CALCULATION TITLE PAGE

CALCULATION NUMBER: PSAT 3019CF.QA.08

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

REV:	ORIGINATOR Print/Sign/Date	CHECKER Print/Sign/Date	IND REVIEWER Print/Sign/Date
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REASON FOR REVISION:		Nonconformance Rpt
0 -	Initial Issue	N/A

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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

Table 1 – VY DBA-LOCA Summary of Dose Results

Location	Dose (rem)		
	Thyroid Inhalation Pathway*	Whole Body/DDE External Radiation*	Total Effective Dose 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 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 2A: 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 Plant Stack – With SGTS 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: Release Via Main Steam Lines and MC – No MSIV 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: Release Via Main Steam Lines and MC – With MSIV Failure			
EAB	1.9E-01	2.7E-02	3.9E-02
LPZ	1.2E-02	1.2E-03	1.7E-03
CR	1.5E+01	2.6E-02	5.6E-01
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

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 thermal-hydraulic 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.

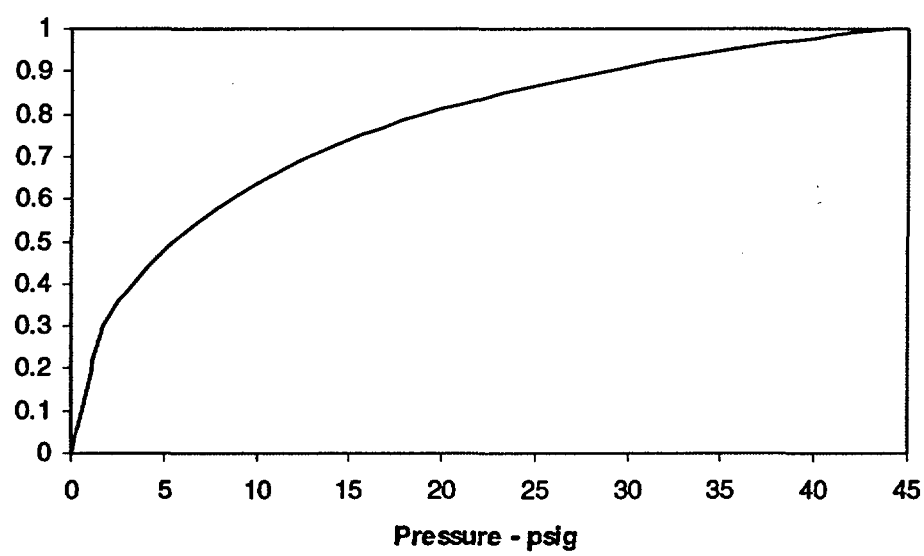
  Typically, PWR containment pressures are reduced rapidly by the use of containment sprays, while BWRs have not credited containment sprays in accident analysis (although they are generally Safety-Related, and the impact of their use on containment pressure is generally described in the plant FSAR).

  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.

Figure 1 - Fraction of Max Leakage vs. Pressure
(density corrected)



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

7. "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 Reference 4 table (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, 120 – 1920 seconds: (Item 2.2)

Gases	Xe, Kr – 0.1/hr (0.05 total)	
	Elemental I – 4.9E-3/hr (2.4E-3 total)	
	Organic I – 1.5E-4/hr (7.5E-5 total)	
Aerosols	I, Br – 0.095/hr (0.0475 total)	
	Cs, Rb – 0.1/hr (0.05 total)	

Fraction of core inventory, 1920 – 7320 seconds: (Item 2.3)

Gases	Xe, Kr – 0.63/hr (0.95 total)
	Elemental I – 8.1E-3/hr (1.2E-2 total)
	Organic I – 2.5E-4/hr (3.8E-4 total)
Aerosols	I, Br – 0.158/hr (0.2375 total)
	Cs, Rb – 0.133/hr (0.2 total)
	Te Group – 0.033/hr (0.05 total)
	Ba, Sr – 0.013/hr (0.02 total)
	Noble Metals – 1.7E-3/hr (2.5E-3 total)
	La Group – 1.3E-4/hr (2E-4 total)
	Ce Group – 3.3E-4/hr (5E-4 total)

Volume of Drywell – 131,470 ft^3 (max), 128,370 ft^3 (min) (Item 3.1)
Volume of Torus Airspace – 103,932 ft^3 (min) (Item 3.2)
Volume of Suppression Pool – 68,000 ft^3 (min), 70,000 ft^3 (max) (Item 3.3)
Volume of Main Condenser (MC) – 107,000 ft^3 (Item 3.5)

Volumetric Leak Rate from Drywell (not including MSIVs) – 0.713 cfm (Item 3.6)
This represents 0.8% of the minimum DW volume per day (Item 3.1).
Volumetric Leak Rate from Torus Airspace – 0.577 cfm (Item 3.7)
This represents 0.8% of the torus airspace volume per day (Item 3.2).
Containment Leakage Bypassing Secondary Containment – 5 scfh (Item 3.16)
Not part of the 0.8% per day containment leakage (Items 3.6 and 3.7)
MSIV Allowable Leakage – 124 scfh total, 62 scfh max for per steamline (Item 3.17)
ESF Leakage – 0.5 gpm analyzed as 1.0 gpm, assumed to start at t = 0 (Item 3.10)

Release Fraction of Radioiodine from ESF leakage – 10% (Item 4.3)
DW Pressure at 24 Hours after DBA-LOCA, with Sprays – ~20 psia (Item 8.10)
Secondary Containment Drawdown Time, 0 minutes with all SGTS (Item 8.11)
10 minutes with one SGTS train failed*

*During the 10 minutes, the Reactor Building pressure is actually negative for at least four minutes (the Reactor Building begins at a negative pressure). Positive pressure will not occur beyond t = 10 minutes (accident time).

Drywell Spray Flow – 6650 gpm (one loop) (Item 3.9)
Drywell Radiation Level Calling for Spray Initiation – 4000 R/hr (Item 9.4)
Spray (Drywell) Initiation Time – 15 minutes, accident time* (Item 9.1)
*as long as drywell radiation level requiring sprays exceeded at least 10 minutes earlier
Spray Header Characteristics: Header Elevation – 264'2" (Item 9.2)
Header Diameter – 60.17'
Drywell Floor Elevation – 238' (Item 10.3)
Biological Shield Wall Diameter – 24'9½" (Item 10.4)

Nominal SGTS Single-Train Flow (with +/- 150 cfm) – 1500 cfm (Item 3.14)
Filter Efficiency – SGTS (Item 4.2)
For Particulate Iodine, Cesium and other Aerosols – 95%
For Elemental and Organic Iodine – 95%
For Noble Gases – 0%

MSIV Test Pressure – Greater than or equal to 24 psig (Item 8.2)
Accident Conditions to be used for SCFH to CFH conversion (Item 8.3)
Pressure: 58.7 psia (44 psig)
Temperature: 338 F
Steam Line Temperature – 550 F (Item 8.4)
Steam Line ID – 16.124" (Item 7.2)
Lengths of Steam Line –
All steamlines, horizontal from outboard MSIV to RB/TB matchline =
20'7" + 3'6" = 24.1'
All steamlines, vertical rise in tunnel =
14' – 6" – 2'6" = 11'
"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 =
3'6" + 11'6" = 15'
Steamlines between MSIVs – estimated to be 18' (based on MSIV location relative to 13' between FW isolation valves)
(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)

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^2 (Item 7.12)

Volume of Control Room (CR) – 41,533.75 ft^3 (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)
**Transition to isolated condition not credited

X/Q values in sec/m^3:

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

#This is for the N_2 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):

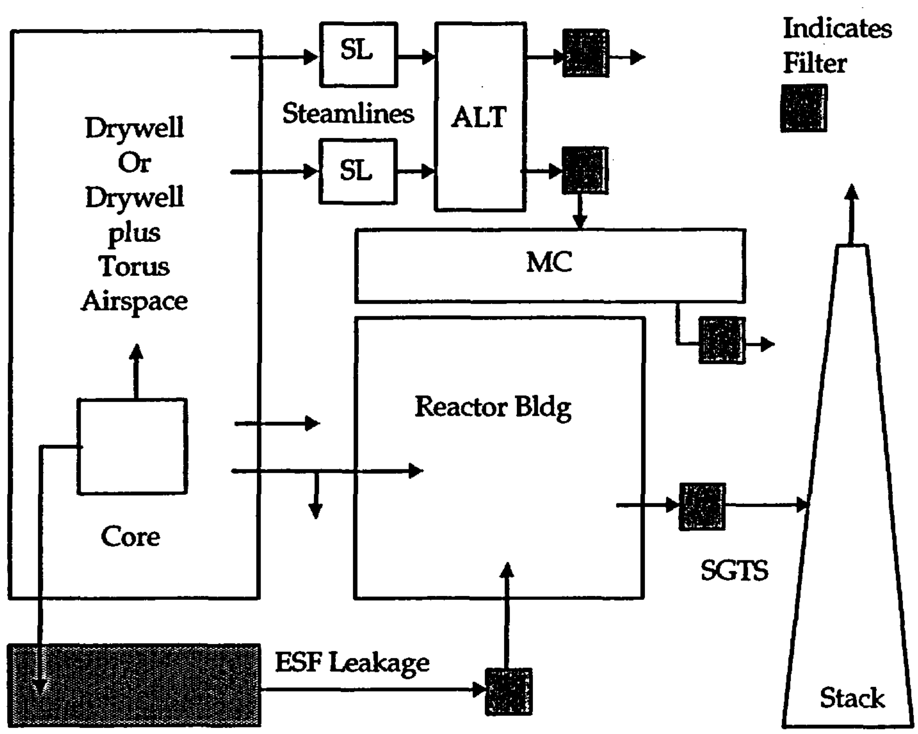
0 – 24 hours	1.0
1-4 days	0.6
4-30 days	0.4

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^3, 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
none      0.0000E+00
none      0.0000E+00
Nuclide 002:
Co-60

  7
 0.1663401096E+09
 0.6000E+02
 0.1425E+03
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 003:
Kr-85
  1
 0.3382974720E+09
 0.8500E+02
 5.05E+02
none      0.0000E+00
none      0.0000E+00
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
none      0.0000E+00
Nuclide 005:
Kr-87
  1
 0.4578000000E+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
```

```
none      0.0000E+00
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
none      0.0000E+00
none      0.0000E+00
Nuclide 010:
Sr-91
  5
 0.3420000000E+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
none      0.0000E+00
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
none      0.0000E+00
Nuclide 014:
Y-92
  9
 0.1274400000E+05
```

```
 0.9200E+02
 4.62E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
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
none      0.0000E+00
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
none      0.0000E+00
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
none     0.0000E+00
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
none     0.0000E+00
none     0.0000E+00
Nuclide 025:
Sb-127
  4
 0.3326400000E+06
 0.1270E+03
 3.69E+03
Te-127m  0.1800E+00
Te-127   0.8200E+00
none     0.0000E+00
Nuclide 026:
Sb-129
  4
 0.1555200000E+05
 0.1290E+03
 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
none     0.0000E+00
```

```
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
 0.4176000000E+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
I-129     0.3500E+00
none      0.0000E+00
Nuclide 031:
Te-131m
  4
 0.1080000000E+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
none      0.0000E+00
none      0.0000E+00
Nuclide 034:
I-132
  2
 0.8280000000E+04
 0.1320E+03
 4.05E+04
```

```
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 035:
I-133
  2
 0.7488000000E+05
 0.1330E+03
 5.79E+04
Xe-133m  0.2900E-01
Xe-133   0.9700E+00
none     0.0000E+00
Nuclide 036:
I-134
  2
 0.3156000000E+04
 0.1340E+03
 6.43E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 037:
I-135
  2
 0.2379600000E+05
 0.1350E+03
 5.39E+04
Xe-135m  0.1500E+00
Xe-135   0.8500E+00
none     0.0000E+00
Nuclide 038:
Xe-133
  1
 0.4531680000E+06
 0.1330E+03
 5.78E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 039:
Xe-135
  1
 0.3272400000E+05
 0.1350E+03
 2.33E+04
Cs-135   0.1000E+01
none     0.0000E+00
none     0.0000E+00
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
```

```
  0.1131840000E+07
  0.1360E+03
  3.90E+03
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 042:
Cs-137
   3
  0.9467280000E+09
  0.1370E+03
  6.08E+03
Ba-137m   0.9500E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 043:
Ba-139
   6
  0.4962000000E+04
  0.1390E+03
  5.35E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
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
none      0.0000E+00
none      0.0000E+00
Nuclide 046:
La-141
   9
  0.1414800000E+05
  0.1410E+03
  4.91E+04
Ce-141    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 047:
La-142
   9
  0.5550000000E+04
  0.1420E+03
  4.81E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 048:
```

```
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
none      0.0000E+00
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
 4.71E+04
none      0.0000E+00
none      0.0000E+00
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
none      0.0000E+00
Nuclide 054:
Pu-238
  8
 0.2768863824E+10
 0.2380E+03
 3.93E+02
U-234     0.1000E+01
none      0.0000E+00
```

```
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
none      0.0000E+00
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
none      0.0000E+00

Nuclide 060:
Cm-244
  9
 0.5715081360E+09
 0.2440E+03
 1.21E+03
Pu-240    0.1000E+01
none      0.0000E+00
none      0.0000E+00
End of Nuclear Inventory File
```

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

Release Fraction and Timing File

```
Release Fraction and Timing Name:
 BWR, NUREG-1465, Tables 3.11 & 3.13, June 1992
 Duration (h):   Design Basis Accident
  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
```

```
 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
```

```
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   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
  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
   0
   0
   0
   0
   0
   0
 Compartment 5:
   0
   1
   0
   0
```

```
  0
  0
  0
  0
  0
Compartment 6:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 7:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 8:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Pathways:
 12
Pathway 1:
  0
  0
  0
  0
  0
  0
  0
  0
  0
  0
  1
  3
  3.3300E-02   8.3500E-01
  1.6700E-01   3.5000E-02
  2.0333E+00   0.0000E+00
  0
Pathway 2:
  0
  0
  0
  0
  0
  0
```

```
  0
  0
  0
  0
  1
  3
  3.3300E-02   0.0000E+00
  1.6700E-01   8.0000E-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
  0
  0
  0
  0
  0
  1
  2
  3.3300E-02   4.3300E-01
  2.0333E+00   0.0000E+00
  0
Pathway 5:
  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 6:
  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 7:
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   1
   4
   3.3300E-02   0.0000E+00
   2.0333E+00   1.9000E-02
   2.4000E+01   1.0000E-02
   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   8.0000E-01
   2.4000E+01   4.0000E-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
  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 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
  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   1.4760E-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:
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
 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^3 for the RB siding release and 2.25E-03 sec/m^3 for the release through the N_2 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_2 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
  0
 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:
```

```
 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
```

```
  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
  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
   0
   0
   0
   0
   0
   0
Compartment 5:
   0
   1
   0
   0
   0
   0
   0
   0
   0
Compartment 6:
   0
   1
   0
   0
   0
   0
   0
   0
   0
```

```
Compartment 7:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 8:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Pathways:
 11
Pathway 1:
  0
  0
  0
  0
  0
  0
  0
  0
  0
  0
  1
  3
  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+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
  2.4000E+01   4.0000E-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
  3.3300E-02   1.5000E+03   9.5000E+01   9.5000E+01   9.5000E+01
  7.2000E+02   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00
  0
  0
  0
  0
  0
  0
Pathway 10:
```

```
  0
  0
  0
  0
  0
  1
  2
  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
  3.3300E-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
  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
   0
 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
   0
 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
```

```
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 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
   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
  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
```

```
  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
  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
  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
  0
  0
  0
  0
  0
Compartment 6:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 7:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 8:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Pathways:
 12
Pathway 1:
  0
  0
  0
  0
  0
  0
  0
  0
  0
  0
  1
  3
```

```
  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+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   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
   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
  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
  2.4000E+01   1.0300E+00   9.5100E+01   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
```

```
   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
```

```
   8.0333E+00   1.0000E-06
   2.4000E+01   5.8000E-07
   9.6000E+01   3.3700E-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
   0
 Effective Volume Location:
   1
   7
   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
   3.3300E-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
```

o
o
o

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 (SGTS 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 (MSIV 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:

Table 2 – VY DBA-LOCA Dose Results

Location	Dose (rem)		
	Thyroid Inhalation Pathway*	Whole Body/DDE External Radiation*	Total Effective Dose 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)

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)
6. 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^3 (Item 3.5)

4.0 Assumptions

Proprietary Material Removed

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

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	62 SCFH	Inboard to Outboard MSIV
B2	62 SCFH	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 ft^3 = 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^3 = 0.24 %/day.

<u>5.2 Leakage Rate out of Each Steam Line Volume</u>

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 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 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)

<u>5.3 Leakage in and out of the Main Condenser Volume</u>

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.

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 x (118.2 + 118.2) = 234.5 cfh = 3.91 cfm. The leakage bypassing the condenser is 0.008 x 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^3 main condenser volume or 1.15E-3 volumes per hour.

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

Proprietary Material Removed

Proprietary Material Removed

Proprietary Material Removed

Proprietary Material Removed

Proprietary Material Removed

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:

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

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:

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

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

Volume A:

Inside Diam:	16.124 in
Length:	185.5 ft
Settling Area:	249.25 ft^2 (DxL)
Volume:	263 ft^3 (πxD^2/4)

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

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

Volume B1:

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

Inside Diam:	16.124 in
Length:	18 ft
Settling Area:	24.2 ft^2 (DxL)
Volume:	26 ft^3 ($\pi x D^2/4$)

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

$$\lambda_{sed\ B1} = 0.55\ /\ hr$$
$$\eta_{B1} = 38\ \%$$

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^3 (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^2 (ratio of the volume to the sedimentation height). This is very conservative. The total tube area is 3.15E5 ft^2, and dividing by π to relate the horizontal projected area of the tubes to the surface area of the tubes, the result is about 1E5 ft^2. 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 ft^2
Volume:	107000 ft^3

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

$$\lambda_{sed\ MC} = 0.0225\ /hr$$
$$\eta_{MC} = 95.1\ \%$$

<u>5.6 Calculation of the Elemental Iodine Removal Coefficients in the Steam Lines and Main Condenser</u>

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.]

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

$$U_{ei} = \exp(\frac{2809}{T} - 12.5) \quad [10]$$

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

Volume A:

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

A_s = 1566 ft^2 = 145.6 m^2 (πxDxL)
Q = 118.2 cfh = 9.3E-4 m^3/s
T = 550 F = 561 K
U_{ei} = 5.56E-4 cm/s

One obtains: η_{ei} = 58 %

Volume B1:

Elemental iodine removal in B1 is neglected.

Volume B2:

Same as Volume A:
η_{ei} = 58 %

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

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

$$\lambda_w = \frac{K_w A_w}{V} \quad [11]$$

where K_w is the deposition velocity (K_w = 4.9 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 ft^2 (from Section 5.5)
Volume: 107,000 ft^3 (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 m/hr = 16.1 ft/hr one obtains:

λ_w = 0.61 /hr

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

η_w = 99.8 %

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

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

Knowing that K_w = 1.8 m/hr = 5.9 ft/hr one obtains:

$$\lambda_w = 0.225 \text{ /hr}$$

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

$$\eta_w = 99.5\ \%$$

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 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^3 + 2 x 26 ft^3 (1.97/0.383) = 1319 ft^3. If one MSIV is assumed to be failed open, the volume becomes 4 x 263 ft^3 + 26 ft^3 (1.97/0.383) = 1185 ft^3.

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 cfm
Removal Efficiency for Particles:	71%
DF for Particles = 1/(1 – 0.71):	3.45
Removal 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 cfm
Removal Efficiency for Particles:	38% in B1, 71% in B2, 82% for two control volumes in series; i.e., series efficiency = 1 – (1 – 0.38) x (1 – 0.71)
DF for Particles = 1/(1 – 0.82):	5.56
Removal 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 x 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

Proprietary Material Removed

Proprietary Material Removed

Proprietary Material Removed

Spreadsheet A1

Proprietary Material Removed

Proprietary Material Removed

Proprietary Material Removed

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

	thyroid	wbody	skin	CEDE
Total dose:	6.2E+1	6.5E-2	2.5E+0	3.2E+0

environment

	thyroid	wbody	skin	CEDE
EAB dose:	2.7E+1	1.7E+0	1.2E+0	1.5E+0
LPZ dose:	1.9E+0	3.9E-1	3.0E-1	9.2E-2

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

Control_Room

	thyroid	wbody	skin	CEDE
Total dose:	3.6E+1	6.25E-2	2.43E+0	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
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-LOCA			
	With SGTS Failure		**With MSIV 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 Room	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
STARDOSE Library File for DBA-LOCA Calculation (LIBFILE1.TXT)

n_isotopes 76 n_isotope_groups 11

Kr83m	N_Gas	NONE	NONE	4.24E+03	1.04E-04	0	1.49E-5	0	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	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	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	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	0
Kr89	N_Gas	NONE	NONE	3.46E+04	3.63E-03	0	0.323	0	0	0.35	0	1.52	0	0	0	0	0
Xe131m	N_Gas	NONE	NONE	3.18E+02	6.68E-07	0	0.00136	0	0	0.02	0	0.04	0	0	0	0	0
Xe133m	N_Gas	NONE	NONE	1.76E+03	3.49E-06	0	0.00472	0	0	0.03	0	0.13	0	0	0	0	0
Xe133	N_Gas	I133Elem	NONE	5.78E+04	1.52E-06	0	0.00558	0	0	0.01	0	0.04	0	0	0	0	0
Xe135m	N_Gas	NONE	NONE	1.14E+04	7.40E-04	0	0.0682	0	0	0.02	0	0.09	0	0	0	0	0
Xe135	N_Gas	I135Elem	NONE	2.33E+04	2.09E-05	0	0.0396	0	0	0.06	0	0.26	0	0	0	0	0
Xe137	N_Gas	NONE	NONE	5.07E+04	2.96E-03	0	0.0303	0	0	0.46	0	2	0	0	0	0	0
Xe138	N_Gas	NONE	NONE	5.05E+04	6.80E-04	0	0.199	0	0	0.15	0	0.65	0	0	0	0	0
I131Org	Org_I	NONE	NONE	2.85E+04	9.96E-07	1080400	0.0606	0	0	0.03	32893	0.13	0	0	0	0	0
I132Org	Org_I	NONE	NONE	4.05E+04	8.27E-05	6438	0.377	0	0	0.11	381.1	0.48	0	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	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	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	0
I131Elem	Elm_I	Te131m	NONE	2.85E+04	9.96E-07	1080400	0.0606	0	0	0.03	32893	0.13	0	0	0	0	0
I132Elem	Elm_I	Te132	NONE	4.05E+04	8.27E-05	6438	0.377	0	0	0.11	381.1	0.48	0	0	0	0	0

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	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	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	0
I131Part	Prt_I	NONE	NONE	2.85E+04	9.96E-07	1080400	0.0606	0	0	0.03	32893	0.13	0	0	0	0	0
I132Part	Prt_I	NONE	NONE	4.05E+04	8.27E-05	6438	0.377	0	0	0.11	381.1	0.48	0	0	0	0	0
I133Part	Prt_I	NONE	NONE	5.79E+04	9.22E-06	179820	0.0973	0	0	0.09	5846	0.39	0	0	0	0	0
I134Part	Prt_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	0
I135Part	Prt_I	NONE	NONE	5.39E+04	2.86E-05	31302	0.264	0	0	0.08	1228.4	0.35	0	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	0
Cs134	CsGrp	NONE	NONE	1.52E+04	9.55E-09	41070	0.254	0	0	0	46250	0	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	0
Cs137	CsGrp	NONE	Ba137m	6.08E+03	7.30E-10	29341	0.0	0	0	0	31931	0	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	0
Sb129	TeGrp	NONE	Te129	1.01E+04	4.42E-05	35.964	0	0	0	0	643.8	0	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	0
Te127	TeGrp	Sb127	NONE	3.67E+03	2.06E-05	6.808	0	0	0	0	318.2	0	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	0
Te129	TeGrp	Sb129	NONE	9.98E+03	1.57E-04	1.8833	0	0	0	0	77.33	0	0	0	0	0	0
Te131m	TeGrp	NONE	I131Elem	4.31E+03	6.42E-06	133570	0	0	0	0	6401	0	0	0	0	0	0
Te132	TeGrp	NONE	I132Elem	3.97E+04	2.51E-06	232360	0.0346	0	0	0	9435	0	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	0
Ba139	BaGrp	NONE	NONE	5.35E+04	1.39E-04	8.88	0	0	0	0	171.68	0	0	0	0	0	0

Ba140	BaGrp	NONE	La140	5.15E+04	6.27E-07	947.2	0	0	0	0	3737	0	0	0	0	0	0
Mo99	NMtls	NONE	Tc99m	5.30E+04	2.87E-06	56.24	0	0	0	0	3959	0	0	0	0	0	0
Tc99m	NMtls	Mo99	NONE	4.64E+04	3.18E-05	185.37	0	0	0	0	32.56	0	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	0
Ru105	NMtls	NONE	Rh105	4.02E+04	4.22E-05	15.355	0	0	0	0	455.1	0	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	0
Rh105	NMtls	Ru105	NONE	3.68E+04	5.40E-06	10.656	0	0	0	0	954.6	0	0	0	0	0	0
Y90	LaGrp	Sr90	NONE	4.29E+03	2.99E-06	1.9129	0	0	0	0	8436	0	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	0
Y92	LaGrp	Sr92	NONE	4.62E+04	5.35E-05	3.885	0	0	0	0	780.7	0	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	0
Zr95	LaGrp	NONE	Nb95	4.95E+04	1.27E-07	4292	0	0	0	0	23347	0	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	0
Nb95	LaGrp	Zr95	NONE	4.96E+04	2.29E-07	1324.6	0	0	0	0	5809	0	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	0
La141	LaGrp	NONE	Ce141	4.91E+04	4.94E-05	9.065	0	0	0	0	562.4	0	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	0
Pr143	LaGrp	Ce143	NONE	4.71E+04	5.85E-07	6.2E-06	0	0	0	0	8103	0	0	0	0	0	0
Nd147	LaGrp	NONE	NONE	1.92E+04	7.10E-07	67.34	0	0	0	0	6845	0	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	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	0
Cm244	LaGrp	NONE	NONE	1.21E+03	1.25E-09	3737	0	0	0	0	2.5E+08	0	0	0	0	0	0

Ce141	CeGrp	La141	NONE	4.75E+04	2.51E-07	94.35	0	0	0	0	8954	0	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	0
Ce144	CeGrp	NONE	NONE	3.73E+04	2.77E-08	1080.4	0	0	0	0	373700	0	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	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	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	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	0
Pu241	CeGrp	NONE	NONE	6.57E+03	1.67E-09	45.88	0	0	0	0	8251000	0	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	0
Sr90	SrGrp	NONE	Y90	4.10E+03	8.00E-10	9768	0	0	0	0	239390	0	0	0	0	0	0
Sr91	SrGrp	NONE	Y91	4.45E+04	2.01E-05	150.96	0	0	0	0	932.4	0	0	0	0	0	0
Sr92	SrGrp	NONE	Y92	4.61E+04	7.29E-05	81.03	0	0	0	0	629	0	0	0	0	0	0

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

```
edit_time
0   2.033  8.033   24   96   720
end_edit_time

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

core
thermal_power           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
0.533   0.1    0.1     0.1     0       0       0        0        0        0
2.033   0.633  0.167   0.133   0.033   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      0.1    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_type              OBJ_CV
name                  DW
air_volume            1.284e+005
water_volume          0
surface_area          1
has_recirc_filter     false
removal_rate_to_surface
Time    NobleGas  ElemIodine  OrgIodine  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        2.0        2.0
end_removal_rate_to_surface

frac_4_daughter_resusp_from_surface
Time  NobleGas    ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720      1           0            0           0           0          0
end_frac_4_daughter_resusp_from_surface

end_control_volume

control_volume
obj_type                 OBJ_CV
name                     WW
air_volume               1.039e+005
water_volume             6.8e+004
surface_area             0
has_recirc_filter        false
removal_rate_to_waterpool
Time  NobleGas    ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720      0           0.0          0           0.0         0.0        0.0
end_removal_rate_to_waterpool

frac_4_daughter_resusp_from_water
Time  NobleGas    ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720      1           0            0           0           0          0
end_frac_4_daughter_resusp_from_water

decontamination_factor
Time  NobleGas    ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720      1           1            1           1           1          1
end_decontamination_factor

end_control_volume

control_volume
obj_type                 OBJ_CV
name                     RB
air_volume               1.5e+003
water_volume             0
surface_area             0
has_recirc_filter        false
end_control_volume

control_volume
obj_type                 OBJ_CV
name                     SL1
air_volume               26
water_volume             0
surface_area             0
has_recirc_filter        false
end_control_volume

control_volume
obj_type                 OBJ_CV
name                     SL2
air_volume               26
water_volume             0
surface_area             0
has_recirc_filter        false
end_control_volume
```

```
control_volume
obj_type            OBJ_CV
name                ALT1
air_volume          526
water_volume        0
surface_area        0
has_recirc_filter   false
end_control_volume

control_volume
obj_type            OBJ_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        0
has_recirc_filter   false
end_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
obj_type            OBJ_CR
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

occupancy_factor
Time (hr)    Value (frac)
24           1
96           0.6
720          0.4
end_occupancy_factor

end_control_volume

junction
junction_type       AIR_JUNCTION
```

```
downstream_location      AIR_SPACE
upstream                 CORE
downstream               DW
flow_rate
Time (hr)    Rate (cfm)
0.533        1
720          1
end_flow_rate
has_filter               false
end_junction

junction
junction_type            AIR_JUNCTION
downstream_location      AIR_SPACE
upstream                 CORE
downstream               SP
flow_rate
Time (hr)    Rate (cfm)
0.533        1
720          1
end_flow_rate
has_filter               false
end_junction

junction
junction_type            AIR_JUNCTION
downstream_location      AIR_SPACE
upstream                 DW
downstream               WW
has_filter               false
flow_rate
Time (hr)    Value (cfm)
2.033        0
720          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)
0.167             0.713
720          0
end_flow_rate

X_over_Q_4_ctrl_room
Time (hr)    Value (s/m*3)
720          2.98e-3
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

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream DW
downstream environment
has_filter false
flow_rate
Time (hr) Value (cfm)
24 0.031
720 0.016
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
24 0
96 0
720 0
end_X_over_Q_4_site_boundary

X_over_Q_4_low_population_zone
Time (hr) Value (s/m*3)
2.033 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
upstream DW
downstream RB
has_filter false
flow_rate
Time (hr) Value (cfm)
0.167 0
24 0.713
720 0.357
end_flow_rate
end_junction

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	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0	0	0	0	0

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream SL1
downstream ALT1
has_filter true
flow_rate

Time (hr)	Value (cfm)
24	0.383
720	0.192

end_flow_rate

filter_efficiency

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0	0	0.38	0.38	0.38

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream ALT1
downstream environment
has_filter true
flow_rate

Time (hr)	Value (cfm)
24	0.016
720	0.008

end_flow_rate

filter_efficiency
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 0 0.58 0 0.71 0.71 0.71
end_filter_efficiency

frac_4_daughter_resusp
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 1 0 0 0 0 0
end_frac_4_daughter_resusp

X_over_Q_4_ctrl_room
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_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 ALT1
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 OrgIodine PartIodine Solubles Insolubles
720 0 0.58 0 0.71 0.71 0.71
end_filter_efficiency

frac_4_daughter_resusp
Time NobleGas ElemIodine OrgIodine PartIodine Solubles Insolubles
720 1 0 0 0 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

Time (hr)	Value (cfm)
24	0.383
720	0.192

end_flow_rate
filter_efficiency

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0	0	0	0	0

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream SL2
downstream ALT2
has_filter true
flow_rate

Time (hr)	Value (cfm)
24	0.383
720	0.192

end_flow_rate

filter_efficiency

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0	0	0.38	0.38	0.38

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

end_junction

junction
junction_type AIR_JUNCTION
downstream_location IR_SPACE
upstream ALT2
downstream environment
has_filter true
flow_rate

Time (hr)	Value (cfm)
24	0.016

720 0.008
end_flow_rate

filter_efficiency

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0.58	0	0.71	0.71	0.71

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

X_over_Q_4_ctrl_room

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_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 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	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0.58	0	0.71	0.71	0.71

end_filter_efficiency

```
frac_4_daughter_resusp
Time  NobleGas   ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720   1          0            0           0            0
end_frac_4_daughter_resusp

end_junction

junction
junction_type            AIR_JUNCTION
downstream_location      AIR_SPACE
upstream                 ALT3
downstream               environment
has_filter               true
flow_rate
Time (hr)   Value (cfm)
24          2.05
720         1.03
end_flow_rate

filter_efficiency
Time  NobleGas   ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720   0          0.998        0           0.951        0.951      0.951
end_filter_efficiency

frac_4_daughter_resusp
Time  NobleGas   ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720   1          0            0           0            0          0
end_frac_4_daughter_resusp

X_over_Q_4_ctrl_room
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_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
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)
720 0
end_X_over_Q_4_site_boundary

X_over_Q_4_low_population_zone
Time (hr) Value (s/m*3)
720 0
end_X_over_Q_4_low_population_zone

end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream 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
upstream WW
downstream environment
has_filter true

```
flow_rate
Time (hr)     Value (cfm)
192           0.0
720           0.0
end_flow_rate

filter_efficiency
Time   NobleGas   ElemIodine   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   ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720    1          1            0           0            0          0
end_frac_4_daughter_resusp

X_over_Q_4_ctrl_room
Time (hr)     Value (s/m*3)
720           0
end_X_over_Q_4_ctrl_room

X_over_Q_4_site_boundary
Time  (hr)    Value (s/m*3)
720           0
end_X_over_Q_4_site_boundary

X_over_Q_4_low_population_zone
Time (hr)     Value (s/m*3)
720           0
end_X_over_Q_4_low_population_zone

end_junction

junction
junction_type              AIR_JUNCTION
downstream_location        AIR_SPACE
upstream                   SP
downstream                 RB
has_filter                 true
flow_rate
Time (hr)     Rate (cfm)
720           0.13
end_flow_rate

filter_efficiency
Time   NobleGas   ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720    0          .9           .9          .9           0          0
end_filter_efficiency

frac_4_daughter_resusp
Time   NobleGas   ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720    0          0            0           0            0          0
end_frac_4_daughter_resusp

end_junction

junction
junction_type              AIR_JUNCTION
downstream_location        AIR_SPACE
upstream                   RB
```

downstream environment
has_filter true
flow_rate
Time (hr) Value (cfm)
720 1500
end_flow_rate

filter_efficiency

Time	NobleGas	ElemIodine	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	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	1	0	0	0	0

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
720 1.79e-7
end_X_over_Q_4_ctrl_room

X_over_Q_4_site_boundary
Time (hr) Value (s/m*3)
1.300 0
1.800 2.03e-4
2.300 1.54e-4
3.300 9.17e-5
720 0
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 AIR_SPACE
upstream 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
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
```

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

```
edit_time
0    2.033  8.033 24      96       240      720
end_edit_time

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

core
thermal_power            1950
elemental_iodine_frac    0.0485
organic_iodine_frac      0.0015
particulate_iodine_fra   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
0.533   0.1    0.1    0.1      0      0      0      0      0      0
2.033  0.633  0.167  0.133  0.033  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    0.1      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_type               OBJ_CV
name                   DW
air_volume              1.284e+005
water_volume             0
surface_area            1
has_recirc_filter        false
removal_rate_to_surface
Time   NobleGas    ElemIodine    OrgIodine    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    2.0    2.0
end_removal_rate_to_surface

frac_4_daughter_resusp_from_surface
Time  NobleGas  ElemIodine  OrgIodine  PartIodine  Solubles  Insolubles
720   1         0           0          0           0         0
end_frac_4_daughter_resusp_from_surface

end_control_volume

control_volume
obj_type              OBJ_CV
name                  WW
air_volume            1.039e+005
water_volume          6.8e+004
surface_area          0
has_recirc_filter     false
removal_rate_to_waterpool
Time  NobleGas  ElemIodine  OrgIodine  PartIodine  Solubles  Insolubles
720   0         0.0         0          0.0         0.0       0.0
end_removal_rate_to_waterpool

frac_4_daughter_resusp_from_water
Time  NobleGas  ElemIodine  OrgIodine  PartIodine  Solubles  Insolubles
720   1         0           0                      0         0         0
end_frac_4_daughter_resusp_from_water

decontamination_factor
Time  NobleGas  ElemIodine  OrgIodine  PartIodine  Solubles  Insolubles
720   1         1           1          1           1         1
end_decontamination_factor

end_control_volume

control_volume
obj_type              OBJ_CV
name                  RB
air_volume            1.5e+003
water_volume          0
surface_area          0
has_recirc_filter     false
end_control_volume

control_volume
obj_type              OBJ_CV
name                  SL2
air_volume            26
water_volume          0
surface_area          0
has_recirc_filter     false
end_control_volume

control_volume
obj_type              OBJ_CV
name                  ALT1
air_volume            526
water_volume          0
surface_area          0
has_recirc_filter     false
```

```
end_control_volume

control_volume
obj_type              OBJ_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          0
has_recirc_filter     false
end_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
obj_type              OBJ_CR
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

occupancy_factor
Time (hr)    Value (frac)
24           1
96           0.6
720          0.4
end_occupancy_factor

end_control_volume

junction
junction_type         AIR_JUNCTION
downstream_location   AIR_SPACE
upstream              CORE
downstream            DW
flow_rate
Time (hr)    Rate (cfm)
0.533        1
720          1
end_flow_rate
```

has_filter false
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream CORE
downstream SP
flow_rate
Time (hr) Rate (cfm)
0.533 1
720 1
end_flow_rate
has_filter false
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream DW
downstream WW
has_filter false
flow_rate
Time (hr) Value (cfm)
2.033 0
720 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)
720 0
end_flow_rate

X_over_Q_4_ctrl_room
Time (hr) Value (s/m*3)
720 2.98e-3
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

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE

```
upstream                DW
downstream              environment
has_filter              false
flow_rate
Time (hr)    Value (cfm)
24                0.031
720        0.016
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
24          0
96          0
720         0
end_X_over_Q_4_site_boundary

X_over_Q_4_low_population_zone
Time (hr)    Value (s/m*3)
2.033             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
upstream                DW
downstream              RB
has_filter              false
flow_rate
Time (hr)    Value (cfm)
24          0.713
720         0.357
end_flow_rate
end_junction

junction
junction_type           AIR_JUNCTION
downstream_location     AIR_SPACE
upstream                DW
downstream              ALT1
has_filter              true
flow_rate
Time (hr)    Value (cfm)
```

24 0.383
720 0.192
end_flow_rate
filter_efficiency

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0	0	0	0	0

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream ALT1
downstream environment
has_filter true
flow_rate
Time (hr) Value (cfm)
24 0.016
720 0.008
end_flow_rate

filter_efficiency

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0.58	0	0.71	0.71	0.71

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

X_over_Q_4_ctrl_room
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_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 ALT1
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	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0.58	0	0.71	0.71	0.71

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	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
Time (hr) Value (cfm)
24 0.383
720 0.192
end_flow_rate
filter_efficiency

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0	0	0	0	0

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream SL2
downstream ALT2
has_filter true

flow_rate

Time (hr)	Value (cfm)
24	0.383
720	0.192

end_flow_rate

filter_efficiency

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0	0	0.38	0.38	0.38

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

end_junction

junction

junction_type	AIR_JUNCTION
downstream_location	AIR_SPACE
upstream	ALT2
downstream	environment
has_filter	true

flow_rate

Time (hr)	Value (cfm)
24	0.016
720	0.008

end_flow_rate

filter_efficiency

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0.58	0	0.71	0.71	0.71

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

X_over_Q_4_ctrl_room

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_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 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	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0.58	0	0.71	0.71	0.71

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream ALT3
downstream environment
has_filter true
flow_rate
Time (hr) Value (cfm)
24 2.05
720 1.03
end_flow_rate

filter_efficiency

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0.998	0	0.951	0.951	0.951

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

X_over_Q_4_ctrl_room
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_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
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)
720          0
end_X_over_Q_4_site_boundary
```

X_over_Q_4_low_population_zone
Time (hr) Value (s/m*3)
720 0
end_X_over_Q_4_low_population_zone

end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream WW
downstream RB
has_filter false
flow_rate
Time (hr) Value (cfm)
24 0.577
720 0.289
end_flow_rate
end_junction

junction
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_flow_rate

filter_efficiency

Time	NobleGas	ElemIodine	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	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	1	0	0	0	0

end_frac_4_daughter_resusp

X_over_Q_4_ctrl_room
Time (hr) Value (s/m*3)
720 0
end_X_over_Q_4_ctrl_room

X_over_Q_4_site_boundary
Time (hr) Value (s/m*3)
720 0
end_X_over_Q_4_site_boundary

X_over_Q_4_low_population_zone
Time (hr) Value (s/m*3)
720 0
end_X_over_Q_4_low_population_zone

end_junction

junction

```
junction_type            AIR_JUNCTION
downstream_location      AIR_SPACE
upstream                 SP
downstream               RB
has_filter               true
flow_rate
Time (hr)     Rate (cfm)
720           0.13
end_flow_rate

filter_efficiency
Time   NobleGas   ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720    0          .9           .9          .9           0          0
end_filter_efficiency

frac_4_daughter_resusp
Time   NobleGas   ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720    0          0            0           0            0          0
end_frac_4_daughter_resusp

end_junction

junction
junction_type            AIR_JUNCTION
downstream_location      AIR_SPACE
upstream                 RB
downstream               environment
has_filter               true
flow_rate
Time (hr)     Value (cfm)
720           1500
end_flow_rate

filter_efficiency
Time   NobleGas   ElemIodine   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   ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720    1          1            0           0            0          0
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
720           1.79e-7
end_X_over_Q_4_ctrl_room

X_over_Q_4_site_boundary
Time (hr)     Value (s/m*3)
1.300         0
1.800         2.03e-4
2.300         1.54e-4
3.300         9.17e-5
720           0
```

```
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          AIR_SPACE
upstream                     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
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

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

```
edit_time
0    2.033  8.033    24    96    720
end_edit_time

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

core
thermal_power             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
0.533  0.1    0.1    0.1    0      0       0       0       0       0
2.033  0.633  0.167  0.133  0.033  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      0.1    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_type                  OBJ_CV
name                      DW
air_volume                1.284e+005
water_volume              0
surface_area              1
has_recirc_filter         false
removal_rate_to_surface
Time    NobleGas   ElemIodine   OrgIodine   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        2.0        2.0
end_removal_rate_to_surface

frac_4_daughter_resusp_from_surface
Time  NobleGas   ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720      1           0           0           0           0          0
end_frac_4_daughter_resusp_from_surface

end_control_volume

control_volume
obj_type              OBJ_CV
name                  WW
air_volume            1.039e+005
water_volume          6.8e+004
surface_area          0
has_recirc_filter     false
removal_rate_to_waterpool
Time  NobleGas   ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720      0          0.0          0           0.0         0.0        0.0
end_removal_rate_to_waterpool

frac_4_daughter_resusp_from_water
Time  NobleGas   ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720      1           0           0           0           0          0
end_frac_4_daughter_resusp_from_water

decontamination_factor
Time  NobleGas   ElemIodine   OrgIodine   PartIodine   Solubles   Insolubles
720      1           1           1           1           1          1
end_decontamination_factor

end_control_volume

control_volume
obj_type              OBJ_CV
name                  RB
air_volume            1.5e+003
water_volume          0
surface_area          0
has_recirc_filter     false
end_control_volume

control_volume
obj_type              OBJ_CV
name                  SL1
air_volume            26
water_volume          0
surface_area          0
has_recirc_filter     false
end_control_volume

control_volume
obj_type              OBJ_CV
name                  SL2
air_volume            26
water_volume          0
surface_area          0
has_recirc_filter     false
end_control_volume
```

```
control_volume
obj_type                OBJ_CV
name                    ALT1
air_volume              526
water_volume            0
surface_area            0
has_recirc_filter       false
end_control_volume

control_volume
obj_type                OBJ_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            0
has_recirc_filter       false
end_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
obj_type                OBJ_CR
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

occupancy_factor
Time (hr)    Value (frac)
24           1
96           0.6
720          0.4
end_occupancy_factor

end_control_volume

junction
junction_type           AIR_JUNCTION
```

downstream_location AIR_SPACE
upstream CORE
downstream DW
flow_rate
Time (hr) Rate (cfm)
0.533 1
720 1
end_flow_rate
has_filter false
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream CORE
downstream SP
flow_rate
Time (hr) Rate (cfm)
0.533 1
720 1
end_flow_rate
has_filter false
end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream DW
downstream WW
has_filter false
flow_rate
Time (hr) Value (cfm)
2.033 0
720 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)
0.167 0.713
720 0
end_flow_rate

X_over_Q_4_ctrl_room
Time (hr) Value (s/m*3)
720 2.98e-3
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

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream DW
downstream environment
has_filter false
flow_rate
Time (hr) Value (cfm)
24 0.031
720 0.016
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
24 0
96 0
720 0
end_X_over_Q_4_site_boundary

X_over_Q_4_low_population_zone
Time (hr) Value (s/m*3)
2.033 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
upstream DW
downstream RB
has_filter false
flow_rate
Time (hr) Value (cfm)
0.167 0
24 0.713
720 0.357
end_flow_rate
end_junction

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	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0	0	0	0	0

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream SL1
downstream ALT1
has_filter true
flow_rate

Time (hr)	Value (cfm)
24	0.383
720	0.192

end_flow_rate

filter_efficiency

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0	0	0.38	0.38	0.38

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream ALT1
downstream environment
has_filter true
flow_rate

Time (hr)	Value (cfm)
24	0.016
720	0.008

end_flow_rate

filter_efficiency

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0.58	0	0.71	0.71	0.71

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

X_over_Q_4_ctrl_room

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_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	ALT1
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	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0.58	0	0.71	0.71	0.71

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	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

Time (hr)	Value (cfm)
24	0.383
720	0.192

end_flow_rate
filter_efficiency

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0	0	0	0	0

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream SL2
downstream ALT2
has_filter true
flow_rate

Time (hr)	Value (cfm)
24	0.383
720	0.192

end_flow_rate

filter_efficiency

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0	0	0.38	0.38	0.38

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream ALT2
downstream environment
has_filter true
flow_rate

Time (hr)	Value (cfm)
24	0.016

720 0.008
end_flow_rate

filter_efficiency

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0.58	0	0.71	0.71	0.71

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

X_over_Q_4_ctrl_room

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_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 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	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0.58	0	0.71	0.71	0.71

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

end_junction

junction

junction_type	AIR_JUNCTION
downstream_location	AIR_SPACE
upstream	ALT3
downstream	environment
has_filter	true

flow_rate

Time (hr)	Value (cfm)
24	2.05
720	1.03

end_flow_rate

filter_efficiency

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0.998	0	0.951	0.951	0.951

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	0	0	0	0	0

end_frac_4_daughter_resusp

X_over_Q_4_ctrl_room

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_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
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)
720          0
end_X_over_Q_4_site_boundary

X_over_Q_4_low_population_zone
Time (hr)    Value (s/m*3)
720          0
end_X_over_Q_4_low_population_zone

end_junction

junction
junction_type           AIR_JUNCTION
downstream_location     AIR_SPACE
upstream                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
upstream                WW
downstream              environment
has_filter              true
```

```
flow_rate
Time (hr)   Value (cfm)
192         0.0
720         20.0
end_flow_rate

filter_efficiency
Time  NobleGas  ElemIodine  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  ElemIodine  OrgIodine  PartIodine  Solubles  Insolubles
720   1         1           0          0           0         0
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
720         1.79e-7
end_X_over_Q_4_ctrl_room

X_over_Q_4_site_boundary
Time (hr)   Value (s/m*3)
1.300       0
1.800       2.03e-4
2.300       1.54e-4
3.300       9.17e-5
720         0
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    AIR_SPACE
upstream               SP
downstream             RB
has_filter             true
flow_rate
Time (hr)   Rate (cfm)
720         0.13
end_flow_rate

filter_efficiency
```

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	.9	.9	.9	0	0

end_filter_efficiency

frac_4_daughter_resusp

Time	NobleGas	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	0	0	0	0	0	0

end_frac_4_daughter_resusp

end_junction

junction
junction_type AIR_JUNCTION
downstream_location AIR_SPACE
upstream RB
downstream environment
has_filter true
flow_rate

Time (hr)	Value (cfm)
720	1500

end_flow_rate

filter_efficiency

Time	NobleGas	ElemIodine	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	ElemIodine	OrgIodine	PartIodine	Solubles	Insolubles
720	1	1	0	0	0	0

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
720	1.79e-7

end_X_over_Q_4_ctrl_room

X_over_Q_4_site_boundary

Time (hr)	Value (s/m*3)
1.300	0
1.800	2.03e-4
2.300	1.54e-4
3.300	9.17e-5
720	0

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 AIR_SPACE
upstream 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
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