB. Ten percent is required. Therefore, the particulate filter is set at 94.74% permitting another 5% of the iodine to become airborne. This iodine does not have the correct chemical form; but since the SGTS filter efficiencies are all 95% and since the CR has no incoming air filtration, the dose calculation for radioiodine is correct.

This approach to ESF leakage also "inadvertently" permits 100% of the noble gas and slightly more than five percent of the particulate in the one gpm "Pool" control volume leakage to be released to the RB along with the intended 10% of the radioiodine. This is conservative.

The RB releases its activity to the environment through the SGTS filters and the plant stack. The RB volume is set numerically (and artificially) equal to the nominal SGTS flow rate (in cfm). This provides essentially zero holdup for the RB.

## **RADTRAD Analysis**

The 60 radionuclides in the default RADTRAD .nif file are used; however, the file is modified to include the core inventories from Reference 4. The .nif file used to analyze this pathway is identical to that used for the bypass pathway model discussed above.

The standard BWR DBA-LOCA release fraction and timing file is used. It is identical to that used for the bypass pathway model discussed above.

Plant and Scenario Files

```
Radtrad 3.02 1/5/2000
RB
Nuclide Inventory File:
c:\polestar\vy\loca ast\vygeneral.nif
Plant Power Level:
```

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1.9500E+03 Compartments: 8 Compartment 1: Drywell 3 1.2840E+05 1 0 0 0 0 Compartment 2: DWandWW 3 2.3230E+05 1 0 0 0 0 Compartment 3: RB 3 1.5000E+03 0 0 0 0 0 Compartment 4: ALT 3 1.3170E+03 0 0 0 0 0 Compartment 5: MC 3 1.0700E+05 0 0 0 0 0 Compartment 6: Pool 3 6.8000E+04 0 0 0 0 0 Compartment 7: Environment 2 0.0000E+00
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```
0
  0
  0
  0
  0
Compartment 8:
Control-Room
  1
 4.1530E+04
  0
  0
  0
  0
  0
Pathways:
 11
Pathway 1:
Drywell to RB
  1
  3
  4
Pathway 2:
Drywell to ALT - SL 1
  1
  4
  4
Pathway 3:
Drywell to ALT - SL 2
  1
  4
  4
Pathway 4:
Pool to RB
  6
  3
  2
Pathway 5:
ALT to MC
  4
  5
  1
Pathway 6:
DWandWW to RB
  2
  3
  4
Pathway 7:
DWandWW to ALT - SL 1
  2
  4
  4
Pathway 8:
DWandWW to ALT - SL 2
  2
  4
  4
Pathway 9:
RB to Environment
  3
  7
  2
```

```
Pathway 10:
Environment to Control-Room
  7
  8
  2
Pathway 11:
Control-Room to Environment
  8
  7
  4
End of Plant Model File
Scenario Description Name:
Plant Model Filename:
Source Term:
  3
  1
      1.0000E+00
  2
      1.0000E+00
  6
      1.0000E+00
c:\polestar\vy\loca ast\fgr11&12.inp
c:\polestar\vy\loca ast\bwr_dba.rft
  3.3300E-02
  1
  9.5000E-01 4.8500E-02
                            1.5000E-03
                                          1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  8
Compartment 1:
  0
  1
  1
  0.0000E+00
 3
               0.0000E+00
 3.3300E-02
 2.5000E-01
             2.0000E+01
 2.0333E+00
               0.0000E+00
 1
 0.0000E+00
 3
 3.3300E-02
               0.0000E+00
 2.5000E-01
               2.0000E+01
 2.0333E+00
               0.0000E+00
 1
 0.0000E+00
 0
 0
 0
 0
  0
Compartment 2:
 0
 1
 1
 0.0000E+00
```

```
5
                0.0000E+00
  3.3300E-02
  2.5000E-01
                2.0000E+01
  2.0333E+00
                1.1300E+01
  2.0677E+00
                1.1300E+00
  7.2000E+02
                0.0000E+00
  1
  0.0000E+00
  5
  3.3300E-02
                0.0000E+00
  2.5000E-01
                2.0000E+01
  2.0333E+00
                1.1300E+01
  2.0677E+00
                1.1300E+00
  7.2000E+02
                0.0000E+00
  1
  0.0000E+00
  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
```

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0 0 0 ٥ 0 1 2 3.3300E-02 4.3300E-01 2.0333E+00 0.0000E+00 0 Pathway 4: 0 0 0 ۵ 0 1 2 3.3300E-02 1.3400E-01 9.4740E+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 5: 0 0 1 3 3.3300E-02 5.6000E+00 3.9100E+00 2.4000E+01 5.6000E+00 1.9600E+00 7.2000E+02 1.0000E+00 0.0000E+00 1 3 3.3300E-02 2.4000E+00 3.9100E+00 2.4000E+01 2.4000E+00 1.9600E+00 7.2000E+02 1.0000E+00 0.0000E+00 1 3 3.3300E-02 1.0000E+00 3.9100E+00 2.4000E+01 1.0000E+00 1.9600E+00 7.2000E+02 1.0000E+00 0.0000E+00 0 0 0 0 0 0 0 Pathway 6: 0 0 0 0 0 0 0 0 0

```
0
  1
  4
  3.3300E-02
               0.0000E+00
  2.0333E+00
               8.0000E-01
               4.0000E-01
  2.4000E+01
  7.2000E+02
               0.0000E+00
  0
Pathway 7:
  0
  0
  0
  0
  0
  0
  0
  0
  0
  0
  1
  4
  3.3300E-02
               0.0000E+00
  2.0333E+00
               2.3900E-01
  2.4000E+01
               1.2000E-01
  7.2000E+02
               0.0000E+00
  0
Pathway 8:
  0
  0
  0
  0
  0
  0
  0
  0
  0
  0
  1
  4
 3.3300E-02
               0.0000E+00
 2.0333E+00
               2.3900E-01
 2.4000E+01
               1.2000E-01
  7.2000E+02
               0.0000E+00
  0
Pathway 9:
 0
  0
  0
  0
  0
  1
 2
                             9.5000E+01
                                          9.5000E+01
                                                        9.5000E+01
 3.3300E-02
               1.5000E+03
                                                        0.0000E+00
 7.2000E+02
               0.0000E+00
                             0.0000E+00
                                          0.0000E+00
 0
 0
 0
 0
  0
  0
Pathway 10:
```

```
PSAT 3019CF.QA.08
```

0

0 0 0 0 1 2 3.3300E-02 3.7000E+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 11: 0 0 0 0 0 0 0 0 0 0 1 1 3.3300E-02 1.2830E+04 0 Dose Locations: 3 Location 1: Control Room 8 0 1 2 3.5000E-04 3.3300E-02 7.2000E+02 0.0000E+00 1 4 3.3300E-02 1.0000E+00 2.4000E+01 6.0000E-01 4.0000E-01 9.6000E+01 7.2000E+02 0.0000E+00 Location 2: EAB 7 1 6 3.3300E-02 0.0000E+00 1.3000E+00 2.0300E-04 1.8000E+00 1.5400E-04 2.3000E+00 9.1700E-05 3.3000E+00 0.0000E+00 7.2000E+02 0.0000E+00 1 4 3.3300E-02 3.5000E-04 8.0333E+00 1.8000E-04

```
2.4000E+01
               2.3000E-04
  7.2000E+02 0.0000E+00
Location 3:
LPZ
  7
  1
  8
  3.3300E-02 1.0100E-05
  1.3000E+00
               2.5500E-05
  2.3000E+00 1.8700E-05
  3.3000E+00 1.0100E-05
  8.0333E+00 1.0900E-06
  2.4000E+01 6.9000E-07
9.6000E+01 4.6100E-07
  7.2000E+02 0.0000E+00
  1
  4
  3.3300E-02 3.5000E-04
  8.0333E+00 1.8000E-04
  2.4000E+01 2.3000E-04
  7.2000E+02 0.0000E+00
Effective Volume Location:
  1
  7
  3.3300E-02 8.2800E-07
  1.3000E+00 1.9200E-05
 3.3000E+00 8.2800E-07
 8.0333E+00 3.3600E-07
 2.4000E+01 3.0800E-07
  9.6000E+01 1.7900E-07
  7.2000E+02 0.0000E+00
Simulation Parameters:
  1
  3.3300E-02
              0.0000E+00
Output Filename:
C:\Polestar\vy\loca ast\CaseLOCARBOK.o0
  1
  1
  1
  0
  0
End of Scenario File
```

Note that for this file, the X/Qs are shifted from those in the Design Inputs section. This is because the worst two-hour EAB dose was identified as being from 1.3 hours to 3.3 hours (using a constant X/Q); and therefore, the X/Qs for all pathways were adjusted to place the highest value at 1.3 hours.

#### Single Failure Considerations

If there is not a single-failure of a SGTS train, there will not be a positive pressure period for the RB, and there will not be any drawdown bypass. To analyze this event, it is only necessary to change the first junction as follows:

```
Pathway 1:
0
```

# Case 3 – Leakage from Primary Containment to the Environment via the Main Steam Lines and the Main Condenser (MSIV Pathway)

For this pathway, two junctions are provided from the "Drywell" control volume and two from the "DW and WW" control volume to represent the two leaking steam lines. These junctions all terminate in the "ALT" control volume. The "ALT" control volume represents the isolated main steam lines out to the turbine stop valves. This control volume can leak directly to the environment (representing main condenser bypass), and it can leak to the main condenser (drain line connection). The main condenser can then leak to the environment.

The RADTRAD model for this pathway also includes leakage from the PC to the RB so that the PC activities are determined correctly. However, no leakage to the environment is permitted other than that through the MSIVs. Drywell sprays are modeled in an identical manner to that described for the bypass pathways above.

#### Pathway Assumptions

The details for developing the RADTRAD modeling of the MSIV leakage pathway are covered in Appendix A. The removal efficiency summary is as follows:

	Aerosol Removal Efficiency	Elem Iodine Removal Efficiency
Steam Lines*, 62 scfh/Line	38%	Assumed Negligible
Same, One MSIV Failed	0%	0%
ALT Volume**	71%	58%
Same, One MSIV Failed	Assumed No Change	Assumed No Change
Combined SL and ALT	82%	58%
Same, One MSIV Failed	77%	Assumed No Change
Main Condenser	95.1%	99.8%

\*Between MSIVs

\*\*Remainder of steam lines up to turbine stop valves

Note that Appendix A does not address the factor of two reduction in MSIV (and other) leak rates that is assumed to occur at 24 hours (see Assumption 2). Even though this reduction in MSIV leak rate would increase the filtration efficiencies, that benefit is conservatively omitted.

# **RADTRAD Analysis**

The 60 radionuclides in the default RADTRAD .nif file are used; however, the file is modified to include the core inventories from Reference 4. The .nif file used to analyze this pathway is identical to that used for the bypass pathway model discussed above.

The standard BWR DBA-LOCA release fraction and timing file is used. It is identical to that used for the bypass pathway model discussed above.

Plant and Scenario Files

```
Radtrad 3.02 1/5/2000
MSIV
Nuclide Inventory File:
 c:\polestar\vy\loca ast\vygeneral.nif
 Plant Power Level:
  1.9500E+03
 Compartments:
   8
 Compartment 1:
Drywell
   3
  1.2840E+05
   1
   0
   0
   0
   0
Compartment 2:
DWandWW
  3
  2.3230E+05
   1
   0
   0
   0
   Δ
Compartment 3:
RB
   3
  1.5000E+03
   0
   0
   0
   0
   0
Compartment 4:
ALT
   3
  1.3170E+03
   0
   0
   0
   0
   0
Compartment 5:
```

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```
MC
  3
 1.0700E+05
  0
  0
  0
  0
  0
Compartment 6:
Pool
 3
 6.8000E+04
  0
  0
  0
  0
  0
Compartment 7:
Environment
 2
 0.0000E+00
  0
  0
  0
  0
  0
Compartment 8:
Control-Room
  1
 4.1530E+04
  0
  0
  0
  0
  0
Pathways:
12
Pathway 1:
Drywell to RB
  1
  3
  4
Pathway 2:
Drywell to ALT - SL 1
  1
  4
  4
Pathway 3:
Drywell to ALT - SL 2
  1
  4
 4
Pathway 4:
Pool to RB
  6
  3
  2
Pathway 5:
ALT to MC
  4
  5
```

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```
1
Pathway 6:
ALT to Environment
  4
  7
  1
Pathway 7:
DWandWW to RB
  2
  3
  4
Pathway 8:
DWandWW to ALT - SL 1
  2
  4
  4
Pathway 9:
DWandWW to ALT - SL 2
  2
  4
  4
Pathway 10:
MC to Environment
  5
  7
  2
Pathway 11:
Environment to Control-Room
  7
  8
  2
Pathway 12:
Control-Room to Environment
  8
  7
  4
End of Plant Model File
Scenario Description Name:
Plant Model Filename:
Source Term:
 3
  1
      1.0000E+00
 2
      1.0000E+00
    1.0000E+00
  6
c:\polestar\vy\loca ast\fgr11&12.inp
c:\polestar\vy\loca ast\bwr dba.rft
 3.3300E-02
 1
  9.5000E-01 4.8500E-02 1.5000E-03
                                         1.0000E+00
Overlying Pool:
  0
 0.0000E+00
 0
 0
  0
  0
Compartments:
 8
Compartment 1:
```

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```
0
  1
   1
   0.0000E+00
  3
  3.3300E-02
                0.0000E+00
  2.5000E-01
                2.0000E+01
  2.0333E+00
                0.0000E+00
  1
  0.0000E+00
  3
  3.3300E-02
                0.0000E+00
  2.5000E-01
                2.0000E+01
  2.0333E+00
                0.0000E+00
  1
  0.0000E+00
  0
  0
  0
  0
  0
Compartment 2:
  0
  1
  1
  0.0000E+00
  5
  3.3300E-02
                0.0000E+00
  2.5000E-01
                2.0000E+01
  2.0333E+00
                1.1300E+01
  2.0677E+00
                1.1300E+00
  7.2000E+02
                0.0000E+00
  1
  0.0000E+00
  5
  3.3300E-02
                0.0000E+00
  2.5000E-01
                2.0000E+01
  2.0333E+00
                1.1300E+01
  2.0677E+00
                1.1300E+00
  7.2000E+02
                0.0000E+00
  1
  0.0000E+00
  0
  0
  0
  0
  0
Compartment 3:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 4:
  0
  1
  0
```

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•

3.3300E-02 0.0000E+00 1.6700E-01 8.0000E-01 2.0333E+00 0.0000E+00 0 Pathway 2: 0 0 0 0 0 0 0 0 0 0 1 2 3.3300E-02 4.3300E-01 2.0333E+00 0.0000E+00 0 Pathway 3: 0 0 0 0 0 0 0 0 0 0 1 2 3.3300E-02 4.3300E-01 2.0333E+00 0.0000E+00 0 Pathway 4: 0 0 0 0 0 1 2 3.3300E-02 1.3400E-01 9.4740E+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 5: 0 0 1 3 3.3300E-02 5.6000E+00 3.9100E+00 2.4000E+01 5.6000E+00 1.9600E+00 7.2000E+02 1.0000E+00 0.0000E+00 1

3 3.3300E-02 2.4000E+00 3.9100E+00 2.4000E+00 2.4000E+01 1.9600E+00 7.2000E+02 1.0000E+00 0.0000E+00 1 3 3.3300E-02 1.0000E+00 3.9100E+00 2.4000E+01 1.0000E+00 1.9600E+00 7.2000E+02 1.0000E+00 0.0000E+00 0 0 0 0 0 0 0 Pathway 6: 0 0 1 3 3.3300E-02 5.6000E+00 3.2000E-02 2.4000E+01 5.6000E+00 1.6000E-02 7.2000E+02 1.0000E+00 0.0000E+00 1 3 3.3300E-02 2.4000E+00 3.2000E-02 2.4000E+01 2.4000E+00 1.6000E-02 7.2000E+02 1.0000E+00 0.0000E+00 1 3 3.3300E-02 1.0000E+00 3.2000E-02 2.4000E+01 1.0000E+00 1.6000E-02 7.2000E+02 1.0000E+00 0.0000E+00 0 0 0 0 0 0 0 Pathway 7: 0 0 0 0 0 0 0 0 0 0 1 4 3.3300E-02 0.0000E+00 2.0333E+00 8.0000E-01 2.4000E+01 4.0000E-01 0.0000E+00 7.2000E+02 0 Pathway 8: 0

```
0
  0
  0
  0
  0
  0
  0
  0
  0
  1
  4
                0.0000E+00
  3.3300E-02
  2.0333E+00
               2.3900E-01
                1.2000E-01
  2.4000E+01
  7.2000E+02
               0.0000E+00
  0
Pathway 9:
  0
  0
  0
  0
  0
  0
  0
  0
  0
  0
  1
  4
  3.3300E-02
               0.0000E+00
  2.0333E+00
               2.3900E-01
  2.4000E+01
               1.2000E-01
  7.2000E+02
               0.0000E+00
  0
Pathway 10:
  0
  0
  0
  0
  0
  1
 3
  3.3300E-02
               2.0500E+00
                             9.5100E+01
                                          9.9800E+01
                                                        0.0000E+00
                           9.5100E+01
 2.4000E+01
               1.0300E+00
                                          9.9800E+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
 3.3300E-02
               3.7000E+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
```

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0 0 0 0 0 0 Pathway 12: 0 0 0 0 0 0 0 0 0 0 1 1 3.3300E-02 1.2830E+04 0 Dose Locations: 3 Location 1: Control Room 8 0 1 2 3.3300E-02 3.5000E-04 7.2000E+02 0.0000E+00 1 4 3.3300E-02 1.0000E+00 2.4000E+01 6.0000E-01 9.6000E+01 4.0000E-01 7.2000E+02 0.0000E+00 Location 2: EAB 7 1 3 3.3300E-02 1.7000E-03 2.4000E+01 0.0000E+00 7.2000E+02 0.0000E+00 1 4 3.3300E-02 3.5000E-04 8.0333E+00 1.8000E-04 2.4000E+01 2.3000E-04 7.2000E+02 0.0000E+00 0 Location 3: LPZ 7 1 8 3.3300E-02 8.0100E-06 3.9000E+00 2.7400E-05 4.9000E+00 1.7500E-05 5.9000E+00 8.0100E-06

```
1.0000E-06
  8.0333E+00
             5.8000E-07
  2.4000E+01
             3.3700E-07
  9.6000E+01
  7.2000E+02 0.0000E+00
  1
  4
  3.3300E-02
               3.5000E-04
             1.8000E-04
  8.0333E+00
  2.4000E+01
              2.3000E-04
              0.0000E+00
  7.2000E+02
Effective Volume Location:
  1
  3.3300E-02
               3.4600E-03
  3.9000E+00
               4.6600E-03
  5.9000E+00
               3.4600E-03
  8.0333E+00
               1.4500E-03
  2.4000E+01
               1.0900E-03
  9.6000E+01
               9.9200E-04
  7.2000E+02
               0.0000E+00
Simulation Parameters:
  1
  3.3300E-02
               0.0000E+00
Output Filename:
C:\Polestar\vy\loca ast\CaseLOCAMSIVOK.o0
  1
  1
  1
  0
  0
End of Scenario File
```

Note that for this file, the X/Qs are shifted from those in the Design Inputs section. This is because the worst two-hour EAB dose was identified as being from 3.9 hours to 5.9 hours (using a constant X/Q); and therefore, the X/Qs for all pathways were adjusted to place the highest value at 3.9 hours.

# Single\_Failure Considerations

To consider a single failure of an MSIV to close, Appendix A considers two MSIV leakage pathway models. The first (using the terminology of Appendix A) is "A" in which the space between the MSIVs is ignored. This would correspond to a failure of one MSIV to close. Under that condition, the space between the MSIVs could be considered part of the drywell (inboard MSIV fails to close) or part of the control volume defined by the closed inboard MSIV (outboard MSIV fails to close) and the turbine stop valves. The former is the more conservative assumption, and it is on that basis that the "A" removal efficiencies were calculated; i.e., they were kept the same as "B2".

The second pathway model considered in Appendix A consists of control volumes "B1" and "B2" in series. This pathway model is for lines with both MSIVs closed. To model a single failure of an MSIV, it is only necessary (1) to use the average particulate DF for the two Appendix A models (instead of that for the B1/B2 models alone) for the RADTRAD input for the pathways from the ALT volume to the main condenser and to the environment and (2) to reduce the ALT volume by the volume of one line between the MSIVs corrected for the

expanded flow in the ALT as compared to that in the space between the two MSIVs. This is explained more fully in Appendix A. The changes in the RADTRAD input are as follows:

```
Compartment 4:
 ALT
   3
  1.1850E+03
   0
   0
   0
   0
   0
Pathway 5:
   0
   0
   1
   3
  3.3300E-02
                4.5000E+00
                             3.9100E+00
  2.4000E+01
                4.5000E+00
                              1.9600E+00
  7.2000E+02
                1.0000E+00
                             0.0000E+00
  1
  3
  3.3300E-02
                2.4000E+00
                             3.9100E+00
  2.4000E+01
                2.4000E+00
                             1.9600E+00
  7.2000E+02
                1.0000E+00
                             0.0000E+00
  1
  3
  3.3300E-02
                1.0000E+00
                             3.9100E+00
  2.4000E+01
                1.0000E+00
                             1.9600E+00
  7.2000E+02
                1.0000E+00
                             0.0000E+00
  0
  0
  0
  0
  0
  0
  0
Pathway 6:
  0
  0
  1
  3
  3.3300E-02
                4.5000E+00
                             3.2000E-02
  2.4000E+01
                4.5000E+00
                             1.6000E-02
  7.2000E+02
               1.0000E+00
                             0.0000E+00
  1
  3
  3.3300E-02
               2.4000E+00
                             3.2000E-02
  2.4000E+01
               2.4000E+00
                             1.6000E-02
  7.2000E+02
               1.0000E+00
                             0.0000E+00
  1
  3
                             3.2000E-02
  3.3300E-02
               1.0000E+00
  2.4000E+01
               1.0000E+00
                             1.6000E-02
  7.2000E+02
               1.0000E+00
                             0.0000E+00
  0
  0
  0
  0
```

0 0 0

# Results

The results provided by RADTRAD 3.02a are as follows:

	WB	Thyroid	TEDE	WB	Thyroid	TEDE
	Case 1A (No SGTS Failure)			Case 1B (SGTS Failure)		
CR	2.4334E-02	1.9839E+01	1.3649E+00	2.9099E-02	4.7960E+01	2.8350E+00
LPZ	2.1646E-02	4.6193E-01	5.3080E-02	2.4375E-02	9.3366E-01	8.0375E-02
EAB	2.8161E-01	1.0808E+01	1.0571E+00	3.4433E-01	2.4203E+01	1.8090E+00
	Case 2A (No	SGTS Failure)		Case 2B (SG	TS Failure)	
CR	5.5574E-03	4.2444E-01	3.5553E-02	5.5567E-03	4.2406E-01	3.5533E-02
LPZ	3.6586E-01	1.0044E+00	4.4187E-01	3.6572E-01	9.9990E-01	4.4149E-01
EAB	1.1663E+00	2.0492E+00	1.2976E+00	1.1662E+00	2.0492E+00	1.2975E+00
	Case 3A (No	MSIV Failure)		Case 3B (MS	IV Failure)	
CR	2.5558E-02	1.4841E+01	5.3136E-01	2.6237E-02	1.5236E+01	5.5867E-01
LPZ	1.1270E-03	1.1319E-02	1.5945E-03	1.1794E-03	1.2229E-02	1.7113E-03
EAB	2.5799E-02	1.5411E-01	3.4984E-02	2.7224E-02	1.9254E-01	3.9392E-02

Combining these into overall results:

Location	Dose (rem)			
	Thyroid	Whole Body/DDE	<b>Total Effective Dose</b>	
	Inhalation Pathway*	External Radiation*	Equivalent (TEDE)	
DBA-LOCA with SGTS Failure (Case 1B + Case 2B + Case 3A)				
EAB	2.6E+01	1.6E+00	3.1E+00	
LPZ	1.9E+00	4.0E-01	5.2E-01	
CR	6.3E+01	6.1E-02	3.4E+00	
DBA-LOCA with MSIV Failure (Case 1A + Case 2A + Case 3B)				
EAB	1.3E+01	1.5E+00	2.4E+00	
LPZ	1.5E+00	3.9E-01	4.9E-01	
CR	3.5E+01	5.6E-02	2.0E+00	
Acceptance Criteria (rem)				
EAB & LPZ	None*	None*	25	
CR	None*	None*	5	

\*These doses provided for information only - no limits apply

# Conclusions

For control room operators and for the general public, the radiation dose acceptance criteria for all design-basis accidents are as defined in Reference 1. For the DBA-LOCA, the limits are 5 rem TEDE for Control Room and 25 rem TEDE for offsite locations. (For the control Room, the exposure interval is 30 days with allowance for partial occupancy after the first 24 hours. The EAB dose is based on the worst 2-hour exposure, and the LPZ dose is based on 30-day exposure just as for the Control Room.) The analysis shows that a DBA-LOCA will result in Control Room operator doses and offsite doses to the general public that are below the stated limits.

#### Table of Contents for Appendix A Determination of Volumetric Flows and Removal Efficiencies/DFs For Alternative Leakage Treatment (ALT)

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#### 1.0 Purpose

The purpose of this appendix is to determine aerosol and elemental iodine removal coefficients in the main steam lines and main condenser to be used in Alternate Source Term dose calculations as an Alternative Leakage Treatment (ALT) for MSIV Leakage.

#### 2.0 Introduction

Aerosol and elemental iodine removal due to sedimentation and adsorption, respectively, is credited in the main steam lines and in the main condenser. It is possible that an inboard or an outboard MSIV of one main steam line may fail to close. The other three main 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 drainlines tap off. Finally, sedimentation will be credited in the main condenser, where activity leaking out of the main steam lines is collected.

Removal coefficients will be independently calculated for aerosols and elemental iodine.

#### 3.0 Design Input Data

Design input data is taken from Ref A1 (item numbers provided below). They are as follows:

- 1. DW sprays assumed to start at t = 15 minutes accident time (Item 9.1)
- 2. MSIV leakage: 124 scfh total, 62 scfh max per line at peak accident pressure/temperature(Item 3.17)
- 3. Peak accident conditions: P = 58.7 psia (44 psig), T = 338 F (Item 8.3)
- 4. Steam line temperature: 550 F (Item 8.4)
- 5. Volume from inboard to outboard MSIV (for each main steam line): 26 cuft (18 ft long from Item 7.3, 16.124" ID from Item 7.2)
- Volume from Outboard MSIV to Stop Valve (for each main steam line): 263 cuft (206.1 ft long from Item 7.3, horizontal runs only, 16.124" ID from Item 7.2, for conservatism and to account for bends, use 90%)
- 7. Main Condenser Leakage Bypass: 0.8% (Item 7.5)
- 8. Main Condenser Volume: 107,000 ft<sup>3</sup> (Item 3.5)

#### 4.0 Assumptions

**APPENDIX A** 

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- Assumption 2: It is assumed that the actual representative droplet size for the VY spray nozzles in the drywell would be between 1000 and 1500 μm.
- Justification 2: These are typical values for mass mean droplet diameters for BWR spray systems. Two diameters are used to demonstrate that the results for main steam line/condenser deposition are not sensitive to a particular value.

#### **5.0 Computation and Analysis**

Three main steam lines are assumed to be intact and unfaulted up to the turbine stop valves, while either an inboard or an outboard MSIV is assumed to be failed open in the remaining main steam line (practically eliminating consideration of any portion of the piping between the reactor vessel and the closed MSIV for that line).

#### **Proprietary Material Removed**

As for the main steam line with the failed open MSIV, removal is being credited in only one single piping volume between the outboard MSIV and turbine stop valve.

#### 5.1 Leakage Rate into the Main Steam Lines

#### 5.1.1 Mass Flow Rate

Section 3.0 provides mass leak rates into the steam lines. One assumes that one-half of the total drywell to steam lines leakage enters one failed line (one MSIV open, referred to as line "A") and one-half 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 partitioning for analysis is, therefore, as follows:

Faulted Line A	62 scfh
Intact Line B	62 scfh
Intact Line C	No Leakage
Intact Line D	No Leakage

#### **APPENDIX A**

Note that line B is made up of two sub control volumes: (i) B1, inboard MSIV to outboard MSIV and (ii) B2, outboard MSIV to turbine stop valve.

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

Case	Leakage	Volume where Aerosol Removal Occurs
A:	62 SCFH	Outboard MSIV to Turbine Stop Valve
B: B1 B2	62 SCFH 62 SCFH	Inboard to Outboard MSIV Outboard MSIV to Turbine Stop Valve

#### 5.1.2 Volumetric Flow Rate

Since Section 3.0 provides MSIV leakage only 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 mass flow rate of 62 scfh is already at peak accident conditions, so the conversion is straightforward. The pressure decrease is a factor of four from 58.7 psia to 14.7 psia, and the temperature decrease from 338 F to standard conditions (70 F) is a factor of (798 R/530 R). The pressure factor tends to make the volumetric flow from the drywell less than the specified (and tested) SCFH and the temperature factor tends to make it greater. The overall decrease is a factor of 2.7; i.e., from 62 scfh to 23 cfh or 0.383 cfm. In terms of the fractional leakage of drywell volume for each of the two leak paths, the result is (0.383 cfm)(60 min/hour)(24 hours/day)/128,370 tf<sup>3</sup> = 0.43 %/day. In terms of combined drywell and torus airspace volume, it is (0.383 cfm)(60 min/hour)(24 hours/day)/(128,370 + 103,932) ft<sup>3</sup> = 0.24 %/day.

#### 5.2 Leakage Rate out of Each Steam Line Volume

#### Volume B1

The volumetric flow in the space between closed MSIVs is assumed to be the same as that leaving the drywell.

Leak Rate (B1) = 23 cfh = 23/26 = 0.885 vol/hour

#### Volumes A and B2

The volume between the outboard MSIV and the turbine stop valves in a single main steam line is  $263 \text{ ft}^3$  (see Section 3.0). In this space, the pressure is assumed to be atmospheric, with a temperature of 550 F (see Section 3.0). Therefore, one needs to apply a temperature correction to calculate the volumetric flow rates out of that space. One will find:

Leak Rate (A) =  $62 \operatorname{scfh} x (460 + 550)/(530)$ 

= 118.2 cfh = 1.97 cfm per line

= 118.2/263/2 = 0.225 vol/hour\*

\*Assuming two main steam line volumes per leaking line because of cross-connections

Leak Rate (B2) = Leak Rate (A)

#### 5.3 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 the total MSIV tested leak rate (124 scfh) decreased by 0.8% to account for condenser bypass; i.e., to 123 scfh.

### **APPENDIX A**

In terms of volumetric flow entering the condenser, it amounts to (1 - 0.008) times the sum of the volumetric flows leaking out of the two steam lines, that is to say  $0.992 \times (118.2 + 118.2) = 234.5$  cfh = 3.91 cfm. The leakage bypassing the condenser is  $0.008 \times 234.5/0.992 = 1.9$  cfh = 0.032 cfm.

In the condenser, the pressure is assumed to be atmospheric (as it is in the A and B2 main steam line control volumes) and the temperature is assumed to be standard (compared to 550 F in the main 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 530 R/1010 R). One obtains a volumetric flow rate of 123 cfh or 2.05 cfm. This is conservative in that no steam condensation in the main condenser is credited, only a decrease in the temperature of the leakage. The leakage of 2.05 cfm is about three percent per day of the 107,000 ft<sup>3</sup> main condenser volume or 1.15E-3 volumes per hour.

5.4 Calculation of the Aerosol Settling velocities in the Steam Lines and Main Condenser with Sprays in Operation

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# APPENDIX A

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**APPENDIX A** 

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### 5.5 Calculation of the Aerosol Removal Coefficients in the Main Steam Lines and Main Condenser

# **Proprietary Material Removed**

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

$$\lambda_{sed} = \frac{u_s \times S}{V}$$
[8]

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:

$$\eta = \frac{\lambda_{sed}}{\lambda_{sed} + \lambda_{leak}}$$
[9]

where  $\lambda_{\text{leak}}$  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:

16.124 in
185.5 ft
249.25 ft <sup>2</sup> (DxL)
263 ft <sup>3</sup> ( $\pi x D^2/4$ )

Knowing that  $u_s = 5E-5$  m/s = 0.59 ft/hr and that  $\lambda_{\text{leak A}} = 0.225$ /hr, one obtains:

$$\lambda_{sed A} = 0.56 / hr$$
  
 $\eta_A = 71 \%$ 

Volume B1:

The dimensions of the "B1" control volume are as follows:Inside Diam:16.124 inLength:18 ftSettling Area:24.2 ft² (DxL)Volume:26 ft³ ( $\pi x D^2/4$ )

Knowing that  $u_s = 5E-5$  m/s = 0.59 ft/hr and that  $\lambda_{\text{teak B1}} = 0.885/\text{hr}$ , one obtains:

 $\begin{array}{l} \lambda_{sed \ B1} = 0.55 \ \text{/ hr} \\ \eta_{B1} = 38 \ \% \end{array}$ 

Volume B2:

Same as Volume A:  $\eta_{B2} = 71 \%$ 

Main Condenser Volume:

For the VY main condenser, it is about 8 meters from the elevation of the condenser centerline (237.47') to the center of the main condenser bellows (average of 265.75' and 262' or 263.88' – see Section 3.0). The primary drain pathway enters the main condenser at about the same elevation as the condenser centerline (at 237.04'). With a main condenser volume of 107,000 ft<sup>3</sup> (see Section 3.0) and a sedimentation height in the main condenser of 8.0 meters, one calculates a sedimentation area of about 4,078 ft<sup>2</sup> (ratio of the volume to the sedimentation height). This is very conservative. The total tube area is 3.15E5 ft<sup>2</sup>, and dividing by  $\pi$  to relate the horizontal projected area of the tubes to the surface area of the tubes, the result is about 1E5 ft<sup>2</sup>. This is almost 25 times the credited sedimentation area. While it is unreasonable to expect that the entire projected surface area of the tubes would act as a surface for sedimentation, using only four percent of that projected surface is clearly conservative.

Therefore, one has:

Settling Area:  $4078 \text{ ft}^2$ Volume:  $107000 \text{ ft}^3$ 

Knowing that  $u_s = 5E-5$  m/s = 0.59 ft/hr and that  $\lambda_{\text{leak MC}} = 1.155E-3/hr$ , one obtains:

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

The model used in the main steam lines is the Bixler Model from NUREG/CR-6604 (Ref A5, Equation 29 p. 212).

[Note that the Cline correlation mentioned in Ref A5 was reviewed, and this review confirmed that the expression of the elemental iodine deposition velocity,  $U_{ei}$ , contains an exponential, unlike what Ref A5 shows. Therefore, the following expression for elemental iodine deposition velocity,  $U_{ei}$ , has been modified from Ref A5 to include the exponential.]

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[10]

$$\eta_{ei} = 1 - \exp(-\frac{U_{ei}A_s}{100Q})$$
$$U_{ei} = \exp(\frac{2809}{T} - 12.5)$$

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

Volume A:

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

 $\begin{array}{rll} A_{s} = & 1566 \ \text{ft}^{2} = 145.6 \ \text{m}^{2} \ (\pi \text{x}\text{D}\text{x}\text{L}) \\ Q = & 118.2 \ \text{cfh} = 9.3\text{E-4} \ \text{m}^{3}\text{/s} \\ T = & 550 \ \text{F} = 561 \ \text{K} \\ U_{ei} = & 5.56\text{E-4} \ \text{cm/s} \end{array}$ 

One obtains:  $\eta_{ei} = 58 \%$ 

Volume B1:

Elemental iodine removal in B1 is neglected.

Volume B2:

Same as Volume A:  $\eta_{ei} = 58 \%$ 

The model used in the main condenser is taken from SRP 6.5.2 (Ref A4).

Per Ref A4, the removal coefficient  $\lambda_w$  for elemental iodine in the containment (applied here to the main condenser) is obtained as follows:

$$\lambda_{w} = \frac{K_{w}A_{w}}{V}$$
[11]

where  $K_w$  is the deposition velocity ( $K_w = 4.9 \text{ m/hr per Ref A4}$ ),  $A_w$  is the surface area for elemental iodine deposition in the main condenser, and V is the volume of the main condenser.

Surface Area:4078 ft² (from Section 5.5)Volume:107,000 ft³ (from Section 3.0)

This surface area is the same as the main condenser sedimentation area, and it is very conservative to use such an area for elemental iodine deposition. Knowing that  $K_w = 4.9 \text{ m/hr} = 16.1 \text{ ft/hr}$  one obtains:

$$\lambda_w = 0.61 / hr$$

With  $\lambda_{\text{leak MC}} = 1.155\text{E-3/hr}$ , one calculate an efficiency  $\eta_w$  using equation 13,

 $\eta_{w} = 99.8 \%$ 

#### **APPENDIX A**

For comparison, if one were to use the Bixler deposition velocity (assuming standard conditions in the main condenser):

 $K_w = \exp(2809/295K - 12.5) = 5.1E-2 \text{ cm/sec} = 1.8 \text{ m/hr}$ 

Knowing that  $K_w = 1.8 \text{ m/hr} = 5.9 \text{ ft/hr}$  one obtains:

$$\lambda_w = 0.225 /hr$$

With  $\lambda_{\text{leak MC}} = 1.155E-3/hr$ , one calculate an efficiency  $\eta_w$  using equation 13,

It is believed that the containment conditions more closely approximate the main condenser conditions than do the main steam line conditions; and given the conservatism of the deposition area, it is acceptable to use the higher removal efficiency.

One may notice that the elemental iodine removal efficiency in the condenser is greater than the corresponding removal efficiency for particles; i.e., 99.8% > 95.1%. In this regard, it is important to note that very small particles are actually removed more readily by diffusion than by sedimentation and that when the removal process becomes dependent on diffusion, the smaller the particle, the better the removal. In the limit, gases diffuse more readily than particles; and, therefore, it is not inconsistent that gases would be removed more readily than very small particles in the main condenser.

One may also take note of the fact that in the main body of the calculation, the spray removal rate in the drywell for elemental iodine was set equal to that for particulate because of the large amount of surface area presented by the particulate for elemental iodine adsorption. The decision as to whether to use the particle removal efficiency or the elemental iodine removal efficiency from SRP 6.5.2 when quantifying elemental iodine removal in the condenser needs to be based on the surface area of the airborne particulate compared to the surface area of the structures since airborne elemental iodine would tend to adsorb on airborne particles and be removed with it.

In containment, even during spray operation, particles are plentiful. 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, the rest being removed on the condenser surfaces, at the rate calculated using the SRP 6.5.2 model.

#### 5.7 Calculation of Combined Removal Efficiencies/DFs to be used in RADTRAD Model

Having calculated removal efficiencies for each main steam line control volume and the main condenser, one needs to develop combined removal efficiencies to be used directly in the plant RADTRAD model for purpose of dose calculation. In the piping mode of RADTRAD, DFs are used instead of efficiencies.

As discussed in the main body of the calculation, VY makes use of the Alternative Leakage Treatment of ALT concept of managing MSIV leakage. In this concept, the main steam lines beyond the MSIVs are isolated post-LOCA and treated as a holdup volume. One or more drainline pathways are provided to direct MSIV leakage from this volume to the main condenser for additional holdup.

The RADTRAD model creates a control volume "ALT" which represents the volume of four steam lines (since they are cross-connected) from the outboard MSIVs to the turbine stop valves. Added to this volume is the volume of two steam lines between the two MSIVs. These two steam lines are each

#### **APPENDIX A**

assumed to be leaking at 62 scfh with a volumetric flow of 0.383 cfm. Beyond the outboard MSIVs, the 0.383 cfm is assumed to expand to 1.97 cfm (23 cfh to 118.2 cfh). Since the RADTRAD model uses the expanded volumetric flow for the junction from main steam line volume to the main condenser and since the volume of the main steam lines are to be added to it, the volume between the MSIVs is increased by the ratio of 1.97/0.383 to preserve the correct holdup time. Therefore, the ALT control volume has the volume 4 x 263 ft<sup>3</sup> + 2 x 26 ft<sup>3</sup> (1.97/0.383) = 1319 ft<sup>3</sup>. If one MSIV is assumed to be failed open, the volume becomes 4 x 263 ft<sup>3</sup> + 26 ft<sup>3</sup> (1.97/0.383) = 1185 ft<sup>3</sup>.

Steam Line Leakage:

Flow Path to Main Condenser through Main Steam Line Pathway with Only One MSIV Closed (Volume A\*):

Volumetric flow rate to Cond:234.5/2 cfh = 117.3 cfh = 1.96 cfmRemoval Efficiency for Particles:71%DF for Particles = 1/(1 - 0.71):3.45Removal Efficiency for Elem I:58%DF for Elem I = 1/(1 - 0.58):2.38

Flow Path to Main Condenser through Main Steam Line Pathway with Both MSIVs Closed (Volumes B1 and B2\*):

Volumetric flow rate to Cond:234.5/2 cfh = 117.3 cfh = 1.96 cfmRemoval Efficiency for Particles: 38% in B1, 71% in B2, 82% for two control volumes in series; i.e., series<br/>efficiency = 1 - (1 - 0.38) x (1 - 0.71)DF for Particles = 1/(1 - 0.82):5.56Removal Efficiency for Elem I:58% (B1 ignored for elemental iodine)DF for Elem I = 1/(1 - 0.58):2.38

\*For one pathway with one closed MSIV and one pathway with two closed MSIVs, the average DF of 4.51 should be used for particles. The total flow to the main condenser is 234.5 cfh.

Condenser Bypass Leakage:

Bypass of the main condenser may occur due to direct leakage from the main steam lines to the HP turbine. The fractional bypass is 0.8% or  $(2 \times 118.2) - 234.5$  cfh = 1.9 cfh = 0.032 cfm. This bypass will experience removal in the main steam lines, but not in the main condenser. The removal DFs for this bypass will be the same as those above.

Condenser Leakage:

Volumetric flow rate from Cond: 123 cfh = 2.05 cfm Removal Efficiency for Particles: 95.1% Removal Efficiency for Elem I: 99.8%

#### 6.0 References

- A1. PSAT 3019CF.QA.03, "Design Database for Application of the Revised DBA Source Term to Vermont Yankee", Revision 2
- A2. AEB 98-03, "Assessment of Radiological Consequences for the Perry Pilot Plant Application Using the Revised (NUREG-1465) Source Term" Appendix A, 1998
- A3. 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
- A4. NUREG-0800, Standard Review Plan, Section 6.5.2
- A5. NUREG/CR-6604, "RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation", December 1997

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## Appendix B Check Calculation Using the STARDOSE Computer Code For: DBA-LOCA with SGTS Failure and DBA-LOCA with MSIV Failure

This appendix presents check calculation results for the DBA-Loss of Coolant Accident (LOCA) analysis using the Polestar STARDOSE computer code (Reference B-1) to check the RADTRAD results for DBA-LOCA with SGTS Failure (Case 1B + Case 2B + Case 3A) and DBA-LOCA with MSIV Failure (Case 1A + Case 2A + Case 3B). The Design Input Data and Assumptions are the same as those used in the main body of the calculation.

The AST application for the LOCA is consistentent with Reference B-2.

## **STARDOSE Calculation**

The STARDOSE LIBFILE1.TXT file is included as Attachment B-1. Common to all AST STARDOSE runs, it contains the radionuclide input data. The core inventories listed in Column 5 of the LIBFILE1.TXT are from Reference B-3. The Dose Conversion Factors (Column 8 for whole body and Column 12 for CEDE) are the same as in the main body of the calculation. Decay constants (per second) come from Reference B-4.

Input data files are provided as Attachments B-2 and B-3.

Attachment B-2 corresponds to RADTRAD Cases 1B + 2B + 3A (Primary Containment Leakage Direct to Environment (With SGTS Failure) + Release Via RB and Plant Stack (With SGTS Failure) + Release via Main Steam Lines and MC (No MSIV Failure)).

Attachment B-3 corresponds to RADTRAD Cases 1A + 2A + 3B (Primary Containment Leakage Direct to Environment (No SGTS Failure) + Release Via RB and Plant Stack (No SGTS Failure) + Release Via Main Steam Lines and MC (With MSIV Failure).

In conducting the RADTRAD analysis, Containment Atmospheric Dilution System (CAD) operation was neglected as mentioned in Assumption 3 contained in the main body of the calculation. However, its operation was evaluated using STARDOSE to determine its effect on radiation dose.

According to the Vermont Yankee FSAR, if hydrogen is detected in the primary containment as a result of a LOCA, the CAD would be used to maintain oxygen concentrations below 5%. After the LOCA, the primary containment would be pressurized at a rate of approximatley 40 scfm until the pressure reached 28 psig. The CAD system at VY is designed to allow pressurization to be initiated within 24 hours of the LOCA. The containment would then be isolated until hydrogen generation by radiolysis caused the oxygen/hydrogen concentration to approach the flammable region. At that time, the containment would be vented at a rate of 20 scfm (treated in this analysis as 20 cfm). As venting would progress, the hydrogen concentration would increase because its generation would exceed its removal by venting. As containment pressure decreased,

repressurization would begin and continue until the pressure returned to 28 psig. This process of continuous venting, with pressurization cycling as required, would continue as long as necessary (Reference B-5). It is assumed that the CAD purge begins at t = 192 hours (Reference B-6).

STARDOSE was utilized to determine the radiation dose impacts of the CAD system venting. Attachment B-4 contains an input data file that includes CAD venting along with the DBA-LOCA with SGTS Failure scenario. The results show that the radiation doses at the EAB, LPZ and Control Room are relatively unaffected, actually decreasing for the limiting Control Room dose while increasing somewhat for the LPZ dose. The two-hour EAB dose is unaffected. Therefore, venting resulting from CAD operation does not create a case that requires further analysis.

### Results

All doses are in rem.

# Excerpt from STARDOSE output corresponding to DBA-LOCA with SGTS Failure (Attachment B-2 INPUT.DAT):

Control\_Room

Total dose:	thyroid 6.2E+1	wbody 6.5E-2	skin 2.5E+0	CEDE 3.2E+0
environment				
EAB dose: LPZ dose:	thyroid 2.7E+1 1.9E+0	wbody 1.7E+0 3.9E-1	skin 1.2E+0 3.0E-1	CEDE 1.5E+0 9.2E-2

# Excerpt from STARDOSE output corresponding to DBA-LOCA with MSIV Failure (Attachment B-3 INPUT.DAT):

Control\_Room

Total dose:	thyroid 3.6E+1	wbody 6.25E-2	skin 2.43E+0	CEDE 1.79E+0
environment				
	thyroid	wbody	skin	CEDE
EAB dose:	1.4E+1	1.6E+0	1.1E+0	8.4E-1
LPZ dose:	1.5E+0	3.8E-1	3.0E-1	6.7E-2

# Excerpt from STARDOSE output corresponding to DBA-LOCA with SGTS Failure with CAD System Operation (Attachment B-4 INPUT.DAT):

Control Room

	thyroid	wbody	skin	CEDE
Total dose:	6.0E+1	6.4E-2	2.3E+0	3.1E+0

environment

		thyroid	wbody	skin	CEDE
EAB	dose:	2.7E+1	1.7E+0	1.2E+0	1.5E+0
$\mathbf{LPZ}$	dose:	2.0E+0	4.3E-1	4.0E-1	9.3E-2

### Conclusions

The dose agreement for all cases is adequate. The STARDOSE runs confirm the results from the main body of the calculation.

The following table compares TEDE values (in rem) calculated from RADTRAD versus STARDOSE.

		DBA	A-LOCA	
	With SGTS I	Failure	With MSIV I	Failure
	RADTRAD	STARDOSE	RADTRAD	STARDOSE
EAB	3.1E+00	3.2R+00	2.4E+00	2.4E+00
LPZ	5.2E-01	4.8E-01	4.9E-01	4.5E-01
Control	2 45 .00	2 25.00	2.017.00	1.05.00
Koom	3.4E+00	3.3E+00	2.0E+00	1.9E+00

## **Appendix References**

B-1. "STARDOSE Model Report", Polestar Applied Technology, Inc., PSATCI09.03, January 1997

B-2. "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors", US NRC Regulatory Guide 1.183, Revision 0, July 2000

B-3. PSAT 3019CF.QA.03, "Design Data Base for Application of the Revised DBA Source Term to Vermont Yankee", Revision 2

B-4. NUREG/CR-5106 (Manual for TACT5 – Version SAIC 9/23/87), File MLWRICRP.30

B-5. VYNPS UFSAR, Revision 18, Section 5.2.7, "Containment Atmospheric Dilution (CAD) System".

B-6. VY Calculation VYC-039, "Technical Support Center 30-Day LOCA Doses Plus Area Doses", Revision 2

Attachment B-1

## Attachment B-1 STARDOSE Library File for DBA-LOCA Calculation (LIBFILE1.TXT)

n_isotope	s	76 n_isoto	ope_groups	s 11											
Kr83m	N_Gas 0	NONE	NONE	4.24E+03	1.04E-04 0	1.49E-5	0	0	0	0	0	0	0	0	0
Kr85m	N_Gas	NONE	NONE	9.71E+03	4.39E-05 0	0.026	0	0	0.05	0	0.22	0	0	0	0
Kr85	N_Gas	NONE	NONE	5.05E+02	2.04E-09 0	3.55E-4	0	0	0.05	0	0.22	0	0	0	0
Kr87	N_Gas	NONE	NONE	1.94E+04	1.52E-04 0	0.142	0	0	0.34	0	1.48	0	0	0	0
Kr88	N_Gas	NONE	NONE	2.75E+04	6.88E-05 0	0.358	0	0	0.08	0	0.35	0	0	0	0
Kr89	0 N_Gas	NONE	NONE	3.46E+04	3.63E-03 0	0.323	0	0	0.35	0	1.52	0	0	0	0
Xe131m	0 N_Gas	NONE	NONE	3.18E+02	6.68E-07 0	0.00136	0	0	0.02	0	0.04	0	0	0	0
Xe133m	0 N_Gas	NONE	NONE	1.76E+03	3.49E-06 0	0.00472	0	0	0.03	0	0.13	0	0	0	0
Xe133	0 N_Gas	I133Elem	NONE	5.78E+04	1. <b>52E-0</b> 6 0	0.00558	0	0	0.01	0	0.04	0	0	0	0
Xe135m	0 N_Gas	NONE	NONE	1.14E+04	7.40E-04 0	0.0682	0	0	0.02	0	0.09	0	0	0	0
Xe135	0 N_Gas	I135Elem	NONE	2.33E+04	2.09E-05 0	0.0396	0	0	0.06	0	0.26	0	0	0	0
Xe137	0 N_Gas	NONE	NONE	5.07E+04	2.96E-03 0	0.0303	0	0	0.46	0	2	0	0	0	0
Xe138	0 N_Gas	NONE	NONE	5.05E+04	6.80E-04 0	0.199	0	0	0.15	0	0.65	0	0	0	0
11210					1080400 0	0606 0	•	0.00	20002	0.10	~	•	•		
11310rg		NONE	NONE 2.8	4.05E+04 9.96E-07	8.27E-05 6438	0.377	0	0.03	0.11	0.13 381.1	0 0.48	0	0	0	0
I133Org	Org_I	NONE	NONE	5.79E+04	9.22E-06 179820	0.0973	0	0	0.09	5846	0.39	0	0	0	0
I134Org	Org_I	NONE	NONE	6.43E+04	2.23E-04 1065.6	0.438	0	0	0.14	131.35	0.61	0	0	0	0
I135Org	Org_I	NONE	NONE	5.39E+04	2.86E-05 31302	0.264	0	0	0.08	1228.4	0.35	0	0	0	0
II21Elan	U Elm I	Ta121-	NONE	3 955.04	0.0412 07 1090400	0.0606	^	0	0.02	20002	0.10	•	•	•	^
TISTER	0	1613111	NONE	2.0JE+V4	7.700-07 1000400	0.0000	U	U	0.05	32893	0.13	U	U	U	U
I132Elem	Elm_I 0	Te132	NONE	4.05E+04	8.27E-05 6438	0.377	0	0	0.11	381.1	0.48	0	0	0	0
	-														

PSAT 3	019CF	7.QA.08						٨	ttoohm	Rev 0					
									Macinin	ent D-1					
I133Elem	Elm_I	NONE	Xe133	5.79E+04	9.22E-06 179820	0.0973	0	0	0.09	5846	0.39	0	0	0	0
I134Elem	Elm_I	NONE	NONE	6.43E+04	2.23E-04 1065.6	0.438	0	0	0.14	131.35	0.61	0	0	0	0
I135Elem	Elm_I	NONE	Xe135	5.39E+04	2.86E-05 31302	0.264	0	0	0.08	1228.4	0.35	0	0	0	0
I131Part P	- Prt_I D	NONE	NONE	2.85E+04	9.96E-07 1080400	0.0606	0	0	0.03	32893	0.13	0	0	0	0
I132Part P	- 'rt_I 0	NONE	NONE	4.05E+04	8.27E-05 6438	0.377	0	0	0.11	381.1	0.48	0	0	0	0
I133Part P	rt_I 0	NONE	NONE	5.79E+04	9.22E-06 179820	0.0973	0	0	0.09	5846	0.39	0	0	0	0
I134Part P	Prt_I 0	NONE	NONE	6.43E+04	2.23E-04 1065.6	0.438	0	0	0.14	131.35	0.61	0	0	0	0
I135Part P	- Prt_I 0	NONE	NONE	5.39E+04	2.86E-05 31302	0.264	0	0	0.08	1228.4	0.35	0	0	0	0
Rb86	CsGrp	NONE	NONE	1.28E+02	4.29E-07 4921	0	0	0	0	6623	0	0	0	0	0
Cs134	CsGrp	NONE	NONE	1.52E+04	9.55E-09 41070	0.254	0	0	0	46250	0	0	0	0	0
Cs136	CsGrp	NONE	NONE	3.90E+03	6.16E-07 6401	0	0	0	0	7326	0	0	0	0	0
Cs137	CsGrp	NONE	Ba137m	6.08E+03	7.30E-10 29341	0.0	0	0	0	31931	0	0	0	0	0
Sb127	TeGrp	NONE	Te127	3.69E+03	2.07E-06 227.55	0	0	0	0	6031	0	0	0	0	0
Sb129	TeGrp	NONE	Te129	1.01E+04	4.42E-05 35.964	0	0	0	0	643.8	0	0	0	0	0
Te127m	TeGrp	NONE	NONE	4.98E+02	7.64E-08 357.42	0	0	0	0	21497	0	0	0	0	0
Te127	TeGrp	Sb127	NONE	3.67E+03	2.06E-05 6.808	0	0	0	0	318.2	0	0	0	0	0
Te129m	TeGrp	NONE	NONE	1.48E+03	2.36E-07 577.2	0	0	0	0	23939	0	0	0	0	0
Te129	TeGrp	Sb129	NONE	9.98E+03	1.57E-04 1.8833	0	0	0	0	77.33	0	0	0	0	0
Te131m	TeGrp	NONE	I131Elen	14.31E+03	6.42E-06 133570	0	0	0	0	6401	0	0	0	0	0
Te132	TeGrp	NONE	I132Elen	13.97E+04	2.51E-06 232360	0.0346	0	0	0	9435	0	0	0	0	0
Ba137m	BaGrp	Cs137	NONE	5.76E+03	4.53E-03 0	0.097	0	0	0	0	0	0	0	0	0
Ba139	BaGrp 0	NONE	NONE	5.35E+04	1.39E-04 8.88	0	0	0	0	171.68	0	0	0	0	0

PSAT	3019C	F.QA.08	3					ł	Attachm	Rev 0 ent B-1					
Ba140	BaGrp	NONE	La140	5.15E+04	6.27E-07 947.2	0	0	0	0	3737	0	0	0	0	0
Mo99	NMtis	NONE	Tc99m	5.30E+04	2.87E-06 56.24	0	0	0	0	3959	0	0	0	0	0
Tc99m	NMtls	Mo99	NONE	4.64 <b>E+</b> 04	3.18E-05 185.37	0	0	0	0	32.56	0	0	0	0	0
Ru103	NMtls	NONE	NONE	5.07E+04	2.03E-07 950.9	0	0	0	0	8954	0	0	0	0	0
Ru105	NMtls	NONE	Rh105	4.02E+04	4.22E-05 15.355	0	0	0	0	455.1	0	0	0	0	0
Ru106	NMtls	NONE	NONE	2.85E+04	2.20E-08 6364	0	0	0	0	477300	0	0	0	0	0
Rh105	NMtls	Ru105	NONE	3.68E+04	5.40E-06 10.656	0	0	0	0	954.6	0	0	0	0	0
¥90	LaGrp	Sr90	NONE	4.29E+03	2.99E-06 1.9129	0	0	0	0	8436	0	0	0	0	0
Y91	LaGrp	Sr91	NONE	4.24E+04	1.38E-07 31.45	0	0	0	0	48840	0	0	0	0	0
Y92	LaGrp	Sr92	NONE	4.62E+04	5.35E-05 3.885	0	0	0	0	780.7	0	0	0	0	0
Y93	LaGrp	NONE	NONE	5.05E+04	1.91E-05 3.4262	0	0	0	0	2153.4	0	0	0	0	0
Zr95	LaGrp	NONE	Nb95	4.95E+04	1.27E-07 4292	0	0	0	0	23347	0	0	0	0	0
Zr97	LaGrp	NONE	NONE	4.92E+04	1.13E-05 85.47	0	0	0	0	4329	0	0	0	0	0
Nb95	LaGrp	Zr95	NONE	4.96E+04	2.29E-07 1324.6	0	0	0	0	5809	0	0	0	0	0
La140	LaGrp	Ba140	NONE	5.17E+04	4.77E-06 254.19	0	0	0	0	4847	0	0	0	0	0
La141	LaGrp	NONE	Ce141	4.91E+04	4.94E-05 9.065	0	0	0	0	562.4	0	0	0	0	0
La142	LaGrp	NONE	NONE	4.81E+04	1.26E-04 18.167	0	0	0	0	203.5	0	0	0	0	0
Pr143	LaGrp	Ce143	NONE	4.71E+04	5.85E-07 6.2E-06	0	0	0	0	8103	0	0	0	0	0
Nd147	LaGrp	NONE	NONE	1.92 <b>E+</b> 04	7.10E-07 67.34	0	0	0	0	6845	0	0	0	0	0
Am241	LaGrp	NONE	NONE	8.73E+00	4.80E-11 5920	0	0	0	0	4.4E+08	0	0	0	0	0
Cm242	LaGrp	NONE	NONE	3.42E+03	4.94E-08 3481.7	0	0	0	0	1.7E+07	0	0	0	0	0
Cm244	LaGrp 0	NONE	NONE	1.21E+03	1.25E-09 3737	0	0	0	0	2.5E+08	0	0	0	0	0

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PSAT	3019CI	F.QA.08	3			-			Attachm	Rev 0 ent B-1					
Ce141	CeGrp	La141	NONE	4.75E+04	2.51E-07 94.35	0	0	0	0	8954	0	0	0	0	0
Ce143	CeGrp	NONE	Pr143	4.73E+04	6.03E-06 23.051	0	0	0	0	3389.2	0	0	0	0	0
Ce144	CeGrp	NONE	NONE	3.73E+04	2.77E-08 1080.4	0	0	0	0	373700	0	0	0	0	0
Np239	CeGrp	NONE	NONE	7.67E+05	3.44E-06 28.194	0	0	0	0	2508.6	0	0	0	0	0
Pu238	CeGrp	NONE	NONE	3.93E+02	2.40E-10 3559.4	0	0	0	0	3.9E+08	0	0	0	0	0
Pu239	CeGrp	NONE	NONE	1.47E+01	9.00E-13 3341.1	0	0	0	0	4.3E+08	0	0	0	0	0
Pu240	CeGrp	NONE	NONE	3.11E+01	3.30E-12 3348.5	0	0	0	0	4.3E+08	0	0	0	0	0
Pu241	CeGrp	NONE	NONE	6.57E+03	1.67E-09 45.88	0	0	0	0	8251000	0	0	0	0	0
Sr89	SrGrp	NONE	NONE	3.45E+04	1.59E-07 1539.2	0	0	0	0	6512	0	0	0	0	0
Sr90	SrGrp	NONE	<b>Y9</b> 0	4.10E+03	8.00E-10 9768	0	0	0	0	239390	0	0	0	0	0
Sr91	SrGrp	NONE	<b>Y9</b> 1	4.45E+04	2.01E-05 150.96	0	0	0	0	932.4	0	0	0	0	0
Sr92	o SrGrp 0	NONE	¥92	4.61E+04	7.29E-05 81.03	0	0	0	0	629	0	0	0	0	0

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## Attachment B-2 STARDOSE Main Input File for DBA-LOCA with SGTS Failure

edit\_time 2.033 8.033 24 96 720 0 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 1134Org I134Elem I134Part I135Org I135Elem I135Part Rb86 Cs134 Cs136 Cs137 Sb127 Sb129 Te127m Te127 Te129m Te129 Te131m Te132 Ba137m Ba139 Ba140 Mo99 Tc99m Ru105 Ru106 Rh105 Ru103 **Y90** Y91 Zr95 Zr97 Nb95 Y92 Y93 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 1950 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 0.033 0 0 0 0 0 0 0 0 0 0 0.533 0.1 0.1 0 0 0 0.1 0 0 0.033 2.033 0.633 0.167 0.133 0.0133 0.00167 0.00033 0.00013 0.0133 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 0.033 0 0 0 0 0 0 0 0 0 0.533 0.1 0 0 0 0 0 0 0 0 2.033 0 0.167 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\_CV obj\_type DW name air\_volume 1.284e+005 0 water\_volume surface\_area 1 has\_recirc\_filter false removal\_rate\_to\_surface Time NobleGas ElemIodine Orglodine Partlodine Solubles Insolubles 0.25 0. 0. 0. 0 0 0 2.0667 20. 0. 20. 20. 20. 0.

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720	0.	2.0	0.	2.0	2.0	2.0
end_re	emoval_rate_	to_surface				
frac 4	daughter re	suso from surfa	ice			
Time	NobleGas	ElemIodine	Orglodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0
end_fr	rac_4_daught	er_resusp_from_	surface			
end_c	ontrol_volum	e				
contro	l_volume					
obj_ty	pe	OBJ_C	V			
name		WW	0.05			
air_vo	lume	1.039e	4005 04			
water_		0.00+0	04			
has re	c_atea	false				
remov	al_rate_to_w	aterpool				
Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0.0	0	0.0	0.0	0.0
end_re	emoval_rate_	to_waterpool				
frac_4	_daughter_re	susp_from_wate	r			
Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0
end_fr	rac_4_daught	er_resusp_from_	water			
decont	tamination_fa	ctor				
Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	1	1	1	1	1
end_d	econtaminatio	on_factor				
end_co	ontrol_volum	e				
contro	i volume					
obi ty	n_volume	OBJ C	v			
name	F-	RB				
air_vo	lume	1.5e+0	03			
water_	volume	0				
surface	e_area	0				
has_re	circ_filter	false				
end_co	ontrol_volum	e				
contro	l_volume					
obj_ty	pe	OBJ_C	v			
name		SLI				
air_vo	lume	26				
water_		0				
has re	circ filter	false				
end_co	ontrol_volum	e				
control	volume					
obi tv	De	OBJ C	7			
name	r-	SL2				
air_vol	lume	26				
water_	volume	0				
surface	e_area	0				
has_re	circ_filter	false				
end_co	ontrol_volum	e				

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control_volume	
obj_type	OBJ_CV
name	ALT1
air_volume	526
water_volume	0
surface_area	0
nas_recirc_niter	Talse
ena_controi_volume	
control volume	
ohi type	OBL CV
name	ALT2
air volume	526
water_volume	0
surface_area	0
has_recirc_filter	false
end_control_volume	
control_volume	
obj_type	OBJ_CV
name	ALT3
air_volume	1.07E5
water_volume	0
surface_area	U folco
end control volume	Taise
ena_control_volume	
control_volume	
obj_type	OBJ_CV
name	SP
air_volume	6.8e+004
water_volume	0
surface_area	0
has_recirc_filter	false
end_control_volume	
control volume	
obi type	OBLCR
name	Control Room
air volume	4.153e4
water_volume	0
surface_area	0
has_recirc_filter	false
breathing_rate	
Time (hr) Value (cms)	
720 0.00035	
end_breathing_rate	
component factor	
Time (br) Value (frac)	
24 1	
96 0.6	
720 0.4	
end_occupancy_factor	
end_control_volume	
iunction	
junction type	AIR JUNCTION

AIR\_SPACE downstream\_location CORE upstream DW downstream flow\_rate Time (hr) Rate (cfm) 0.533 1 720 1 end\_flow\_rate has\_filter false end\_junction junction junction\_type AIR\_JUNCTION AIR\_SPACE downstream\_location upstream CORE downstream SP flow\_rate Time (hr) Rate (cfm) 0.533 1 720 1 end\_flow\_rate has\_filter false end\_junction junction AIR\_JUNCTION junction\_type AIR\_SPACE downstream\_location DW upstream downstream ww has\_filter false flow\_rate Time (hr) Value (cfm) 0 2.033 720 1.284e+005 end\_flow\_rate end\_junction junction junction\_type AIR\_JUNCTION downstream\_location AIR\_SPACE DW upstream downstream environment has\_filter false flow\_rate Time (hr) Value (cfm) 0.713 0.167 0 720 end\_flow\_rate X\_over\_Q\_4\_ctrl\_room Value (s/m\*3) 2.98e-3 Time (hr) 720 end\_X\_over\_Q\_4\_ctrl\_room  $X\_over\_Q\_4\_site\_boundary$ Time (hr) Value (s/m\*3) 720 1.476e-3 end\_X\_over\_Q\_4\_site\_boundary X\_over\_Q\_4\_low\_population\_zone

Time (hr) Value (s/m\*3) 720 5.253e-5 end\_X\_over\_Q\_4\_low\_population\_zone

end\_junction

end\_junction

junction AIR\_JUNCTION junction\_type downstream\_location AIR\_SPACE DW upstream downstream environment has\_filter false flow\_rate Time (hr) Value (cfm) 0.031 24 0.016 720 end\_flow\_rate  $X_over_Q_4_ctrl_room$ Time (hr) Value (s/m\*3) 2.033 0.00225 8.033 0.000818 24 0.000353 96 0.000277 720 0.000223 end\_X\_over\_Q\_4\_ctrl\_room X\_over\_Q\_4\_site\_boundary Time (hr) Value (s/m\*3) 2.033 1.476e-3 8.033 0 0 24 96 0 720 0 end\_X\_over\_Q\_4\_site\_boundary  $X_over_Q_4_low_population_zone$ Value (s/m\*3) Time (hr) 2.033 5.253e-5 2.227e-5 8.033 24 1.469e-5 96 5.948e-6 1.625e-6 720 end\_X\_over\_Q\_4\_low\_population\_zone end\_junction junction junction\_type AIR\_JUNCTION downstream\_location AIR\_SPACE DW upstream RB downstream has\_filter false flow\_rate Time (hr) Value (cfm) 0.167 0 0.713 24 0.357 720 end\_flow\_rate

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Junonon					
junction_type	AIR_	JUNCTION			
downstream_location	AIR_S	PACE			
upstream	DW				
downstream	SL1				
has_filter	true				
flow_rate					
Time (hr) Value (	cfm)				
24 0.383	•				
720 0.192					
end flow rate					
filter efficiency					
Time NobleGas	ElemIodine	Orglodine	PartIodine	Solubles	Insolubles
720 0	n	0	0	0	0
end filter efficiency	Ū	v	v	v	v
end_mer_enterency					
frac 4 daughter resu	\$D				
Time NobleGas	FlemIndine	Orglodine	Partlodine	Solubles	Insolubles
720 1	Λ	Orgiounic	Λ	0	0
and frac A daughter	recuen	U	Ū	U	U
chu_nac_+_uaughter_	_icsusp				
end_junction					
innetion					
junction type	AID	IUNCTION			
downstream location		SDACE			
upstream	SI 1				
downstream					
downstican box filter	ALTI				
flow rote	uue				
HOW FALL					
Time (br) Velue (	- <b>f</b> )				
Time (hr) Value (d	cfm)				
Time (hr) Value (c 24 0.383	cfm)				
Time (hr)   Value (d     24   0.383     720   0.192     and flow mix	cfm)				
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate	cfm)				
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate	cfm)				
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time_NableGas	cfm) ElemIodine	Orglodine	PartIndine	Solubles	Incolubles
Time (hr) Value (a 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0	cfm) ElemIodine 0	OrgIodine 0	PartIodine 0.38	Solubles 0.38	Insolubles 0.38
Time (hr) Value (a 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency	cfm) ElemIodine 0	OrgIodine 0	PartIodine 0.38	Solubles 0.38	Insolubles 0.38
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac 4 daughter result	efm) ElemIodine O	OrgIodine 0	PartIodine 0.38	Solubles 0.38	Insolubles 0.38
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus	sp ElemIodine 0 ElemIodine	OrgIodine 0	PartIodine 0.38	Solubles 0.38	Insolubles 0.38
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas	efm) ElemIodine 0 sp ElemIodine	OrgIodine 0 OrgIodine	PartIodine 0.38 PartIodine	Solubles 0.38 Solubles	Insolubles 0.38 Insolubles
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 720 1 end_fac_4_daughter_resus	elemIodine 0 sp ElemIodine 0 reusp	OrgIodine 0 OrgIodine 0	PartIodine 0.38 PartIodine 0	Solubles 0.38 Solubles 0	Insolubles 0.38 Insolubles 0
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 720 1 end_frac_4_daughter_	efm) ElemIodine 0 sp ElemIodine 0 resusp	OrgIodine 0 OrgIodine 0	PartIodine 0.38 PartIodine 0	Solubles 0.38 Solubles 0	Insolubles 0.38 Insolubles 0
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 720 1 end_frac_4_daughter_ end_junction	cfm) ElemIodine 0 sp ElemIodine 0 resusp	OrgIodine 0 OrgIodine 0	PartIodine 0.38 PartIodine 0	Solubles 0.38 Solubles 0	Insolubles 0.38 Insolubles 0
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 720 1 end_frac_4_daughter_ end_junction	sfm) ElemIodine 0 sp ElemIodine 0 resusp	OrgIodine 0 OrgIodine 0	PartIodine 0.38 PartIodine 0	Solubles 0.38 Solubles 0	Insolubles 0.38 Insolubles 0
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 720 1 end_frac_4_daughter_ end_frac_4_daughter_ end_junction	cfm) ElemIodine 0 ElemIodine 0 resusp	OrgIodine 0 OrgIodine 0	PartIodine 0.38 PartIodine 0	Solubles 0.38 Solubles 0	Insolubles 0.38 Insolubles 0
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 720 1 end_frac_4_daughter_ end_junction junction junction_type downstream_lectrice	ElemIodine 0 sp ElemIodine 0 resusp	OrgIodine 0 OrgIodine 0	PartIodine 0.38 PartIodine 0	Solubles 0.38 Solubles 0	Insolubles 0.38 Insolubles 0
Time (hr) Value (a 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 720 1 end_frac_4_daughter_ end_junction junction junction_type downstream_location	ElemIodine 0 sp ElemIodine 0 resusp AIR_ AIR_	OrgIodine 0 OrgIodine 0	PartIodine 0.38 PartIodine 0	Solubles 0.38 Solubles 0	Insolubles 0.38 Insolubles 0
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 720 1 end_frac_4_daughter_ end_junction junction junction junction_type downstream_location upstream	cfm) ElemIodine 0 sp ElemIodine 0 resusp AIR_ AIR_	OrgIodine 0 OrgIodine 0	PartIodine 0.38 PartIodine 0	Solubles 0.38 Solubles 0	Insolubles 0.38 Insolubles 0
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 720 1 end_frac_4_daughter_ end_junction junction junction junction upstream downstream bas filter	cfm) ElemIodine 0 sp ElemIodine 0 resusp AIR_ AIR_ AIR_ envird	OrgIodine 0 OrgIodine 0	PartIodine 0.38 PartIodine 0	Solubles 0.38 Solubles 0	Insolubles 0.38 Insolubles 0
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 720 1 end_frac_4_daughter_ end_junction junction junction junction junction flow.rate	cfm) ElemIodine 0 sp ElemIodine 0 resusp AIR_ AIR_ AIR_ ALT1 enviro true	OrgIodine 0 OrgIodine 0	PartIodine 0.38 PartIodine 0	Solubles 0.38 Solubles 0	Insolubles 0.38 Insolubles 0
Time (hr) Value (a 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 720 1 end_frac_4_daughter_ end_junction junction junction junction junction pystream downstream has_filter flow_rate	cfm) ElemIodine 0 sp ElemIodine 0 resusp AIR_ AIR_ ALT1 enviro true	OrgIodine 0 OrgIodine 0	PartIodine 0.38 PartIodine 0	Solubles 0.38 Solubles 0	Insolubles 0.38 Insolubles 0
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 720 1 end_frac_4_daughter_ end_junction junction junction junction junction upstream downstream has_filter flow_rate Time (hr) Value (c	cfm) ElemIodine 0 sp ElemIodine 0 resusp AIR_ AIR_ ALT1 enviro true	OrgIodine 0 OrgIodine 0	PartIodine 0.38 PartIodine 0	Solubles 0.38 Solubles 0	Insolubles 0.38 Insolubles 0
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 720 1 end_frac_4_daughter_ end_junction junction junction junction junction topstream downstream has_filter flow_rate Time (hr) Value (c 24 0.016	cfm) ElemIodine 0 sp ElemIodine 0 resusp AIR_ AIR_ ALT1 enviro true	OrgIodine OrgIodine O JUNCTION SPACE	PartIodine 0.38 PartIodine 0	Solubles 0.38 Solubles 0	Insolubles 0.38 Insolubles 0
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 720 1 end_frac_4_daughter_ end_junction junction junction junction junction_type downstream location upstream downstream has_filter flow_rate Time (hr) Value (c 24 0.016 720 0.008	cfm) ElemIodine 0 sp ElemIodine 0 resusp AIR_ AIR_ ALT1 enviro true	OrgIodine OrgIodine O JUNCTION SPACE	PartIodine 0.38 PartIodine 0	Solubles 0.38 Solubles 0	Insolubles 0.38 Insolubles 0
Time (hr) Value (c 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 720 1 end_frac_4_daughter_ end_junction junction junction junction junction junction time (hr) Value (c 24 0.016 720 0.008 end_flow_rate	cfm) ElemIodine 0 sp ElemIodine 0 resusp AIR_ ALT1 enviro true	OrgIodine 0 OrgIodine 0	PartIodine 0.38 PartIodine 0	Solubles 0.38 Solubles 0	Insolubles 0.38 Insolubles 0

filter_effic Time No 720	ciency obleGas 0	ElemIodine 0.58	Orglodine	0	PartIodine	Solubles	Insolubles 0.71	0.71
end_filter	_efficiency	0.50		Č		0.71	0.71	0.71
frac_4_da	ughter_rest	isp						
Time No	obleGas	ElemIodine	Orglodine	~	PartIodine	Solubles	Insolubles	
720	 	0 0	0	0		0	0	
end_irac_	4_daughter	_resusp						
X over (	) 4 ctrl ro	om						
Time (hr)	Value (	(s/m*3)						
3.900	0	.00346						
5.900	0.00466							
8.033	0.00346							
24	0.00145							
96	0.00109							
720	0.000992	_						
end_X_ov	/er_Q_4_ct	rl_room						
V anna C	) <b>/</b>							
X_over_(	2_4_site_do	oundary						
3 000	vanue ( O	Sur 3)						
5.900	1	70-3						
720	0	.,						
end_X_ov	er_O_4_sit	e_boundary						
X_over_Q	_4_low_pc	pulation_zone						
Time (hr)	Value (	s/m*3)						
3.900	8	.01e-6						
4.900	2	.74e-5						
5.900		.75e-5						
8.033	8.010-0							
24 06	5 90. 7							
720	3.30c-7							
end X ov	ver $O 4 lo$	w population :	zone					
•••	·· <b>·</b> · ···							
end_junct	ion							
-								
junction								
junction_t	ype	AIR_	JUNCTION					
downstrea	m_location	AIR_S	SPACE					
upstream		ALT						
downstrea	m	ALIS						
flow rate		liuc						
Time (hr)	Value (	cfm)						
24	1.955							
720	0.978							
end_flow_	rate							
	_							
filter_effic	ciency							
Time No	bleGas	ElemIodine	OrgIodine	~	PartIodine	Solubles	Insolubles	
720 ·	U 	0.58		U		0.71	0.71	0.71
ena_nner_	_emciency							
frac 4 da	ughter resu	SD.					•	
Time No	bleGas	ElemIodine	OrgIodine		Partlodine	Solubles	Insolubles	
720	1	0	0		0	0	0	

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end\_frac\_4\_daughter\_resusp

end\_junction

junction junction_type downstream_location upstream downstream has_filter flow_rate	AIR_J AIR_S DW SL2 true	IUNCTION SPACE			
Time (hr) Value ( 24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas	cfm) ElemIodine	Orelofine	PartIodine	Solubles	Insolubles
720 0 end_filter_efficiency	0	0	0	0	0
frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_	sp ElemIodine 0 _resusp	OrgIodine 0	Partlodine 0	Solubles 0	Insolubles 0
end_junction	•				
junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Value ( 24 0.383 720 0.192 end_flow_rate	AIR_J AIR_S SL2 ALT2 true	UNCTION SPACE			
filter_efficiency Time NobleGas 720 0 end_filter_efficiency	ElemIodine 0	OrgIodine 0	PartIodine 0.38	Solubles 0.38	Insolubles 0.38
frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_	sp ElemIodine 0 _resusp	Orglodine 0	PartIodine 0	Solubles 0	Insolubles 0
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Value (o 24 0.016	AIR_J IR_SI ALTZ enviro true	UNCTION PACE 2 onment			

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720 0.008 end_flow_rate					
filter_efficiency					
Time NobleGas	ElemIodine	OrgIodine	Partlodine	Solubles	Insolubles
720 0	0.58	0	0.71	0.71	0.71
end_filter_efficien	icy				
frac_4_daughter_i	esusp FlemIodine	Orglodine	PartIodina	Solubles	Incolublec
720 1	0	Orgiounic	0	0	0
end_frac_4_daugh	ter_resusp	Ū	Ū	Ū	•
X_over_Q_4_ctrl	room				
Time (hr) Valu	ie (s/m*3)				
3.900 0.00346					
5.900 0.004 9.022 0.002	00 46				
8.033 0.003 24 0.0014	40 5				
96 0.0014	9				
720 0.0009	92				
end_X_over_Q_4	_ctrl_room				
X_over_Q_4_site	boundary				
11me(nr) value $2.000$	ie (s/m+3)				
5.900	0 1 7e-3				
720 0	1.70-5				
end_X_over_Q_4	_site_boundary				
X_over_Q_4_low_	_population_zone	:			
Time (hr) Valu	e (s/m*3)				
3.900	8.010-0 2.74e-5				
5 900	1 75e-5				
8.033 8.01e	6				
24 1.00e-6	-				
96 5.80e-7	r				
720 3.37e-	7				
end_X_over_Q_4_	_low_population_	zone			
end_junction					
iunction					
junction_type	AIR_JU	NCTION			
downstream_locati	on AIR_SF	PACE			
upstream	ALT2				
downstream	ALT3				
has_filter	true				
flow_rate	- (				
1  ime(nr)  valu	e (cim)				
24 1.933 720 0.078					
end flow rate					
filter_efficiency	<b></b>	_			
Time NobleGas	ElemIodine	Orglodine	PartIodine	Solubles	Insolubles
120 U	U.58	U	0.71	0.71	0.71
end_mer_emclen	-y				

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frac_4_daughter_resu Time NobleGas 720 1 0 end_frac_4_daughter_	sp ElemIodine 0 _resusp	Orglodine 0	Partlodine 0 0	Solubles	Insolubles
end_junction					
junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Value (of 24 2.05 720 1.03 end_flow_rate	AIR_ AIR_ ALT3 envirou true	JUNCTION SPACE			
filter_efficiency Time NobleGas 720 0 end filter efficiency	ElemIodine 0.998	OrgIodine 0	PartIodine 0.951	Solubles 0.951	Insolubles 0.951
frac_4_daughter_resu: Time NobleGas 720 i end_frac_4_daughter_	sp ElemIodine 0 resusp	Orglodine 0	PartIodine 0	Solubles 0	Insolubles O
X_over_Q_4_ctrl_roo Time (hr) Value (s 3.900 0.0 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_site_bou X_over_Q_4_site_bou	om s/m*3) 00346 L_room undary				
Time (hr) Value (s	:/m*3)				
5.900 1. <sup>4</sup>	7e-3				
end_X_over_Q_4_site	e_boundary				
X_over_Q_4_low_pop Time (hr) Value (s 3.900 8.0 4.900 2.7 5.900 1.7 8.033 8.01e-6 24 1.00e-6 96 5.80e-7 720 3.37e-7 end_X_over_Q_4_low	pulation_zone /m*3) D1e-6 74e-5 75e-5 v_population_z	one			
end_junction					

ene\_jenene

junction

AIR\_JUNCTION junction\_type AIR\_SPACE downstream\_location upstream WW downstream DW has\_filter false flow\_rate Time (hr) Value (cfm) 2.035 0 720 1.284e+005 end\_flow\_rate end\_junction junction AIR\_JUNCTION junction\_type AIR\_SPACE downstream\_location ww upstream downstream environment has\_filter faise flow\_rate Value (cfm) Time (hr) 720 0 end\_flow\_rate X\_over\_Q\_4\_ctrl\_room Time (hr) Value (s/m\*3) 0 720 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) 0 720 end\_X\_over\_Q\_4\_low\_population\_zone end\_junction junction junction\_type AIR\_JUNCTION downstream\_location AIR\_SPACE upstream WW downstream RB has\_filter false flow\_rate Time (hr) Value (cfm) 0.167 0 24 0.577 720 0.289 end\_flow\_rate end\_junction junction AIR\_JUNCTION junction\_type downstream\_location AIR\_SPACE upstream ww downstream environment has\_filter true

flow_rate					
Time (hr) Value (c	fm)				
192 0.0					
720 U.U and flow rate					
chd_now_tate					
filter_efficiency					
Time NobleGas	ElemIodine	Orglodine	PartIodine	Solubles	Insolubles
720 0	0.95	0.95	0.95	0.95	0.95
end_filter_efficiency					
for a develter marie	-				
Time NobleCas	p FlemIodine	Oralodina	PartIodine	Solubles	Incomples
720 1 1	n			30100103	monutes
end frac 4 daughter	resusp	Č .			
····_·	F				
X_over_Q_4_ctrl_room	m				
Time (hr) Value (si	/m*3)				
720 0					
end_X_over_Q_4_ctrl	_room				
V avec O I site have	a dom.				
X_over_Q_4_site_bou	ndary (m#3)				
720 $1000$	(m <sup>2</sup> 5)				
end X over O 4 site	boundary				
X_over_Q_4_low_pop	ulation_zone				
Time (hr) Value (s/	/m*3)				
720 0					
end_X_over_Q_4_low	_population_2	tone			
and investor					
end_junction					
end_junction					
end_junction junction junction_type	AIR_J	IUNCTION			
end_junction junction junction_type downstream_location	AIR_J AIR_S	UNCTION SPACE			
end_junction junction junction_type downstream_location upstream	AIR_J AIR_S SP	UNCTION SPACE			
end_junction junction junction_type downstream_location upstream downstream	AIR_) AIR_S SP RB	UNCTION SPACE			
end_junction junction_type downstream_location upstream downstream has_filter	AIR_J AIR_S SP RB true	UNCTION SPACE			
end_junction junction_type downstream_location upstream downstream has_filter flow_rate	AIR_J AIR_S SP RB true	UNCTION PACE			
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm	AIR_J AIR_S SP RB true	UNCTION PACE			
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm 720 0.13	AIR_J AIR_S SP RB true	UNCTION PACE			
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm 720 0.13 end_flow_rate	AIR_J AIR_S SP RB true n)	IUNCTION PACE			
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm 720 0.13 end_flow_rate filter efficiency	AIR_) AIR_S SP RB true	UNCTION SPACE			
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm 720 0.13 end_flow_rate filter_efficiency Time NobleGas	AIR_J AIR_S SP RB true n)	UNCTION PACE OrgIodine	PartIodine	Solubles	Insolubles
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm 720 0.13 end_flow_rate filter_efficiency Time NobleGas 1 720 0	AIR_J AIR_S SP RB true n) ElemIodine .9	UNCTION PACE OrgIodine .9	PartIodine .9	Solubles 0	Insolubles 0
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm 720 0.13 end_flow_rate filter_efficiency Time NobleGas 1 720 0 end_filter_efficiency	AIR_J AIR_S SP RB true n) ElemIodine .9	UNCTION PACE OrgIodine .9	PartIodine .9	Solubles 0	Insolubles 0
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm 720 0.13 end_flow_rate filter_efficiency Time NobleGas 1 720 0 end_filter_efficiency	AIR_J AIR_S SP RB true n) ElemIodine .9	UNCTION PACE OrgIodine .9	PartIodine .9	Solubles 0	Insolubles 0
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm 720 0.13 end_flow_rate filter_efficiency Time NobleGas 1 720 0 end_filter_efficiency	AIR_J AIR_S SP RB true n) ElemIodine .9	UNCTION PACE OrgIodine .9	Partlodine .9	Solubles 0	Insolubles 0
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm 720 0.13 end_flow_rate filter_efficiency Time NobleGas 1 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 1	AIR_J AIR_S SP RB true n) ElemIodine .9 P ElemIodine	UNCTION PACE OrgIodine .9 OrgIodine	PartIodine .9 PartIodine	Solubles 0 Solubles	Insolubles 0 Insolubles
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm 720 0.13 end_flow_rate filter_efficiency Time NobleGas 1 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 1 720 0 end_frac_4_daughter_resus	AIR_J AIR_S SP RB true n) ElemIodine .9 P ElemIodine 0 resuso	OrgIodine OrgIodine 0	PartIodine .9 PartIodine 0	Solubles 0 Solubles 0	Insolubles O Insolubles O
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm 720 0.13 end_flow_rate filter_efficiency Time NobleGas 1 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 1 720 0 end_frac_4_daughter_t	AIR_J AIR_S SP RB true n) ElemIodine .9 ElemIodine 0 resusp	UNCTION SPACE OrgIodine .9 OrgIodine 0	PartIodine .9 PartIodine 0	Solubles 0 Solubles 0	Insolubles O Insolubles O
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm 720 0.13 end_flow_rate filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas Time NobleGas end_frac_4_daughter_t end_junction	AIR_J AIR_S SP RB true n) ElemIodine .9 ElemIodine 0 resusp	UNCTION PACE OrgIodine .9 OrgIodine 0	PartIodine .9 PartIodine 0	Solubles 0 Solubles 0	Insolubles 0 Insolubles 0
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm 720 0.13 end_flow_rate filter_efficiency Time NobleGas 1 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 1 720 0 end_frac_4_daughter_1 end_junction	AIR_J AIR_S SP RB true n) ElemIodine .9 ElemIodine 0 resusp	UNCTION PACE OrgIodine .9 OrgIodine 0	PartIodine .9 PartIodine 0	Solubles O Solubles O	Insolubles O Insolubles O
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm 720 0.13 end_flow_rate filter_efficiency Time NobleGas 1 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 1 720 0 end_frac_4_daughter_resus Time NobleGas 1 720 0 end_frac_4_daughter_resus Time NobleGas 1 720 0 end_frac_4_daughter_resus	AIR_J AIR_S SP RB true n) ElemIodine .9 ElemIodine 0 resusp	UNCTION PACE OrgIodine .9 OrgIodine 0	PartIodine .9 PartIodine 0	Solubles O Solubles O	Insolubles O Insolubles O
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm 720 0.13 end_flow_rate filter_efficiency Time NobleGas 1 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 1 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 1 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 1 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 1 720 0 end_filter_officiency	AIR_J AIR_S SP RB true n) ElemIodine .9 ElemIodine 0 resusp	UNCTION PACE OrgIodine .9 OrgIodine 0	PartIodine .9 PartIodine 0	Solubles 0 Solubles 0	Insolubles O Insolubles O
end_junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfm 720 0.13 end_flow_rate filter_efficiency Time NobleGas 1 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 1 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 1 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 1 720 0 end_filter_efficiency frac_4_daughter_resus Time NobleGas 1 720 0 end_filter_efficiency	AIR_J AIR_S SP RB true n) ElemIodine .9 ElemIodine 0 resusp AIR_J AIR_J	UNCTION PACE OrgIodine .9 OrgIodine 0	PartIodine .9 PartIodine 0	Solubles 0 Solubles 0	Insolubles O Insolubles O

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downstream	envir	onment			
has_filter	true				
flow_rate					
Time (hr) Value (	cfm)				
720 1500					
end flow rate					
filter efficiency					
Time NobleGas	FlamIndina	Oralodina	PortIodine	Solubles	Incolubles
	Licimodine 0.05	Orgiounic	1 4100000	0.05	0.05
120 0	0.95	0.95	0.95	0.95	0.95
end_inter_enciency					
Constant de la coltate de constant					
trac_4_daugnter_resu	sp	0 T F	<b>D</b> ( <b>I !</b>		
Time NobleGas	Elemiodine	Orgloaine	Partiodine	Solubles	Insolubles
720 1	1	0	0	0	0
end_frac_4_daughter_	_resusp				
X_over_Q_4_ctrl_roo	om				
Time (hr) Value (s	s/m*3)				
1.300 8.1	28e-7				
3.300 1.	92e-5				
8.033 8.28e-7					
24 3.36e-7					
96 3.08e-7					
70 1 70e-7					
and V over O A stri	1				
V aver O A site has	undo-				
A_over_Q_4_site_dot	unuary				
Time (nr) Value (s	s/m+3)				
1.300 0					
1.800 2.	03e-4				
2.300 1.5	54e-4				
3.300 9.	17e-5				
720 0					
end_X_over_Q_4_site	e_boundary				
X_over_Q_4_low_po	pulation_zone				
Time (hr) Value (s	s/m*3)				
1.300 1.0	01e-5				
2.300 2.5	55e-5				
3.300 1.5	87e-5				
8.033 1	.01e-5				
24 1.	09e-6				
96 6	90e-7				
720 4	61e-7				
end X over O 4 lov	v nonulation :	70ne			
	-population_	Lonc			
and junction					
end_junction					
in attac					
Junction					
junction_type	AIK_				
downstream_location	AIR_SI	ACE			
upstream	environ	ment			
downstream	Control_	Room			
has_filter	false				
flow_rate					
Time (hr) Value (c	:fm)				
720 3700	-				
end flow rate					
end junction					
and Juneaon					

junction AIR\_JUNCTION junction\_type AIR\_SPACE downstream\_location Control\_Room upstream downstream environment has\_filter false flow\_rate Value (cfm) Time (hr) 3700 720 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

environment breathing\_rate\_sb Time (hr) Value (cms) 24 0.00035 720 0.0 end\_breathing\_rate\_sb

breathing\_rate\_lpz Time (hr) Value (cms) 8.033 0.00035 24 0.00018 720 0.00023 end\_breathing\_rate\_lpz

end\_environment

## Attachment B-3 STARDOSE Main Input File for DBA-LOCA with MSIV Failure

edit\_time 96 240 2.033 8.033 24 720 0 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 Sb129 Te127m Te127 Te129m Te129 Te131m Te132 Sb127 Ba137m Ba139 Ba140 Mo99 Tc99m Ru103 Ru105 Ru106 Rh105 Y91 Y92 Y93 Zr95 Zr97 Nb95 Y90 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 1950 elemental\_iodine\_frac 0.0485 organic\_iodine\_frac 0.0015 particulate\_iodine\_fra 0.95 release\_frac DW to\_control\_volume Time N\_Gas I\_Grp CsGrp TeGrp BaGrp NMtls CeGrp LaGrp SrGrp 0.033 0 0 0 0 0 0 0 0 0 0.533 0.1 0.1 0.1 0 0 0 0 0 0 0.167 0.133 0.033 0.0133 0.00167 0.00033 0.00013 0.0133 2.033 0.633 720 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 0.033 0 0 0 0 0 0 0 0 0 0 0 0 0 0.533 0 0.1 0 0 0 0 2.033 0 0.167 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\_CV obj\_type DW name 1.284e+005 air\_volume water\_volume 0 surface\_area 1 has\_recirc\_filter false removal\_rate\_to\_surface Time NobleGas ElemIodine OrgIodine Partlodine Solubles Insolubles 0.25 0. 0. 0. 0 0 0

2.0667 720 end_remova	0. 0. I_rate_to_s	20. 2.0 surface	0. 0.	20. 2.0	20. 2.0	20. 2.0
frac_4_daug Time Nob 720 end_frac_4_	shter_resus leGas l 1 _daughter_r	p_from_surfa ElemIodine 0 resusp_from_s	ce OrgIodine 0 surface	Partlodine 0	Solubles 0	Insolubles 0
end_control	_volume					
control_volu	ume					
obj_type		OBJ_C	V			
name		ww				
air_volume		1.039e+	-005			
water_volur	ne	6.8e+0	04			
surface_area	) ~1.	0				
has_recirc_1	hiter	false				
removal_rat	e_to_water	pool FlomIodino	Oraladina	Deutlodine	Calublas	Turalitation
Time Nob	leGas I		Orgioaine	Partiodine	Solubles	Insolubles
720	U Jirota to v	U.U	0	0.0	0.0	0.0
chu_iemova		waterpoor				
frac 4 daug	ther resust	n from water				
Time Nob	leGas I	ElemIodine	Orglodine	PartIodine	Solubles	Insolubles
720	1	0	0	- and outline	0	0 0
end frac 4	daughter r	esusp from v	vater		•	• •
		1				
decontamina	ation_factor	r				
Time Nob	leGas I	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	1	1	1	1	1
end_deconta	amination_f	factor				
end_control	_volume					
control volu	ime					
obi type		OBJ C	v			
name		RB				
air_volume		1.5e+003	;			
water_volur	ne	0				
surface_area	1	0				
has_recirc_f	ilter	false				
end_control	_volume					
control_volu	ime	0.0.1				
obj_type		OBJ_C	V			
name		SL2				
air_volume		20				
surface area		0				
bas recirc f	i ilter	falce				
end control	volume	10150				
control_volu	ime					
obj_type		OBJ_CV	V			
name		ALT1				
air_volume		526				
water_volun	ne	0				
surface_area	l –	0				
has_recirc_f	ilter	false				

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end\_control\_volume

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control_volume obj_type name air_volume water_volume surface_area has_recirc_filter end_control_volume	OBJ_CV ALT2 526 0 0 false
control_volume obj_type name air_volume water_volume surface_area has_recirc_filter end control volume	OBJ_CV ALT3 1.07E5 0 0 false
control_volume obj_type name air_volume water_volume surface_area has_recirc_filter end_control_volume	OBJ_CV SP 6.8e+004 0 0 false
control_volume obj_type name air_volume water_volume surface_area has_recirc_filter breathing_rate Time (hr) Value (cms)	OBJ_CR Control_Room 4.153e4 0 0 false
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_type downstream_location upstream flow_rate Time (hr) Rate (cfm) 0.533 1 720 1	AIR_JUNCTION AIR_SPACE CORE DW
end_flow_rate	

has\_filter false end\_junction junction junction\_type AIR\_JUNCTION downstream\_location AIR\_SPACE upstream CORE downstream SP flow\_rate Rate (cfm) Time (hr) 0.533 1 720 1 end\_flow\_rate has\_filter false end\_junction junction AIR\_JUNCTION junction\_type downstream\_location AIR\_SPACE DW upstream downstream WW has\_filter false flow\_rate Time (hr) Value (cfm) 2.033 0 720 1.284e+005 end\_flow\_rate end\_junction junction junction\_type AIR\_JUNCTION downstream\_location AIR\_SPACE upstream DW downstream environment has\_filter false flow\_rate Time (hr) Value (cfm) 0 720 end\_flow\_rate X\_over\_Q\_4\_ctrl\_room Value (s/m\*3) Time (hr) 720 2.98e-3 end\_X\_over\_Q\_4\_ctrl\_room X\_over\_Q\_4\_site\_boundary Time (hr) Value (s/m\*3) 1.476e-3 720 end\_X\_over\_Q\_4\_site\_boundary X\_over\_Q\_4\_low\_population\_zone Time (hr) Value (s/m\*3) 720 5.253e-5 end\_X\_over\_Q\_4\_low\_population\_zone end\_junction junction AIR\_JUNCTION junction\_type

AIR\_SPACE

downstream\_location

DW upstream downstream environment has\_filter false flow\_rate Time (hr) Value (cfm) 24 0.031 0.016 720 end\_flow\_rate X\_over\_Q\_4\_ctri\_room Value (s/m\*3) Time (hr) 2.033 0.00225 0.000818 8.033 24 0.000353 96 0.000277 720 0.000223 end\_X\_over\_Q\_4\_ctrl\_room X\_over\_Q\_4\_site\_boundary Value (s/m\*3) Time (hr) 2.033 1.476e-3 8.033 0 0 24 96 0 720 0 end\_X\_over\_Q\_4\_site\_boundary X\_over\_Q\_4\_low\_population\_zone Time (hr) Value (s/m\*3) 2.033 5.253e-5 8.033 2.227e-5 24 1.469e-5 96 5.948e-6 720 1.625e-6 end\_X\_over\_Q\_4\_low\_population\_zone end\_junction junction junction\_type AIR\_JUNCTION downstream\_location AIR\_SPACE DW upstream downstream RB has\_filter false flow\_rate Time (hr) Value (cfm) 0.713 24 720 0.357 end\_flow\_rate end\_junction junction AIR\_JUNCTION junction\_type AIR\_SPACE downstream\_location upstream DW downstream ALT1 has\_filter true flow\_rate Time (hr) Value (cfm)

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24 0.383					
720 0.192					
end_flow_rate					
filter_efficiency			De de Para	0.1.17	T h. h. l
Time NobieGas	Elemiodine	Orgiodine	Partiodine	Solubles	Insolubles
and filter efficiency	U	U	Ū	U	0
ena_inter_enterency					
frac 4 daughter res	uso				
Time NobleGas	ElemIodine	Orglodine	PartIodine	Solubles	Insolubles
720 1	0	0	0	0	0
end_frac_4_daughter	r_resusp				
end_junction					
junction		UNOTION			
junction_type	AIK_J	UNCTION			
downstream_location		PACE			
downstream	ALII	nment			
has filter	true				
flow rate	u uc				
Time (hr) Value	(cfm)				
24 0.016	()				
720 0.008					
end_flow_rate					
filter_efficiency		<b>.</b>	<b>D</b> .7 4		
Time NobleGas	Elemiodine	Orglodine	Partiodine	Solubles	Insolubles
720 0 0	0.58	U	0.71	0.71	0.71
end_mer_enciency					
frac 4 daughter resu	150				
frac_4_daughter_resu Time NobleGas	ısp ElemIodine	Orglodine	PartIodine	Solubles	Insolubles
frac_4_daughter_rest Time NobleGas 720 1	ısp ElemIodine 0	Orglodine 0	PartIodine 0	Solubles 0	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter	usp ElemIodine 0 _resusp	Orglodine 0	PartIodine 0	Solubles 0	Insolubles 0
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter	usp ElemIodine 0 -resusp	Orglodine 0	PartIodine 0	Solubles 0	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro	usp ElemIodine 0 _resusp om	Orglodine 0	PartIodine 0	Solubles 0	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value (	usp ElemIodine 0 ·_resusp om (s/m*3)	Orglodine 0	PartIodine 0	Solubles 0	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value ( 3.900 0	usp ElemIodine 0 c_resusp om (s/m*3) 0.00346	Orglodine 0	PartIodine 0	Solubles 0	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value ( 3.900 0 5.900 0.00466 8.033 0.00346	usp ElemIodine 0 resusp om (s/m*3) 0.00346	Orglodine 0	PartIodine 0	Solubles 0	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value ( 3.900 0 5.900 0.00466 8.033 0.00346 24 0.00145	usp ElemIodine 0 ·_resusp om (s/m*3) :.00346	Orglodine 0	PartIodine 0	Solubles 0	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value ( 3.900 0 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109	usp ElemIodine orresusp om (s/m*3) 0.00346	Orglodine 0	PartIodine 0	Solubles O	Insolubles O
frac_4_daughter_rest     Time   NobleGas     720   1     end_frac_4_daughter     X_over_Q_4_ctrl_ro     Time (hr)   Value (     3.900   0     5.900   0.00466     8.033   0.00346     24   0.00145     96   0.00109     720   0.000992	USP ElemIodine O resusp om (s/m*3) 000346	Orglodine 0	PartIodine 0	Solubles O	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value ( 3.900 0 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ct	usp ElemIodine 0 c_resusp om (s/m*3) 0.00346	Orglodine 0	PartIodine 0	Solubles O	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value ( 3.900 0 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctrl_ro 5.000 0.000922 end_X_over_Q_4_ctrl_ro 5.000 0.000922 5.000 0.000922 5.0000922 5.0000922 5.000 0.000922 5.0000922 5.0000922 5.0000922 5.0000000922 5.000000922 5.000000000000000000000000000000000000	ISP ElemIodine 0 resusp om (s/m*3) .00346 	Orglodine 0	PartIodine 0	Solubles O	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value ( 3.900 0 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_site_bo	usp ElemIodine 0 resusp om (s/m*3) .00346 .00346 c rl_room	Orglodine 0	PartIodine 0	Solubles O	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value ( 3.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctrl X_over_Q_4_site_bo Time (hr) Value ( 2.000 0.000	USP ElemIodine 0 '_resusp om (s/m*3) 200346 cl_rl_room pundary (s/m*3)	Orglodine 0	PartIodine 0	Solubles O	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value ( 3.900 0 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctrl X_over_Q_4_site_bo Time (hr) Value ( 3.900 0	USP ElemIodine 0 resusp om (s/m*3) 0.00346 rl_room oundary (s/m*3)	Orglodine 0	PartIodine 0	Solubles O	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value ( 3.900 0 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctrl X_over_Q_4_site_bo Time (hr) Value ( 3.900 0 5.900 1 720 0	Lisp ElemIodine 0 resusp om (s/m*3) 00346 	Orglodine 0	PartIodine 0	Solubles O	Insolubles O
frac_4_daughter_rest   Time NobleGas   720 1   end_frac_4_daughter   X_over_Q_4_ctrl_ro   Time (hr) Value (10,000,000,000,000,000,000,000,000,000,	Isp ElemIodine 0 -resusp om (s/m*3) 00346 rl_room oundary (s/m*3) .7e-3 te boundary	Orglodine O	PartIodine 0	Solubles O	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value ( 3.900 0 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctrl X_over_Q_4_site_bo Time (hr) Value ( 3.900 0 5.900 1 720 0 end_X_over_Q_4_site	Lisp ElemIodine 0 -resusp om (s/m*3) 00346 rl_room oundary (s/m*3) .7e-3 te_boundary	Orglodine O	PartIodine 0	Solubles O	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value ( 3.900 0 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctrl X_over_Q_4_site_bo Time (hr) Value ( 3.900 0 5.900 1 720 0 end_X_over_Q_4_site X_over_Q_4_site X_over_Q_4_site	Jsp ElemIodine 0 -resusp om (s/m*3) 00346 rl_room oundary (s/m*3) .7e-3 te_boundary opulation_zone	Orglodine O	PartIodine 0	Solubles O	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value ( 3.900 0 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctrl X_over_Q_4_site_bo Time (hr) Value ( 3.900 0 5.900 1 720 0 end_X_over_Q_4_site X_over_Q	usp ElemIodine 0 resusp om (s/m*3) 00346 rl_room oundary (s/m*3) .7e-3 te_boundary opulation_zone (s/m*3)	Orglodine O	PartIodine 0	Solubles O	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value ( 3.900 0 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctrl X_over_Q_4_site_bo Time (hr) Value ( 3.900 0 5.900 1 720 0 end_X_over_Q_4_site X_over_Q_4_low_po Time (hr) Value ( 3.900 8	Isp ElemIodine 0 -resusp om (s/m*3) .00346 rl_room oundary (s/m*3) .7e-3 te_boundary opulation_zone (s/m*3) .01e-6	Orglodine 0	PartIodine 0	Solubles	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value ( 3.900 0 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctt X_over_Q_4_site_bo Time (hr) Value ( 3.900 0 5.900 1 720 0 end_X_over_Q_4_site X_over_Q_4_low_po Time (hr) Value ( 3.900 8 4.900 2	Isp ElemIodine 0 resusp om (s/m*3) .00346 rl_room oundary (s/m*3) .7e-3 te_boundary opulation_zone (s/m*3) .01e-6 .74e-5	Orglodine 0	PartIodine 0	Solubles	Insolubles O
frac_4_daughter_rest Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_ro Time (hr) Value ( 3.900 0 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctrl X_over_Q_4_site_bo Time (hr) Value ( 3.900 0 5.900 1 720 0 end_X_over_Q_4_site X_over_Q_4_low_po Time (hr) Value ( 3.900 8 4.900 2 5.900 1	Isp ElemIodine 0 resusp om (s/m*3) .00346 .00346 com sundary (s/m*3) 7e-3 te_boundary pulation_zone s/m*3) .01e-6 .74e-5 .75e-5	Orglodine 0	PartIodine 0	Solubles	Insolubles O

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24 1.00e-6					
96 5.80e-7					
720 3.37e-7					
end X over O 4 lo	w nonulation	2006			
01071701017674710	-population_	_20110			
end_junction					
iunction					
junction type	AIR I	UNCTION			
dounstream location		DACE			
downstream_location	ו הנוג_י אדידו	JIACE			
upsitean	ALII				
downstream	ALT3				
has_filter	true				
flow_rate					
Time (hr) Value (	(cfm)				
24 1.955					
720 0.978					
end_flow_rate					
filter efficiency					
Time NobleGas	FlemIodine	Orglodine	PartIodine	Solubles	Incolubles
720 0	0 58	A	0.71	0.71	11130100/C3 0 71
and filter officiance	0.56	U	0.71	0.71	0.71
end_inter_enciency					
free & development					
Trac_4_daugnier_resu	isp	<b>.</b>	<b>N</b> . <b>I I</b>		
Time NobleGas	Elemiodine	Orgiodine	Partiodine	Solubles	Insolubles
720 1	0	0	U	0	0
end_frac_4_daughter	_resusp				
end_junction					
junction					
junction_type	AIR_	JUNCTION			
downstream location	AIR	SPACE			
upstream	DW				
downstream	SL2				
has filter	true				
flow rate	400				
Time (hr) Value (	ofm)				
	cim)				
24 U.363 720 0.102					
720 0.192					
end_liow_rate					
filter_efficiency					
Time NobleGas	ElemIodine	Orglodine	PartIodine	Solubles	Insolubles
720 0	0	0	0	0	0
end_filter_efficiency					
frac_4_daughter_resu	sp				
Time NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720 1	0	0	0	0	0
end frac 4 daughter	resusp				
end junction					
innetion					
junction tree		INCTION			
Junction_type	AIK_J				
uownstream_location	1 Th 7				
	AIR_S	PACE			
upstream	AIR_S SL2	PACE			
upstream downstream	AIR_S SL2 ALT2	PACE			

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now_rate					
Time (hr) Value (	cfm)				
24 0.383					
720 0.192					
end_flow_rate					
filter officianau					
Time NobleGas	FlemIndine	Orolodine	PartIodine	Solubles	Incolubles
720 0	n n	0	0.38	0 38	0.38
end filter efficiency	v	Ŭ	0.50	0.50	0.50
ena_mar_ennerency					
frac_4_daughter_resu	ISP				
Time NobleGas	ElemIodine	Orglodine	PartIodine	Solubles	Insolubles
720 1	0	0	0	0	0
end_frac_4_daughter	_resusp				
-	_				
end_junction					
•					
junction	AID				
Junction_type		SDACE			
uowiistream_location		SFACE			
downstream	AL12	nment			
has filter	true	mont			
flow rate					
Time (hr) Value (	cfm)				
24 0.016	,				
720 0.008					
end flow rate					
filter_efficiency					
filter_efficiency Time NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
filter_efficiency Time NobleGas 720 0	ElemIodine 0.58	OrgIodine 0	PartIodine 0.71	Solubles 0.71	Insolubles 0.71
filter_efficiency Time NobleGas 720 0 end_filter_efficiency	ElemIodine 0.58	OrgIodine 0	PartIodine 0.71	Solubles 0.71	Insolubles 0.71
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac 4 daughter resu	ElemIodine 0.58	OrgIodine 0	PartIodine 0.71	Solubles 0.71	Insolubles 0.71
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas	ElemIodine 0.58	OrgIodine 0 OrgIodine	PartIodine 0.71 PartIodine	Solubles 0.71 Solubles	Insolubles 0.71 Insolubles
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1	ElemIodine 0.58 sp ElemIodine 0	OrgIodine 0 OrgIodine 0	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71 Insolubles 0
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_	ElemIodine 0.58 Isp ElemIodine 0 _resusp	OrgIodine 0 OrgIodine 0	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71 Insolubles 0
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_	ElemIodine 0.58 Isp ElemIodine 0 _resusp	OrgIodine 0 OrgIodine 0	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71 Insolubles 0
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_ X_over_Q_4_ctrl_roo	ElemIodine 0.58 ElemIodine 0 _resusp	OrgIodine 0 OrgIodine 0	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71 Insolubles 0
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_ X_over_Q_4_ctrl_roo Time (hr) Value (0	ElemIodine 0.58 ElemIodine 0 _resusp om s/m*3) 00246	OrgIodine 0 OrgIodine 0	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71 Insolubles 0
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter X_over_Q_4_ctrl_roo Time (hr) Value ( 3.900 0.00466	ElemIodine 0.58 ElemIodine 0 _resusp om s/m*3) .00346	OrgIodine 0 OrgIodine 0	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71 Insolubles 0
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_ X_over_Q_4_ctrl_roo Time (hr) Value (0 3.900 0.00466 \$ 023 0.00466	ElemIodine 0.58 ElemIodine 0 _resusp om s/m*3) .00346	OrgIodine 0 OrgIodine 0	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71 Insolubles 0
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_ X_over_Q_4_ctrl_roo Time (hr) Value (0 3.900 0.00466 8.033 0.00346	ElemIodine 0.58 ElemIodine 0 _resusp om s/m*3) .00346	OrgIodine 0 OrgIodine 0	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71 Insolubles 0
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_ X_over_Q_4_ctrl_roo Time (hr) Value (0 3.900 0.00466 8.033 0.00346 24 0.00145 96 0.000	ElemIodine 0.58 ElemIodine 0 _resusp om s/m*3) .00346	OrgIodine OrgIodine O	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71 Insolubles 0
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_ X_over_Q_4_ctrl_root Time (hr) Value ( 3.900 0.0 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0 000992	ElemIodine 0.58 sp ElemIodine 0 _resusp om s/m*3) 00346	OrgIodine OrgIodine O	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71 Insolubles 0
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_ X_over_Q_4_ctrl_roo Time (hr) Value ( 3.900 0. 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end X over Q 4 ctrl	ElemIodine 0.58 ElemIodine 0_resusp om s/m*3) 00346	OrgIodine OrgIodine O	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71 Insolubles 0
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_ X_over_Q_4_ctrl_roc Time (hr) Value ( 3.900 0.0 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctrl	ElemIodine 0.58 ElemIodine 0 _resusp om s/m*3) 00346	OrgIodine OrgIodine O	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71 Insolubles 0
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_ X_over_Q_4_ctrl_roo Time (hr) Value (0) 3.900 0. 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctrl X_over_Q_4_site_bo	ElemIodine 0.58 ElemIodine 0 _resusp om s/m*3) .00346	OrgIodine OrgIodine O	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71 Insolubles 0
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_ X_over_Q_4_ctrl_row Time (hr) Value (1) 3.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctrl X_over_Q_4_site_bo Time (hr) Value (1)	ElemIodine 0.58 sp ElemIodine 0 _resusp om s/m*3) .00346 fl_room undary s/m*3)	OrgIodine OrgIodine O	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71 Insolubles 0
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_ X_over_Q_4_ctrl_roo Time (hr) Value (0 3.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctrl X_over_Q_4_site_bo Time (hr) Value (0 3.900 0	ElemIodine 0.58 sp ElemIodine 0 _resusp om s/m*3) .00346 d_room undary s/m*3)	OrgIodine OrgIodine O	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71 Insolubles 0
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_ X_over_Q_4_ctrl_roo Time (hr) Value (0 3.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctrl X_over_Q_4_site_bo Time (hr) Value (0 3.900 0 5.900 1.	ElemIodine 0.58 sp ElemIodine 0 _resusp om s/m*3) .00346 d_room undary s/m*3) .7e-3	OrgIodine OrgIodine O	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_ X_over_Q_4_ctrl_roo Time (hr) Value (0 3.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_site_bo Time (hr) Value (0 3.900 0 5.900 1. 720 0	ElemIodine 0.58 sp ElemIodine 0 _resusp om s/m*3) 00346 d_room undary s/m*3) .7e-3	OrgIodine OrgIodine O	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71 Insolubles 0
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_ X_over_Q_4_ctrl_roo Time (hr) Value ( 3.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_site_bo Time (hr) Value ( 3.900 0 5.900 1. 720 0 end_X_over_Q_4_site_bo	ElemIodine 0.58 sp ElemIodine 0 _resusp om s/m*3) 00346 d_room undary s/m*3) .7e-3 e_boundary	OrgIodine OrgIodine O	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_ X_over_Q_4_ctrl_root Time (hr) Value ( 3.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_site_bo Time (hr) Value ( 3.900 0 5.900 1. 720 0 end_X_over_Q_4_site V_over_Q_4_site	ElemIodine 0.58 sp ElemIodine 0_resusp om s/m*3) 00346 d_room undary s/m*3) .7e-3 e_boundary	OrgIodine OrgIodine O	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_ X_over_Q_4_ctrl_root Time (hr) Value (1) 3.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_site_bot Time (hr) Value (1) 3.900 0 5.900 1. 720 0 end_X_over_Q_4_site X_over_Q_4_site_bot Time (hr) Value (1) 3.900 0 5.900 1. 720 0 end_X_over_Q_4_site	ElemIodine 0.58 sp ElemIodine 0 _resusp om s/m*3) 00346 d_room undary s/m*3) .7e-3 e_boundary	OrgIodine OrgIodine O	PartIodine 0.71 PartIodine 0	Solubles 0.71 Solubles 0	Insolubles 0.71
filter_efficiency Time NobleGas 720 0 end_filter_efficiency frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter. X_over_Q_4_ctrl_roo Time (hr) Value ( 3.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctrl X_over_Q_4_site_bo Time (hr) Value ( 3.900 0 5.900 1. 720 0 end_X_over_Q_4_sit X_over	ElemIodine 0.58 sp ElemIodine 0 _resusp om s/m*3) 00346 d_room undary s/m*3) .7e-3 e_boundary pulation_zone s/m*3) 01e 6	OrgIodine O	PartIodine 0.71 PartIodine 0	Solubles 0.71	Insolubles 0.71

0.71

4.900	2.74e-5				
5.900	1.75e-5				
8.033 8.01e-	6				
24 1.00e-6					
96 5.80e-7	_				
720 3.37e-	<b>,</b> , , ,				
end_X_over_Q_4_	low_population	_zone			
end_junction					
junction					
junction_type	AIR	JUNCTION			
downstream_locati	on AIR	_SPACE			
upstream	ALT	2			
downstream	ALT	[3			
has_niter	true	1			
Time (hr) Valu	e (cfm)				
$\frac{11110}{24}$	e (ciiii)				
720 0.978					
end flow rate					
una_no n_nate					
filter_efficiency					
Time NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720 0	0.58	0	0.71	0.71	0.
end_filter_efficien	cy				
free & development					
Time NobleGas	FlemIndine	Oralodine	PartIndine	Solubles	Insolubles
720 1	Cicilitatine O	0 Orgiounic	0	0	0
end frac 4 daught	er_resusp	Ū	· ·	v	Ū
end_junction					
junction	4.10	HINGTON			
junction_type		JUNCTION			
downstream_locati		_oface			
downstream	envi	ronment			
has filter	true	10milent			
flow_rate					
Time (hr) Valu	e (cfm)				
24 2.05					
720 1.03					
end_flow_rate					
Cites all states					
Time NobleGoc	FlamIndina	Oralodine	DortIndine	Solubles	Incolubles
720 0		Orgiodalic	0.951	0 951	0.951
end filter efficiend	ev ev	Ū	0.701	0.701	0.001
	- J				
frac_4_daughter_re	esusp				
Time NobleGas	ElemIodine	Orglodine	PartIodine	Solubles	Insolubles
720 1	0	0	0	0	0
end_frac_4_daught	er_resusp				
V over O A and					
$\pi_0$ $V_4$ $U_1$	e (s/m*3)				
3.900	0.00346				
5.900 0.0046	6				

8.033 0.00346 24 0.00145 0.00109 96 720 0.000992 end\_X\_over\_Q\_4\_ctrl\_room X\_over\_Q\_4\_site\_boundary Time (hr) Value (s/m\*3) 3.900 0 5.900 1.7e-3 720 0 end\_X\_over\_Q\_4\_site\_boundary X\_over\_Q\_4\_low\_population\_zone Time (hr) Value (s/m\*3) 3.900 8.01e-6 4.900 2.74e-5 5.900 1.75e-5 8.033 8.01e-6 24 1.00e-6 96 5.80e-7 720 3.37e-7 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 1.284e+005 end\_flow\_rate end\_junction junction junction\_type AIR\_JUNCTION downstream\_location AIR\_SPACE ww upstream downstream environment has\_filter false flow\_rate Time (hr) Value (cfm) 720 0 end\_flow\_rate X\_over\_Q\_4\_ctri\_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) 0 720 end\_X\_over\_Q\_4\_site\_boundary

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X_over_Q_4_low_population	n_zone									
Time (hr) Value (s/m*3)										
720 0 end_X_over_Q_4_low_popu	ulation_zone									
end_junction	-									
inaction										
iunction type	AIR JUNCTION									
downstream location	AIR SPACE									
upstream	WW									
downstream	RB									
has filter	false									
flow rate	1000									
Time (hr) Value (cfm)										
24 0.577										
720 0.289										
end_flow_rate										
end_junction										
innction										
junction type	AIR JUNCTION									
downstream_location	AIR_SPACE									
upstream	ww									
downstream	environment									
has_filter	true									
flow_rate										
Time (hr) Value (cfm)										
192 0.0										
720 0.0										
end_now_rate										
filter_efficiency				-						
Time NobleGas ElemI	odine OrgIodine	PartIodine	Solubles	Insolubles						
720 0 0	.95 0.95	0.95	0.95	0.95						
end_filter_efficiency										
frac 4 daughter resusp										
Time NobleGas ElemI	odine Orglodine	PartIodine	Solubles	Insolubles						
720 1 1	0	0	0	0						
end_frac_4_daughter_resusp										
N O I I										
X_over_Q_4_ctrl_room										
$\frac{1}{200}$										
end X over O A ctrl room	,									
~!!~_v_v_v*v_v_v_1_000										
X_over_Q_4_site_boundary										
Time (hr) Value (s/m*3)										
720 0										
end_X_over_Q_4_site_boun	dary			•						
X over () 4 low nonvestion	n 70ne									
Time (br) Value (s/m*3)										
720 0										
720 0					end_X_over_Q_4_low_population_zone					
720 0 end_X_over_Q_4_low_popu	lation_zone									
720 0 end_X_over_Q_4_low_popu	lation_zone									
720 0 end_X_over_Q_4_low_popu end_junction	lation_zone									
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junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Rate (cfi 720 0.13 end_flow_rate	AIR_ AIR_ SP RB true m)	JUNCTION SPACE			
filter_efficiency Time NobleGas 720 0 end_filter_efficiency	Elemlodine .9	Orglodine .9	PartIodine .9	Solubles O	Insolubles 0
frac_4_daughter_resus Time NobleGas 720 0 end_frac_4_daughter_	p Elemlodine 0 resusp	Orglodine 0	PartIodine 0	Solubles 0	Insolubles 0
end_junction					
junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Value (ct 720 1500 end_flow_rate	AIR_J AIR_S RB enviro true	UNCTION SPACE onment			
filter_efficiency Time NobleGas 720 0 end filter efficiency	ElemIodine 0.95	OrgIodine 0.95	Partlodine 0.95	Solubles 0.95	Insolubles 0.95
Charles development	_				
Time NobleGas 720 1 end frac 4 daughter 1	P ElemIodine 1 resusp	OrgIodine 0	PartIodine 0	Solubles 0	Insolubles O
X_over_Q_4_ctrl_roor           Time (hr)         Value (s/           1.300         8.2           3.300         1.9           8.033         8.28e-7           24         3.36e-7           96         3.08e-7           720         1.79e-7           end_X_over_Q_4_ctrl_           X_over_Q_4_site_bour           Time (hr)         Value (s/           1.300         0           1.800         2.03e-4           2.300         1.5           3.300         9.1           720         0	n m*3) 8e-7 2e-5 room ndary m*3) 4e-4 7e-5				

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end\_X\_over\_Q\_4\_site\_boundary

X\_over\_Q\_4\_low\_population\_zone Time (hr) Value (s/m\*3) 1.300 1.01e-5 2.300 2.55e-5 3.300 1.87e-5 8.033 1.01e-5 24 1.09e-6 96 6.90e-7 720 4.61e-7 end\_X\_over\_Q\_4\_low\_population\_zone

end\_junction

junction	
junction_type	AIR_JUNCTION
downstream_location upstream	AIR_SPACE environment
downstream	Control_Room
has_filter	false
flow_rate	
Time (hr) Value (cfm)	
720 3700	
end_flow_rate	
end_junction	
junction	
junction_type	AIR_JUNCTION
downstream location	AIR SPACE

downstream\_locationAIR\_SPACEupstreamControl\_Roomdownstreamenvironmenthas\_filterfalseflow\_rateTime (hr)7203700end\_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

environment breathing\_rate\_sb Time (hr) Value (cms) 24 0.00035 720 0.0

end\_breathing\_rate\_sb

 breathing\_rate\_lpz

 Time (hr)
 Value (cms)

 8.033
 0.00035

 24
 0.00018

 720
 0.00023

 end\_breathing\_rate\_lpz

end\_environment

#### Attachment B-4 STARDOSE Main Input File for SGTS Failure with Effects of CAD System

edit\_time

2.033 8.033 720 0 24 96 end\_edit\_time participating\_isotopes Kr83m Kr85m Kr85 Kr87 Kr88 Kr89 Xe131m Xe133m Xe133 Xe135m Xe135 Xe137 Xe138 I131Org I131Elem I131Part 1132Org 1132Elem 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 1950 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 0.033 0 0 Ω 0 0 ß 0 0 0 0.1 0.1 0 0 0 0 0 0 0.533 0.1 2.033 0.633 0.167 0.133 0.033 0.0133 0.00167 0.00033 0.00013 0.0133 0 720 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 0.033 0 0 0 0 0 0 0 0 0 0.533 0 0.1 0 0 0 0 0 0 0 0.167 0 0 2.033 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\_CV obj\_type DW name air\_volume 1.284e+005water\_volume 0 surface\_area 1 has\_recirc\_filter false removal\_rate\_to\_surface ElemIodine Time NobleGas Orglodine PartIodine Solubles Insolubles 0.25 0. 0. 0. 0 0 0 2.0667 0. 20. 0. 20. 20. 20.

720	0.	2.0	0.	2.0	. 2	2.0	2.0
end_re	moval_rate_	to_surface					
frac_4	_daughter_re	susp_from_sur	face				
Time	NobleGas	ElemIodine	Orglodine	Partle	odine	Solubles	Insolubles
720	1	0	0		0	0	0
end_fr	ac_4_daught	er_resusp_from	_surface				
	•	- •-					
end_co	ontrol_volum	e					
control	l_volume						
obj_ty	pe	OBJ_C	:v				
name		WW					
air_vol	lume	1.0396	:+005				
water_	volume	6.8e+	-004				
surface	e_area	0					
has_re	circ_filter	fals	e				
remova	al_rate_to_w	aterpool					
Time	NobleGas	Elemlodine	Orglodine	PartIc	odine	Solubles	Insolubles
720	0	0.0	0		0.0	0.0	0.0
end_re	moval_rate_	to_waterpool					
frac_4	_daughter_re	susp_from_wat	er				
Time	NobleGas	ElemIodine	Orglodine	Partle	odine	Solubles	Insolubles
720	1	0	0		0	0	0
end_fra	ac_4_daught	er_resusp_from	_water				
decont	amination_fa	ctor	~			<u></u>	
Time	NobleGas	Elemiodine	Orglodine	Partic	dine	Solubles	Insolubles
120	1		1		1	1	1
ena_de	contaminatio	on_factor					
and as	mtaal value						
end_co	ontroi_volum	e					
aantral	volume						
obi tu		OPL	CV				
nome	pc	DB					
air vol	ume	15e4	003				
water	volume	0	005				
surface	area	õ					
has rec	circ filter	false	•				
end co	ontrol volum	e					
		-	•				
control	volume						
obi tyr	De	OBJ C	v				
name		SLI					
air vol	ume	26					
water	volume	0					
surface	area	0					
has_rec	circ_filter	false					
end_co	ontrol_volum	e					
control	_volume						
obj_tyr	be	OBJ_C	CV				
name		SL2					
air_vol	ume	26					
water_	volume	0					
surface	_area	0					
has_rec	circ_filter	false					
end_co	ntrol_volum	6					

\_

control_volume	
obj_type	OBJ_CV
name	ALT1
air_volume	526
water_volume	0
surface area	0
has recirc filter	false
and control volume	14100
cha_control_volume	
control valuma	
control_volume	
ooj_type	UBJ_CV
name	AL12
air_volume	526
water_volume	0
surface_area	0
has_recirc_filter	false
end control volume	
control volume	
control_volume	OPLCV
ooj_type	
name	ALIS
air_volume	1.0/E5
water_volume	0
surface_area	0
has_recirc_filter	false
end_control_volume	
control volume	
obj type	OBL CV
	50,004
air_volume	0.86+004
water_volume	0
surface_area	0
has_recirc_filter	false
end_control_volume	
control_volume	
obi type	OBJ CR
name	Control Room
air volume	4 153e4
water volume	0
	0
Surface_area	0 falaa
nas_recirc_niter	Taise
breathing_rate	
Time (hr) Value (cms)	
720 0.00035	
end_breathing_rate	
-	
occupancy factor	
Time (hr) Value (frac)	
24 1	
96 0.6	
70 0.4	
120 U.4	
end_occupancy_factor	
end_control_volume	
junction	
junction_type	AIR_JUNCTION

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downstream_location upstream downstream flow_rate Time (hr) Rate (cfm) 0.533 1 720 1 end_flow_rate has_filter end_junction	AIR_SPACE CORE DW false
junction junction_type downstream_location upstream downstream flow_rate Time (hr) Rate (cfm) 0.533 1 720 1 end_flow_rate has_filter end_junction	AIR_JUNCTION AIR_SPACE CORE SP
junction junction_type downstream_location upstream has_filter flow_rate Time (hr) Value (cfm) 2.033 0 720 1.284e+005 end_flow_rate end_junction	AIR_JUNCTION AIR_SPACE DW WW false
junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Value (cfm) 0.167 0.713 720 0 end_flow_rate	AIR_JUNCTION AIR_SPACE DW environment false
X_over_Q_4_ctrl_roomTime (hr)Value (s/m*3)7202.98e-3end_X_over_Q_4_ctrl_roomX_over_Q_4_site_boundaryTime (hr)Value (s/m*3)7201.476e-3end_X_over_Q_4_site_boundaryX_over_Q_4_low_population	n / ndary on_zone

Time (hr)Value (s/m\*3)7205.253e-5end\_X\_over\_Q\_4\_low\_population\_zone

end\_junction

end\_junction

junction AIR\_JUNCTION junction\_type AIR\_SPACE downstream\_location DW upstream downstream environment has\_filter false flow\_rate Value (cfm) Time (hr) 24 0.031 0.016 720 end\_flow\_rate X\_over\_Q\_4\_ctrl\_room Value (s/m\*3) Time (hr) 2.033 0.00225 8.033 0.000818 24 0.000353 96 0.000277 720 0.000223 end\_X\_over\_Q\_4\_ctrl\_room X\_over\_Q\_4\_site\_boundary Value (s/m\*3) Time (hr) 2.033 1.476e-3 8.033 0 0 24 96 0 0 720 end\_X\_over\_Q\_4\_site\_boundary X\_over\_Q\_4\_low\_population\_zone Value (s/m\*3) Time (hr) 2.033 5.253e-5 8.033 2.227e-5 24 1.469e-5 96 5.948e-6 720 1.625e-6 end\_X\_over\_Q\_4\_low\_population\_zone end\_junction junction AIR\_JUNCTION junction\_type downstream\_location AIR\_SPACE DW upstream downstream RB has\_filter false flow\_rate Time (hr) Value (cfm) 0.167 0 24 0.713 720 0.357 end\_flow\_rate

junction					
junction_type	AIR_	JUNCTION			
downstream_location	AIR_	SPACE			
upstream	DW				
downstream	SL1				
has_filter	true				
flow_rate					
Time (hr) Value (	cfm)				
24 0.383	·				
720 0.192					
end flow rate					
filter efficiency					•
Time NobleGas	ElemIodine	Orglodine	PartIodine	Solubles	Insolubles
720 0	0	0	0	0	0
end filter efficiency	v	Ū	· ·	Ũ	°
end_man_ennery					
frac 4 daughter resu	<b>SD</b>				
Time NobleGas	FlemIndine	Oralodine	PartIndine	Solubles	Incolubles
720 1	Δ	0 giodilic 0	n an too nic	00100103	Λ
and free A dependence	U Mecuco	v	Ŭ	U	U
end_mac_4_daughter_	_iesusp				
end_junction					
innetion					
junction type	AIR	IUNCTION			
downstream location		SPACE			
unstream	SL1	JI NCE			
downstream	AITI	1			
has filter	true	l de la constante de			
flow rate	uuc				
Time (hr) Value (	ofm)				
$\frac{1}{24} = 0.383$	cini)				
24 0.365 720 0.102					
720 0.192					
enu_now_nate					
filter officionau					
Time NebleCas	ElamIndina	Oraladiaa	DortInding	Colubles	Incolubics
	Diennoume	Orgiounie		30100105	
720 U	Ū	0	0.58	0.38	0.38
ena_niter_eniciency					
for a development					
Trac_4_daugnier_resus	sp Files dia e	On to the s	De alle d'an	0.1.1.1.	T
Time NobleGas	Elemiodine	Orgiodine	Partiodine	Solubles	Insolubles
120 1	U	U	U	U	U
end_trac_4_daughter_	_resusp				
end_junction					
iunction					
junction type	AIR	UNCTION			
downstream location		SPACE			
unstream	ערג. גיר זא				
downstream	ALII	ment			
has filter	CIVITON	meik			
flow mte	uue				
HUW_IAU Time (hr) Value (c	afan)				
24 U.UIO					
120 U.008					
end_now_rate					

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	filter_efficienc	у				
	Time Noble	Gas Elemlodir	ne Orglodine	PartIodine	Solubles	Insolubles
	720 0	0.58	0	0.71	0.71	0.71
	end_filter_effi	ciency				
		•				
	frac 4 daught	er resusp				
	Time Noble	Gas ElemIodir	e Orglodine	PartIodine	Solubles	Insolubles
	720 1	0	0	0	0	0
	and free 4 de	wahtar roowan	Ū	U	U	U
	end_nac_4_ua	inginei_iesusp				
	¥ 0. 4					
	A_over_Q_4_	ctri_room				
	Time (hr)	Value (s/m*3)				
	3.900	0.00346				
	5.900 0.	00466				
	8.033 0.	00346				
	24 0.0	0145				
	96 0.0	0109				
	720 0.0	)00992				
	end X over C	) 4 ctrl room				
		<u></u>				
	X over O 4	site boundary				
	Time (br) $\mathbf{V}$	Value (s/m*3)				
	2 000					
	5.900	17.2				
	5.900	1./e-3				
	720 0					
	end_X_over_(	2_4_site_boundary	/			
	X_over_Q_4_	low_population_zo	one			
	Time (hr) V	Value (s/m*3)				
	3.900	8.01e-6				
	4.900	2.74e-5				
	5.900	1.75e-5				
	8.033 8.0	01e-6				
	24 1.0	0e-6				
	96 5.8	0e-7				
	720 3.3	7e-7				
	end X over C	) A low nonulatic	00 700e			
	and innotion					
	end_Junedon					
	innation					
	Junction					
	Junction_type	Al Al	K_JUNCTION			
	downstream_ic	cation Al	IK_SPACE			
	upstream	A				
	downstream	A	LT3			
	has_filter	tru	ie			
	flow_rate					
	Time (hr) V	/alue (cfm)				
	24 1.9	55				
	720 0.9	78				
	end_flow_rate					
4						
	filter efficiency	v				
	Time Noble	as ElemIndin	e <b>Org</b> Iodine	PartIodine	Solubles	Insolubles
	720 0	ስ ናያ	Λ	071	Λ 71	n 71
	and filter offi	U.Jo	v	0.71	0.71	0.71
	end_inter_enit	licity				
	£					
	Irac_4_daughte	r_resusp	<u> </u>	<b>N</b> . <b>1</b>		
	Time NobleC	as Elemlodin	e Urglodine	Partlodine	Solubles	Insolubles
	720	1 0	0	0	0	0

end\_frac\_4\_daughter\_resusp

end\_junction

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junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Value (or	AIR AIR_ DW SL2 . true	JUNCTION SPACE			
24 0.383 720 0.192 end_flow_rate filter_efficiency Time NobleGas 720 0	ElemIodine 0	OrgIodine 0	PartIodine 0	Solubles 0	Insolubles 0
end_filter_efficiency					
frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_	sp Elemlodine 0 _resusp	OrgIodine 0	PartIodine 0	Solubles 0	Insolubles 0
end_junction					
junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Value (a 24 0.383 720 0.192 end_flow_rate	AIR_ AIR_ SL2 ALT2 true	UNCTION SPACE			
filter_efficiency Time NobleGas 720 0 end_filter_efficiency	ElemIodine 0	Orglodine 0	PartIodine 0.38	Solubles 0.38	Insolubles 0.38
frac_4_daughter_resu: Time NobleGas 720 1 end_frac_4_daughter_	sp Elemlodine 0 resusp	OrgIodine 0	Partlodine 0	Solubles 0	Insolubles 0
end_junction					
junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Value (o 24 0.016	AIR_J AIR_S ALT2 environ true	UNCTION SPACE ment			

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720 0.008					
end_flow_rate					
filter efficiency					
Time NobleGas	ElemIodine	Orglodine	PartIodine	Solubles	Insolubles
720 0	0.58	0	0.71	0.71	0.71
end filter efficiency	v	-			
frac_4_daughter_res	susp				
Time NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720 1	0	0	0	0	0
end_frac_4_daughte	er_resusp				
V aver O A atri r					
Time (br) Value	(e/m*3)				
3 000	0.00346				
5 900 0 00466	5				
8 033 0 00346	5				
24 0.00145	,				
96 0.00149					
720 0.00099	2				
end X over O 4 c	trl room				
•					
X over O 4 site b	oundary				
Time (hr) Value	(s/m*3)				
3,900	Ò Í				
5,900	1.7e-3				
720 0					
end_X_over_O_4_s	ite_boundary				
	- ,				
X_over_Q_4_low_p	opulation_zone				
Time (hr) Value	(s/m*3)				
3.900	8.01e-6				
4.900	2.74e-5				
5.900	1.75e-5				
8.033 8.01e-6	•				
24 1.00e-6					
96 5.80e-7					
720 3.37e-7					
end_X_over_Q_4_l	ow_population_	zone			
ena_junction					
iunction					
junction type	AIR JI	JNCTION			
downstream locatio	n AIR S	PACE			
upstream	ALT2				
downstream	ALT3				
has filter	true			÷	
flow_rate					
Time (hr) Value	(cfm)				
24 1.955	-				
720 0.978					
end_flow_rate					
filter_efficiency					
Time NobleGas	ElemIodine	Orglodine	PartIodine	Solubles	Insolubles
720 0	0.58	0	0.71	0.71	0.71
end_filter_efficiency	/				

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frac_4_daughter_resu Time NobleGas 720 1 end_frac_4_daughter_	sp ElemIodine 0 _resusp	OrgIodine 0	PartIodine 0	Solubles 0	Insolubles 0
end_junction					
junction junction_type downstream_location upstream downstream has_filter flow_rate Time (hr) Value (o 24 2.05 720 1.03 end_flow_rate	AIR_ AIR_ ALT envira true	JUNCTION SPACE 3 onment			
filter_efficiency Time NobleGas 720 0 end filter efficiency	ElemIodine 0.998	Orglodine 0	PartIodine 0.951	Solubles 0.951	Insolubles 0.951
frac_4_daughter_resu: Time NobleGas 720 1 end_frac_4_daughter_	sp ElemIodine 0 _resusp	OrgIodine 0	PartIodine 0	Solubles O	Insolubles 0
X_over_Q_4_ctrl_roo Time (hr) Value (s 3.900 0.0 5.900 0.00466 8.033 0.00346 24 0.00145 96 0.00109 720 0.000992 end_X_over_Q_4_ctrl	om √m*3) 00346 I_room				
X_over_Q_4_site_box Time (hr) Value (s 3.900 0 5.900 1.7 720 0 end_X_over_Q_4_site	undary /m*3) 7e-3 2 boundary				
X_over_Q_4_low_poj           Time (hr)         Value (s           3.900         8.0           4.900         2.7           5.900         1.7           8.033         8.01e-6           24         1.00e-6           96         5.80e-7           720         3.37e-7           end X_over O_A low	ooundary pulation_zone /m*3) D1e-6 74e-5 75e-5	TORE			
end_junction					

junction

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AIR\_JUNCTION junction\_type AIR\_SPACE downstream\_location WW upstream downstream DW has\_filter false flow\_rate Time (hr) Value (cfm) 0 2.035 720 1.284e+005 end\_flow\_rate end\_junction junction AIR\_JUNCTION junction\_type downstream\_location AIR\_SPACE upstream ww downstream environment has\_filter false flow\_rate Time (hr) Value (cfm) 720 0 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) 0 720 end\_X\_over\_Q\_4\_site\_boundary X\_over\_Q\_4\_low\_population\_zone Value (s/m\*3) Time (hr) 0 720 end\_X\_over\_Q\_4\_low\_population\_zone end\_junction junction AIR\_JUNCTION junction\_type downstream\_location AIR\_SPACE upstream ww downstream RB has\_filter false flow\_rate Time (hr) Value (cfm) 0.167 0 24 0.577 720 0.289 end\_flow\_rate end\_junction junction junction\_type AIR\_JUNCTION downstream\_location AIR\_SPACE ww upstream downstream environment has\_filter true

flow\_rate Value (cfm) Time (hr) 192 0.0 720 20.0 end\_flow\_rate filter\_efficiency Solubles Insolubles Time NobleGas ElemIodine OrgIodine PartIodine 720 0 0.95 0.95 0.95 0.95 0.95 end\_filter\_efficiency frac\_4\_daughter\_resusp Time NobleGas ElemIodine Orglodine PartIodine Solubles Insolubles 720 0 0 0 0 1 1 end\_frac\_4\_daughter\_resusp X\_over\_Q\_4\_ctrl\_room Time (hr) Value (s/m\*3) 1.300 8.28e-7 3.300 1.92e-5 8.033 8.28e-7 24 3.36e-7 96 3.08e-7 1.79e-7 720 end\_X\_over\_Q\_4\_ctrl\_room X\_over\_Q\_4\_site\_boundary Value (s/m\*3) Time (hr) 1.300 0 1.800 2.03e-4 2.300 1.54e-4 3.300 9.17e-5 0 720 end\_X\_over\_Q\_4\_site\_boundary X\_over\_Q\_4\_low\_population\_zone Time (hr) Value (s/m\*3) 1.300 1.01e-5 2.300 2.55e-5 3.300 1.87e-5 1.01e-5 8.033 24 1.09e-6 96 6.90e-7 720 4.61e-7 end\_X\_over\_Q\_4\_low\_population\_zone end\_junction junction junction\_type AIR JUNCTION downstream\_location AIR\_SPACE upstream SP downstream RB has\_filter true flow\_rate Time (hr) Rate (cfm) 0.13 720 end\_flow\_rate filter\_efficiency

Time N	lobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	.9	.9	.9	0	0
end_filter	r_efficiency					
frac 4 da	anghter resu					
Time N	obleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0		0 0	0	0
end_frac_	4_daughter	_resusp				
end_junc	tion					
innction						
junction	type	AIR	UNCTION			
downstrea	am_location	AIR	SPACE			
upstream	-	RB	•			
downstrea	am	enviro	onment			
has_filter		true				
flow_rate		- <b>C</b> - \				
710 (nr)		cim)				
end flow	1000					
chd_now	_rate					
filter_effi	ciency					
Time N	obleGas	ElemIodine	Orglodine	Partlodine	Solubles	Insolubles
720	0	0.95	0.95	0.95	0.95	0.95
end_filter	_efficiency					
frac A da	uchter room	en.				
Time N	obleGas	sp FlemIodine	Orglodine	PartIndine	Solubles	Incolubles
720	1	1	0	0	0	0
end_frac_	4_daughter_	_resusp	· ·	·	· ·	•
	-	-				
X_over_Q	_4_ctrl_roo	m				
Time (hr)	Value (s	s/m*3)				
1.300	ð. 1	286-7				
8.033	8.28e-7	720-5				
24	3.36e-7					
96	3.08e-7					
720	1.79e-7					
end_X_ov	er_Q_4_ctr	l_room				
V	A	· - 4 ·				
Time (hr)	2_4_SICC_DOU Value (s	(m+3)				
1.300		viii <i>5)</i>				
1.800	2.03e-4					
2.300	1.:	54e-4				
3.300	9.	17e-5				
720	0					
end_X_ov	er_Q_4_site	_boundary				
X over C	) 4 low no	nulation zone				
Time (hr)	Value (s	/m*3)				
1.300	1.0	D1e-5				
2.300	2.5	55e-5				
3.300	1.8	37e-5				
8.033	1.01e-5					
24	1.09e-6					
90	0.90e-7					

720 4.61e-7

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#### end\_X\_over\_Q\_4\_low\_population\_zone

end\_junction

junction AIR\_JUNCTION junction\_type AIR\_SPACE downstream\_location environment upstream downstream Control\_Room has\_filter false flow\_rate Value (cfm) Time (hr) 3700 720 end\_flow\_rate end\_junction

junction AIR\_JUNCTION junction\_type downstream\_location AIR\_SPACE upstream Control\_Room downstream environment has\_filter false flow\_rate Time (hr) Value (cfm) 720 3700 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

environment breathing\_rate\_sb Time (hr) Value (cms) 24 0.00035 720 0.0 end\_breathing\_rate\_sb

 breathing\_rate\_lpz

 Time (hr)
 Value (cms)

 8.033
 0.00035

 24
 0.00018

 720
 0.00023

 end\_breathing\_rate\_lpz

end\_environment