CALCULATION TITLE PAGE

CALCULATION NUMBER: PSAT 3019CF.QA.07

CALCULATION TITLE: Radiological Evaluation of a Control Rod Drop Accident

		ORIGINATOR Print/Sign/Date	CHECKER Print/Sign/Date	IND REVIEWER Print/Sign/Date
REV:	0	James Metcalf 7/23/03	Vera Geba 7/23/03	Dave Leaver 7/30/03
	1			
	2			
	3			
	4			

REASON FOR REVISION:	Nonconformance Rpt
0 - Initial Issue	N/A

CONTROLLED COPY

Table of Contents

Purpose

This calculation is prepared by Polestar Applied Technology, Inc. at the request of Vermont Yankee (VY) to determine the offsite and control room doses following a Control Rod Drop Accident (CRDA). The analysis includes releases through three separate pathways (or cases) and evaluates the radiological impact at the Exclusion Area Boundary (EAB), Low Population Zone (LPZ) and control room (CR). The three release pathways are as follows:

Case 1: Leakage from the main condenser based on the assumption of manual isolation of the Main Steam Isolation Valves (MSIVs);

Case 2: Release from the AOG system based on the assumption that the MSIVs remain open;

Case 3: Release from the RCS recirculation sampling lines in the Reactor Building.

Release Pathways #1 and #2 are mutually exclusive, while Pathway #3 is additive to both Pathway #1 and #2. Summaries of the results are presented in Table 1.

Summary of Results

Table 1 – VY CRDA Summary of Dose Results

Location	Dose (rem)		
	Thyroid Inhalation Pathway*	Whole Body/DDE External Radiation*	Total Effective Dose Equivalent (TEDE)
Case 1: Condenser Leakage, with MSIV and/or AOG isolation (24-hr Leakage)			
EAB	2.4E+00	2.0E-01	2.7E-01
LPZ	6.8E-02	3.9E-03	6.1E-03
CR	1.1E+01	1.5E-02	3.5E-01
Case 2: AOG Releases (24 hr holdup for Kr, 16.6 days for Xe)			
EAB	0.0E+00	1.6E-01	1.6E-01
LPZ	0.0E+00	2.1E-02	2.1E-02
CR	0.0E+00	4.5E-03	4.5E-03
Case 3: RCS Sampling Line Releases (32 gph for 30 days)			
EAB	3.1E+00	1.2E-02	1.1E-01
LPZ	1.8E+00	3.6E-03	6.0E-02
CR	1.5E+00	1.8E-04	4.8E-02
Condenser Leakage + RCS Sampling Line Releases			
EAB	5.5E+00	2.1E-01	3.8E-01
LPZ	1.9E+00	7.5E-03	6.6E-02
CR	1.2E+01	1.5E-02	4.0E-01
AOG + RCS Sampling Line Releases			
EAB	3.1E+00	1.7E-01	2.7E-01
LPZ	1.8E+00	2.4E-02	8.1E-02
CR	1.5E+00	4.6E-03	5.2E-02
Acceptance Criteria (rem)			
EAB & LPZ	None*	None*	6.3
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 by at least a factor of ten.

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 CRDA. The computer code RADTRAD 3.02a (Reference 2) was used to determine the activity releases, offsite dose and control room dose. Verification of the RADTRAD runs was performed using the STARDOSE 1.01 computer code (Reference 3) and is documented in Appendix A.

Assumptions

Assumption 1: The Case 1 release is from the main condenser via the Turbine Building and at ground level. The Case 2 and Case 3 releases are from the plant stack.
Justification: The exact leak location for the assumed 1% per day condenser leakage is not known, but it is conservatively assumed to be at ground level. The AOG releases and the releases associated with the sampling line coolant leakage into the Reactor Building will be via the plant stack.

Assumption 2: No credit is taken for SGTS iodine filtration for the sampling line coolant leakage (Case 3).
Justification: This is conservative.

Assumption 3: 10% of the iodine in the sampling line coolant leakage is assumed to become airborne for Case 3.
Justification: This is consistent with the DBA-LOCA ESF leakage analytical treatment.

Assumption 4: The AOG releases are permitted to decay for the specified holdup times and then released instantaneously. Fumigation X/Qs and the least favorable breathing rates and control room occupancy factors are assumed to be experienced at the time of the release for both the Kr holdup (Case 2a) and the Xe holdup (Case 2b).
Justification: This is conservative. The X/Q, breathing rate, and occupancy factor assumptions are not only conservatively inconsistent between Cases 2a and 2b, both Cases 2a and 2b are conservatively inconsistent with respect to the assumed t = 0 start of release for Cases 1 and 3.

Assumption 5: The coolant density for Case 3 is 62.3 lbm/ft^3 (standard conditions).
Justification: This is conservative. Assuming a large value for density yields a conservatively small coolant volume

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 1.

Design Inputs

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

Power level = 1950 MWt (Item 8.1)
Core inventories (Item 1.1 – full core inventory at t = 0)
Peaking factor = 1.5 (Item 2.11)
Total number of fuel assemblies in core = 368 (Item 1.2)
Fuel failure: 850 rods (conservatively based on 8x8 fuel) for a failure fraction of 0.0385 (Item 2.8)
No pins are assumed to melt (Item 2.9)
Release and plateout fractions for all radionuclide groups (Item 2.10)
Iodine species assumed: 97% elemental and 3% organic (Item 2.12)
Leakage rate from main condenser to environment, Case 1 = 1% per day (Item 3.11)
Delay times for charcoal beds of AOG, Case 2: Iodines – infinite
Kryptons – 24 hours
Xenons – 16.6 days (Item 7.10)
Coolant mass assumed to mix with iodine release, Case 3 = 393,197 lbm (Item 3.12)
Coolant Release from RCS Sampling Line (CRDA) = 32 gal/hour (Item 3.13)
Control Room volume = 41,533.75 cuft (Item 3.4)
Control Room intake (unfiltered): 3700 cfm (Item 3.8)

X/Q values in sec/m3:

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	---	---	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	1.75E-5	8.01E-6	1.00E-6	5.80E-7	3.37E-7
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)	---	3.665E-3	2.187E-3	7.572E-4	3.934E-4	2.705E-4	2.044E-4
Control Room stack (Item 5.3)	Fumigation: 2.39E-4 (0.5 hr) Normal: 1.05E-6 (0.5 hr) 8.70E-7 (1.0 hr)	---	---	4.79E-7	2.34E-7	1.23E-7	6.90E-8

Control Room breathing rates in m3/s (Item 5.4):

0-30 days	3.5E-4

EAB & LPZ breathing rates in m3/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

Case 1 – Condenser Leakage

Scenario Assumptions

Manual isolation of the MSIV takes place prior to any release of activity to the atmosphere via the Advanced Off Gas (AOG) system. As a result, the activity released from the damaged fuel that reaches the turbine and condenser is retained within these systems and the AOG lines. Retention by the AOG charcoal beds, if any, is neglected, and release to the environment is due to condenser leakage.

100% of the noble gases released from the damaged fuel rods into the reactor vessel, 10% of the iodines, and 1% of cesiums/rubidiums are assumed to reach the turbine and condenser.

The flow from the condenser/LP turbine to the environment consistes of 1% leakage/day for 24 hours. Any combination of volume and leak rate giving 1% leakage per day can be used; e.g., 144,000 ft^3 at one cfm. The Turbine Building is ignored – the condenser release is assumed to be direct to the environment.

100% of the noble gases released to the condenser, 10% of the iodines, and 1% of cesiums/rubidiums are assumed to reach the environment.

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
```

Activity is assumed to be released from the core to the condenser in 1/1000 of an hour to simulate an instantaneous release.

The release fractions for noble gas, iodine, and cesium/rubidium are based on the product of the peaking factor (1.5), the fuel damage fraction (0.0385), the gap fraction (0.1 for noble gas and iodine; 0.12 for cesium/rubidium), and the fractional penetration for the steam line (1.0 for noble gas, 0.1 for iodine, and 0.01 for cesium/rubidium). This gives 0.00578 for noble gas, 0.000578 for iodine, and 0.0000693 for cesium/rubidium.

Release Fraction and Timing File

```
Release Fraction and Timing Name:
 Case 1 Release
 Duration (h):
  0.1000E-02  0.0000E+00  0.0000E+00  0.0000E+00
 Noble Gases:
  0.5774E-02  0.0000E+00  0.0000E+00  0.0000E+00
 Iodine:
  0.5774E-03  0.0000E+00  0.0000E+00  0.0000E+00
 Cesium:
  0.6929E-04  0.0000E+00  0.0000E+00  0.0000E+00
 Tellurium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Strontium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Barium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Ruthenium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Cerium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Lanthanum:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Non-Radioactive Aerosols (kg):
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 End of Release File
```

A volumetric flowrate of one cfm is specified for flow from the condenser to the environment for a period of 24 hours. With an assumed condenser volume of 1.44E4 ft^3 the result is a release of one percent per day. A filter with an efficiency of 99% for particulate and 90% for elemental and organic iodine is placed in the release flowpath to simulate retension in the condenser. The relevant plant model for Case 1 is as follows:

Plant and Scenario File

```
Radtrad 3.02 1/5/2000
VY AST CRDA Case 1
Nuclide Inventory File:
c:\polestar\vy\crda ast\vygeneral.nif
Plant Power Level:
 1.9500E+03
Compartments:
  3
```

```
Compartment 1:
Condenser
  3
 1.4400E+05
  0
  0
  0
  0
  0
Compartment 2:
Control-Room
  1
 4.1530E+04
  0
  0
  0
  0
  0
Compartment 3:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Pathways:
  3
Pathway 1:
Condenser to Environment
  1
  3
  2
Pathway 2:
Environment to Control-Room
  3
  2
  2
Pathway 3:
Control-Room to Environment
  2
  3
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\polestar\vy\crda ast\fgr11&12.inp
c:\polestar\vy\crda ast\case1release.rft
  0.0000E+00
  1
  0.0000E+00   9.7000E-01   3.0000E-02   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
```

```
   0
   0
   0
 Compartments:
   3
 Compartment 1:
   0
   1
   0
   0
   0
   0
   0
   0
   0
 Compartment 2:
   0
   1
   0
   0
   0
   0
   0
   0
   0
 Compartment 3:
   0
   1
   0
   0
   0
   0
   0
   0
   0
 Pathways:
   3
 Pathway 1:
   0
   0
   0
   0
   0
   1
   3
   0.0000E+00    1.0000E+00    9.9000E+01    9.0000E+01    9.0000E+01
   2.4000E+01    0.0000E+00    9.9000E+01    9.0000E+01    9.0000E+01
   7.2000E+02    0.0000E+00    9.9000E+01    9.0000E+01    9.0000E+01
   0
   0
   0
   0
   0
   0
 Pathway 2:
   0
   0
   0
   0
   0
   1
```

```
   2
   0.0000E+00   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 3:
   0
   0
   0
   0
   0
   1
   2
   0.0000E+00   3.7000E+03   1.0000E+02   1.0000E+02   1.0000E+02
   7.2000E+02   0.0000E+00   1.0000E+02   1.0000E+02   1.0000E+02
   0
   0
   0
   0
   0
   0
 Dose Locations:
   3
 Location 1:
 Control-Room
   2
   0
   1
   2
   0.0000E+00   3.5000E-04
   7.2000E+02   0.0000E+00
   1
   4
   0.0000E+00   1.0000E+00
   2.4000E+01   6.0000E-01
   9.6000E+01   4.0000E-01
   7.2000E+02   0.0000E+00
 Location 2:
 EAB
   3
   1
   2
   0.0000E+00   1.7000E-03
   2.0000E+00   0.0000E+00
   1
   4
   0.0000E+00   3.5000E-04
   8.0000E+00   1.8000E-04
   2.4000E+01   2.3000E-04
   7.2000E+02   0.0000E+00
   0
 Location 3:
 LPZ
   3
   1
   7
   0.0000E+00   2.7400E-05
```

```
  1.0000E+00   1.7500E-05
  2.0000E+00   8.0100E-06
  8.0000E+00   1.0000E-06
  2.4000E+01   5.8000E-07
  9.6000E+01   3.3700E-07
  7.2000E+02   0.0000E+00
  1
  4
  0.0000E+00   3.5000E-04
  8.0000E+00   1.8000E-04
  2.4000E+01   2.3000E-04
  7.2000E+02   0.0000E+00
  0
Effective Volume Location:
  1
  7
  0.0000E+00   3.6650E-03
  1.0000E+00   2.1870E-03
  2.0000E+00   7.5720E-04
  8.0000E+00   3.9340E-04
  2.4000E+01   2.7050E-04
  9.6000E+01   2.0440E-04
  7.2000E+02   0.0000E+00
Simulation Parameters:
  1
  0.0000E+00   0.0000E+00
Output Filename:
C:\Polestar\vy\crda ast\Case1.o0
  1
  1
  1
  0
  0
End of Scenario File
```

Case 2 – AOG Releases

Scenario Assumptions

For this scenario, the MSIVs remain open after the postulated CRDA, and the AOG remains operational.

The source term consists of the noble gas, iodine, and cesium/rubidium that would reach the condenser. There is, in principle, no difference between Case 1 and Case 2 in terms of the magnitude of this release. However, because of the infinite iodine delay associated with the AOG charcoal decay beds and the impact of the beds on the particulate release, as well (i.e., the cesium and rubidium particulates which have already been released by a factor of 100 in the steam lines), only noble gas is assumed to be released in this analysis. All releases to the environment are via the AOG and main stack and include only kryptons and xenons.

The AOG is assumed to be operating with six charcoal beds in series. The associated holdup times are 24 hours for the kryptons and 16.6 days for the xenons.

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. Two .nif files are used in this analysis; one for Case2a (no Xe) and one for Case2b (no Kr). Both of these are provided below.

Nuclear Information Files

```
Nuclide Inventory Name:
 VY Kr only
 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
 0.00E+00
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 039:
Xe-135
  1
 0.3272400000E+05
 0.1350E+03
 0.00E+00
```

```
Cs-135    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 040:
Cs-134

  3
 0.6507177120E+08
 0.1340E+03
 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

Nuclide Inventory Name:
 VY Xe only
 Power Level:
  0.1000E+01
 Nuclides:
  60
 Nuclide 001:
 Co-58
   7
  0.6117120000E+07
  0.5800E+02
  0.1430E+03
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 002:
 Co-60

   7
  0.1663401096E+09
  0.6000E+02
  0.1425E+03
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 003:
 Kr-85
   1
  0.3382974720E+09
  0.8500E+02
  0.00E+00
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 004:
 Kr-85m
   1
  0.1612800000E+05
  0.8500E+02
  0.00E+00
 Kr-85     0.2100E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 005:
 Kr-87
   1
  0.4578000000E+04
  0.8700E+02
```

```
  0.00E+00
 Rb-87     0.1000E+01
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 006:
 Kr-88
   1
  0.1022400000E+05
  0.8800E+02
  0.00E+00
 Rb-88     0.1000E+01
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 007:
 Rb-86
   3
  0.1612224000E+07
  0.8600E+02
  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
```

Activity is assumed to be released from the core to the condenser in 1/1000 of an hour to simulate an instantaneous release.

The release fraction for the noble gas is based on the product of the peaking factor (1.5), the fuel damage fraction (0.0385), and the gap fraction (0.1) = 0.00578.

Release Fraction and Timing File

```
Release Fraction and Timing Name:
 Case 2 Release
 Duration (h):
  0.1000E-02  0.0000E+00  0.0000E+00  0.0000E+00
 Noble Gases:
  0.5774E-02  0.0000E+00  0.0000E+00  0.0000E+00
 Iodine:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Cesium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Tellurium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Strontium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Barium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Ruthenium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Cerium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Lanthanum:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Non-Radioactive Aerosols (kg):
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 End of Release File
```

A volumetric flowrate of 7,200 cfm is specified for flow from the condenser to the environment once the environmental release begins. Since this is one volume every 20 minutes (with an assumed condenser volume of 1.44E4 ft^3), the condenser is completely emptied in about one hour. For Case 2a (Kr only), the environmental release begins at t = 24 hours; for Case 2b (Xe only), the environmental release begins at t = 398.4 hours. No change is needed for the assumed filtration in

this pathway (from that assumed for Case 1) since only noble gas is released (RADTRAD has no filtration option for noble gas).

The X/Qs, breathing rates, and occupancy factors are all keyed to the assumed release times from the condenser (t = 24 hours for Case 2a and t = 398.4 hours for Case 2b). Because the condenser requires one hour to empty, the fumigation X/Q duration is extended from 0.5 hours to 1.0 hours for conservatism.

The relevant plant models for Case 2a and 2b are as follows:

Plant and Scenario Files

```
Radtrad 3.02 1/5/2000
VY AST CRDA Case 2a
Nuclide Inventory File:
c:\polestar\vy\crda ast\vykronly.nif
Plant Power Level:
 1.9500E+03
Compartments:
  3
Compartment 1:
Condenser
  3
 1.4400E+05
  0
  0
  0
  0
  0
Compartment 2:
Control-Room
  1
 4.1530E+04
  0
  0
  0
  0
  0
Compartment 3:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Pathways:
  3
Pathway 1:
Condenser to Environment
  1
  3
  2
Pathway 2:
Environment to Control-Room
  3
```

```
  2
  2
Pathway 3:
Control-Room to Environment
  2
  3
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\polestar\vy\crda ast\fgr11&12.inp

c:\polestar\vy\crda ast\case2release.rft
  0.0000E+00
  1
  0.0000E+00   9.7000E-01   3.0000E-02   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  3
Compartment 1:
  0
  1
  0
  0
  0
  0

  0
  0
  0
Compartment 2:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 3:
  0
  1
  0
  0
  0
  0
  0
  0
  0
```

```
Pathways:
  3
Pathway 1:
  0
  0
  0
  0
  0
  1
  3
  0.0000E+00   0.0000E+00   9.9000E+01   9.0000E+01   9.0000E+01
  2.4000E+01   7.2000E+03   9.9000E+01   9.0000E+01   9.0000E+01
  7.2000E+02   0.0000E+00   9.9000E+01   9.0000E+01   9.0000E+01
  0
  0
  0
  0
  0
  0
Pathway 2:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   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 3:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00   3.7000E+03   1.0000E+02   1.0000E+02   1.0000E+02
  7.2000E+02   0.0000E+00   1.0000E+02   1.0000E+02   1.0000E+02
  0
  0
  0
  0
  0
  0
Dose Locations:
  3
Location 1:
Control-Room
  2
  0
  1
  3
  0.0000E+00   0.0000E+00
  2.4000E+01   3.5000E-04
```

```
   7.2000E+02    0.0000E+00
   1
   5
   0.0000E+00    0.0000E+00
   2.4000E+01    1.0000E+00
   4.8000E+01    6.0000E-01
   1.2000E+02    4.0000E-01
   7.2000E+02    0.0000E+00
Location 2:
EAB
   3
   1
   5
   0.0000E+00    0.0000E+00
   2.4000E+01    2.0300E-04
   2.4500E+01    2.0300E-04
   2.5000E+01    9.1700E-05
   2.6000E+01    0.0000E+00
   1
   5
   0.0000E+00    0.0000E+00
   2.4000E+01    3.5000E-04
   3.2000E+01    1.8000E-04
   4.8000E+01    2.3000E-04
   7.2000E+02    0.0000E+00
   0
Location 3:
LPZ
   3
   1
   8
   0.0000E+00    0.0000E+00
   2.4000E+01    2.5500E-05
   2.5000E+01    1.8700E-05
   2.6000E+01    1.0100E-05
   3.2000E+01    1.0900E-06
   4.8000E+01    6.9000E-07
   1.2000E+02    4.6100E-07
   7.2000E+02    0.0000E+00
   1
   5
   0.0000E+00    0.0000E+00
   2.4000E+01    3.5000E-04
   3.2000E+01    1.8000E-04
   4.8000E+01    2.3000E-04
   7.2000E+02    0.0000E+00
   0
Effective Volume Location:
   1
   9
   0.0000E+00    0.0000E+00
   2.4000E+01    2.3900E-04
   2.4500E+01    2.3900E-04
   2.5000E+01    8.7000E-07
   2.6000E+01    4.7900E-07
   3.2000E+01    2.3400E-07
   4.8000E+01    1.2300E-07
   1.2000E+02    6.9000E-08
   7.2000E+02    0.0000E+00
Simulation Parameters:
   1
```

```
  0.0000E+00   0.0000E+00
Output Filename:
C:\Polestar\vy\crda ast\Case2a'.o0
  1
  1
  1
  0
  0
End of Scenario File

Radtrad 3.02 1/5/2000
VY AST CRDA Case 2b
Nuclide Inventory File:
c:\polestar\vy\crda ast\vyxeonly.nif
Plant Power Level:
 1.9500E+03
Compartments:
  3
Compartment 1:
Condenser
  3
 1.4400E+05
  0
  0
  0
  0
  0
Compartment 2:
Control-Room
  1
 4.1530E+04
  0
  0
  0
  0
  0
Compartment 3:
Environment
  2
 0.0000E+00
  0
  0
  0
  0
  0
Pathways:
  3
Pathway 1:
Condenser to Environment
  1
  3
  2
Pathway 2:
Environment to Control-Room
  3
  2
  2
Pathway 3:
Control-Room to Environment
  2
  3
```

```
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\polestar\vy\crda ast\fgr11&12.inp

c:\polestar\vy\crda ast\case2release.rft
  0.0000E+00
  1
  0.0000E+00   9.7000E-01   3.0000E-02   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  3
Compartment 1:
  0
  1
  0
  0
  0
  0

  0
  0
  0
Compartment 2:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 3:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Pathways:
  3
Pathway 1:
  0
  0
  0
```

```
  0
  0
  1
  3
  0.0000E+00    0.0000E+00    9.9000E+01    9.0000E+01    9.0000E+01
  3.9840E+02    7.2000E+03    9.9000E+01    9.0000E+01    9.0000E+01
  7.2000E+02    0.0000E+00    9.9000E+01    9.0000E+01    9.0000E+01
  0
  0
  0
  0
  0
  0
Pathway 2:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00    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 3:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00    3.7000E+03    1.0000E+02    1.0000E+02    1.0000E+02
  7.2000E+02    0.0000E+00    1.0000E+02    1.0000E+02    1.0000E+02
  0
  0
  0
  0
  0
  0
Dose Locations:
  3
Location 1:
Control-Room
  2
  0
  1
  3
  0.0000E+00    0.0000E+00
  3.9840E+02    3.5000E-04
  7.2000E+02    0.0000E+00
  1
  5
  0.0000E+00    0.0000E+00
  3.9840E+02    1.0000E+00
  4.2240E+02    6.0000E-01
```

```
   4.9440E+02   4.0000E-01
   7.2000E+02   0.0000E+00
 Location 2:
 EAB
   3
   1
   5
   0.0000E+00   0.0000E+00
   3.9840E+02   2.0300E-04
   3.9890E+02   2.0300E-04
   3.9940E+02   9.1700E-05
   4.0040E+02   0.0000E+00
   1
   5
   0.0000E+00   0.0000E+00
   3.9840E+02   3.5000E-04
   4.0640E+02   1.8000E-04
   4.2240E+02   2.3000E-04
   7.2000E+02   0.0000E+00
   0
 Location 3:
 LPZ
   3
   1
   8
   0.0000E+00   0.0000E+00
   3.9840E+02   2.5500E-05
   3.9940E+02   1.8700E-05
   4.0040E+02   1.0100E-05
   4.0640E+02   1.0900E-06
   4.2240E+02   6.9000E-07
   4.9440E+02   4.6100E-07
   7.2000E+02   0.0000E+00
   1
   5
   0.0000E+00   0.0000E+00
   3.9840E+02   3.5000E-04
   4.0640E+02   1.8000E-04
   4.2240E+02   2.3000E-04
   7.2000E+02   0.0000E+00
   0
 Effective Volume Location:
   1
   9
   0.0000E+00   0.0000E+00
   3.9840E+02   2.3900E-04
   3.9890E+02   2.3900E-04
   3.9940E+02   8.7000E-07
   4.0040E+02   4.7900E-07
   4.0640E+02   2.3400E-07
   4.2240E+02   1.2300E-07
   4.9440E+02   6.9000E-08
   7.2000E+02   0.0000E+00
 Simulation Parameters:
   1
   0.0000E+00   0.0000E+00
 Output Filename:
 C:\Polestar\vy\crda ast\Case2b'.o0
   1
   1
   1
```

```
   0
   0
End of Scenario File
```

Case 3 – RCS Recirculation Sampling Lines

Scenario Assumptions

One hundred percent of the iodines released as a result of the postulated CRDA are assumed to be retained by the RCS liquid mass and to mix uniformly therein.

The RCS recirculation sampling line remains unisolated for 30 days, and this results in the release of contaminated RCS coolant at the rate of 32 gph. The corresponding RCS fractional release rate is equal to 0.01627 per day (the RCS mass is assumed to remain constant).

The noble gases produced by the decay of iodine retained by the RCS (Xe133 from I133 and Xe135 from I135) are conservatively assumed to remain within the liquid phase and form part of the source term for the dose analysis.

Ten percent of the released iodines are conservatively assumed to become airborne within the Reactor Building and to then get released to the environment via the main stack without holdup.

RADTRAD Analysis

The 60 radionuclides in the default RADTRAD .nif file are used. It is the same .nif file used for Case 1.

Activity is assumed to be released from the core to the coolant in 1/1000 of an hour to simulate an instantaneous release.

The release fraction for the noble gas is based on the product of the peaking factor (1.5), the fuel damage fraction (0.0385), and the gap fraction (0.1) = 0.00578.

Release Fraction and Timing File

```
Release Fraction and Timing Name:
 Case 3 Release
 Duration (h):
  0.1000E-02  0.0000E+00  0.0000E+00  0.0000E+00
 Noble Gases:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Iodine:
  0.5774E-02  0.0000E+00  0.0000E+00  0.0000E+00
 Cesium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Tellurium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Strontium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Barium:
```

```
 0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
Ruthenium:
 0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
Cerium:
 0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
Lanthanum:
 0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
Non-Radioactive Aerosols (kg):
 0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
End of Release File
```

A volumetric flowrate of 0.0713 cfm is specified for coolant leakage flow to the environment (no holdup in the Reactor Building is assumed) for a period of 720 hours. The coolant volume is 393,197 lbm divided by an assumed coolant density of 62.3 lbm/ft^3 (standard conditions) = 6,311 ft^3. Assuming a large value for density yields a conservatively small coolant volume.

The assumed filtration in this pathway is the same as that for Case 1 (90%), but in this case, it represents the fraction of the iodine in the coolant becoming airborne in the Reactor Building.

As with Case 2, the release is assumed to via the plant stack.

The relevant plant model for Case 3 is as follows:

Plant and Scenario File

```
Radtrad 3.02 1/5/2000
VY AST CRDA Case 3
Nuclide Inventory File:
c:\polestar\vy\crda ast\vygeneral.nif
Plant Power Level:
 1.9500E+03
Compartments:
  3
Compartment 1:
Coolant
  3
 6.3110E+03
  0
  0
  0
  0
  0
Compartment 2:
Control-Room
  1
 4.1530E+04
  0
  0
  0
  0
  0
Compartment 3:
Environment
  2
 0.0000E+00
  0
```

```
  0
  0
  0
  0
Pathways:
  3
Pathway 1:
Coolant to Environment
  1
  3
  2
Pathway 2:
Environment to Control-Room
  3
  2
  2
Pathway 3:
Control-Room to Environment
  2
  3
  2
End of Plant Model File
Scenario Description Name:

Plant Model Filename:

Source Term:
  1
  1   1.0000E+00
c:\polestar\vy\crda ast\fgr11&12.inp
c:\polestar\vy\crda ast\case3release.rft
  0.0000E+00
  1
  0.0000E+00   9.7000E-01   3.0000E-02   1.0000E+00
Overlying Pool:
  0
  0.0000E+00
  0
  0
  0
  0
Compartments:
  3
Compartment 1:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Compartment 2:
  0
  1
  0
  0
  0
  0
  0
```

```
  0
  0
Compartment 3:
  0
  1
  0
  0
  0
  0
  0
  0
  0
Pathways:
  3
Pathway 1:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00    7.1300E-02    1.0000E+02    9.0000E+01    9.0000E+01
  7.2000E+02    0.0000E+00    1.0000E+02    9.0000E+01    9.0000E+01
  0
  0
  0
  0
  0
  0
Pathway 2:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00    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 3:
  0
  0
  0
  0
  0
  1
  2
  0.0000E+00    3.7000E+03    1.0000E+02    1.0000E+02    1.0000E+02
  7.2000E+02    0.0000E+00    1.0000E+02    1.0000E+02    1.0000E+02
  0
  0
  0
  0
  0
```

```
  0
Dose Locations:
  3
Location 1:
Control-Room
  2
  0
  1
  2
  0.0000E+00   3.5000E-04
  7.2000E+02   0.0000E+00
  1
  4
  0.0000E+00   1.0000E+00
  2.4000E+01   6.0000E-01
  9.6000E+01   4.0000E-01
  7.2000E+02   0.0000E+00
Location 2:
EAB
  3
  1
  4
  0.0000E+00   2.0300E-04
  5.0000E-01   1.5400E-04
  1.0000E+00   9.1700E-05
  2.0000E+00   0.0000E+00
  1
  4
  0.0000E+00   3.5000E-04
  8.0000E+00   1.8000E-04
  2.4000E+01   2.3000E-04
  7.2000E+02   0.0000E+00
  0
Location 3:
LPZ
  3
  1
  7
  0.0000E+00   2.5500E-05
  1.0000E+00   1.8700E-05
  2.0000E+00   1.0100E-05
  8.0000E+00   1.0900E-06
  2.4000E+01   6.9000E-07
  9.6000E+01   4.6100E-07
  7.2000E+02   0.0000E+00
  1
  4
  0.0000E+00   3.5000E-04
  8.0000E+00   1.8000E-04
  2.4000E+01   2.3000E-04
  7.2000E+02   0.0000E+00
  0
Effective Volume Location:
  1
  8

  0.0000E+00   2.3900E-04
  5.0000E-01   1.0500E-06
  1.0000E+00   8.7000E-07
  2.0000E+00   4.7900E-07
  8.0000E+00   2.3400E-07
```

```
  2.4000E+01   1.2300E-07
  9.6000E+01   6.9000E-08
  7.2000E+02   0.0000E+00
Simulation Parameters:
  1
  0.0000E+00   0.0000E+00
Output Filename:
C:\Polestar\vy\crda ast\Case3.o0
  1
  1
  1
  0
  0
End of Scenario File
```

Results

The results provided by RADTRAD 3.02a are as follows:

Case 1

Control-Room Doses:			
Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Accumulated dose (rem)	1.46E-02	1.08E+01	3.53E-01

EAB Doses:			
Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Accumulated dose (rem)	1.96E-01	2.37E+00	2.71E-01

LPZ Doses:			
Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Accumulated dose (rem)	3.91E-03	6.79E-02	6.05E-03

Case 2a

Control-Room Doses:			
Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Accumulated dose (rem)	2.10E-03	0.00E+00	2.10E-03

EAB Doses:			
Time (h) = 720.0000	Whole Body	Thyroid	TEDE
Accumulated dose (rem)	7.91E-02	0.00E+00	7.91E-02

LPZ Doses:

Time (h) = 720.0000 Accumulated dose (rem)	Whole Body	Thyroid	TEDE
	1.01E-02	0.00E+00	1.01E-02

Case 2b

Control-Room Doses:

Time (h) = 720.0000 Accumulated dose (rem)	Whole Body	Thyroid	TEDE
	2.35E-03	0.00E+00	2.35E-03

EAB Doses:

Time (h) = 720.0000 Accumulated dose (rem)	Whole Body	Thyroid	TEDE
	8.26E-02	0.00E+00	8.26E-02

LPZ Doses:

Time (h) = 720.0000 Accumulated dose (rem)	Whole Body	Thyroid	TEDE
	1.05E-02	0.00E+00	1.05E-02

Case 3

Control-Room Doses:

Time (h) = 720.0000 Accumulated dose (rem)	Whole Body	Thyroid	TEDE
	1.82E-04	1.52E+00	4.80E-02

EAB Doses:

Time (h) = 720.0000 Accumulated dose (rem)	Whole Body	Thyroid	TEDE
	1.16E-02	3.08E+00	1.09E-01

LPZ Doses:

Time (h) = 720.0000 Accumulated dose (rem)	Whole Body	Thyroid	TEDE
	3.59E-03	1.82E+00	6.01E-02

Combining these into overall results:

Table 2 – VY CRDA Dose Results

Location	Dose (rem)		
	Thyroid Inhalation Pathway*	Whole Body/DDE External Radiation*	Total Effective Dose Equivalent (TEDE)
Condenser Leakage (Case 1) + RCS Sampling Line Releases (Case 3)			
EAB	5.5E+00	2.1E-01	3.8E-01
LPZ	1.9E+00	7.5E-03	6.6E-02
CR	1.2E+01	1.5E-02	4.0E-01
AOG (Cases 2a + 2b) + RCS Sampling Line Releases (Case 3)			
EAB	3.1E+00	1.7E-01	2.7E-01
LPZ	1.8E+00	2.4E-02	8.1E-02
CR	1.5E+00	4.6E-03	5.2E-02
Acceptance Criteria (rem)			
EAB & LPZ	None*	None*	6.3
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 BWR control rod drop accident, the limits are 5 rem TEDE for Control Room and 6.3 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 control rod drop accident will result in Control Room operator doses and offsite doses to the general public that are below the stated limits.

Appendix A
Check Calculation Using the STARDOSE Computer Code For Cases 1, 2 (a,b) and 3

This appendix presents check calculation results for the CRDA analysis using the Polestar STARDOSE computer code (Reference A-1) to check the RADTRAD results for Case 1, Case 2a, Case 2b, and Case 3. The Design Input Data and Assumptions are the same as those used in the main body of the calculation.

The AST application described below for the CRDA is consistentent with Reference A-2.

STARDOSE Calculation

The STARDOSE LIBFILE.TXT file is included as Attachment A-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 A-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 A-4.

The LIBFILE1.TXT file was modified for Case 2 to account for AOG system holdup times for iodines (infinite), kryptons (24 hours) and xenons (16.6 days). Accordingly, Attachment A-2 contains the radionuclide input data for krypton holdup (Case 2a) and Attachment A-3 for xenon holdup (Case 2b).

LIBFILE1CASE2A is the same as LIBFILE1.TXT but with all the iodine and xenon removed. LIBFILE1CASE2B is the same as LIBFILE1.TXT but with all the iodine and krypton removed.

Input data files are provided as Attachments A-4 through A-7 for each case.

Knowing that the damaged fuel rod fraction is 3.85%, that none of this fraction is assumed to melt, and that the peaking factor is 1.5, one can calculate the release fractions for the difference radionuclide groups.

For instance, the gap and fuel releases for the iodine group are respectively 10% and 50%. 10% of the iodine reaches the condenser and 10% of the iodine in the condenser remains airborne. Therefore, the release fractions for the iodine group are as follows:

From the core to the condenser:

$$(0.0385) \times 1.5 \times [(10\% \times 100\%) + (50\% \times 0\%)] \times 10\% = 5.775E\text{-}4$$

Fraction airborne in the condenser available for release:

$$10\% \times 5.775E\text{-}4 = 5.775E\text{-}05$$

The release fractions used in STARDOSE for Case 1 are shown in the table below:

Radionuclide Group	Release Fraction from Gap to Coolant	Activity That Reaches the Condenser	Fraction of Condenser Activity Available for Release to Environment	Total Available Release (with peaking factor of 1.5 and 850 pins failed out of 22,080)
Noble Gas	10%	100%	100%	5.78E-03
Iodine	10%	10%	10%	5.78E-05
Cs, Rb	12%	1%	1%	6.93E-07

The iodine and cesium/rubidium release fractions take into account removal by the main condenser; and therefore, no filter in the release to the environment is needed. In Case 2, the same release fraction for noble gas is used (there is no iodine or cesium/rubidium released). In Case 3, there is no noble gas or cesium/rubidium released, but the iodine release fraction must be increased by a factor of ten because there is no factor of ten reduction in the steam line (as with Case 1).

Results

All doses are in rem.

Excerpt from STARDOSE output corresponding to Case 1 (Attachment A-4 INPUT.DAT):

```
Control_Room

             thyroid     wbody       skin        CEDE
Total dose:  1.07E+1     1.51E-2     3.80E-1     3.37E-1

environment

             thyroid     wbody       skin        CEDE
EAB dose:    2.37E+0     2.29E-1     1.80E-1     7.53E-2
LPZ dose:    6.78E-2     4.19E-3     3.38E-3     2.14E-3
```

Excerpt from STARDOSE output corresponding to Case 2a (Attachment A-5 INPUT.DAT):

```
Control_Room

             thyroid     wbody       skin        CEDE
Total dose:  0.00E+0     2.53E-3     1.11E-1     0.00E+0

environment

             thyroid     wbody       skin        CEDE
EAB dose:    0.00E+0     6.77E-2     8.99E-2     0.00E+0
LPZ dose:    0.00E+0     8.50E-3     1.13E-2     0.00E+0
```

Excerpt from STARDOSE output corresponding to Case 2b (Attachment A-6 INPUT.DAT):

```
Control_Room

             thyroid     wbody       skin        CEDE
Total dose:  0.00E+0     3.07E-3     1.84E-1     0.00E+0

environment

             thyroid     wbody       skin        CEDE
EAB dose:    0.00E+0     7.88E-2     1.46E-1     0.00E+0
LPZ dose:    0.00E+0     9.90E-3     1.84E-2     0.00E+0
```

Excerpt from STARDOSE output corresponding to Case 3 (Attachment A-7 INPUT.DAT):

```
Control_Room

             thyroid     wbody       skin        CEDE
Total dose:  1.51E+0     1.62E-4     2.12E-3     4.76E-2

environment

             thyroid     wbody       skin        CEDE
EAB dose:    3.07E+0     1.04E-2     4.50E-3     9.67E-2
LPZ dose:    1.81E+0     3.50E-3     2.32E-3     5.63E-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.

	Case 1 RAD-TRAD	Case 1 STAR-DOSE	Case 2 RAD-TRAD	Case 2 STAR-DOSE	Case 3 RAD-TRAD	Case 3 STAR-DOSE
EAB	2.7E-01	3.0E-01	1.6E-01	1.5E-01	1.1E-01	1.1E-01
LPZ	6.1E-03	6.3E-03	2.1E-02	1.8E-02	6.0E-02	6.0E-02
Control Room	3.5E-01	3.5E-01	4.5E-03	5.6E-03	4.8E-02	4.8E-02

Appendix References

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

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

A-3. PSAT 3019CF.QA.03, "Design Data Base for Application of the Revised DBA Source Term to Vermont Yankee", Revision 1.

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

Attachment A-1
STARDOSE Library File for Cases 1,3 (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
Kr85m	N_Gas	NONE	NONE	9.71E+03	4.39E-05	0	0.026	0	0	0.05	0	0.22	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
Kr87	N_Gas	NONE	NONE	1.94E+04	1.52E-04	0	0.142	0	0	0.34	0	1.48	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
Kr89	N_Gas	NONE	NONE	3.46E+04	3.63E-03	0	0.323	0	0	0.35	0	1.52	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
Xe133m	N_Gas	NONE	NONE	1.76E+03	3.49E-06	0	0.00472	0	0	0.03	0	0.13	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
Xe135m	N_Gas	NONE	NONE	1.14E+04	7.40E-04	0	0.0682	0	0	0.02	0	0.09	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
Xe137	N_Gas	NONE	NONE	5.07E+04	2.96E-03	0	0.0303	0	0	0.46	0	2	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
I131Org	Org_I	NONE	NONE	2.85E+04	9.96E-07		1080400	0.0606	0	0	0.03	32893	0.13	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
I133Org	Org_I	NONE	NONE	5.79E+04	9.22E-06	179820	0.0973	0	0	0.09	5846	0.39	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
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
I131Elem	Elm_I	Te131m	NONE	2.85E+04	9.96E-07	1080400	0.0606	0	0	0.03	32893	0.13	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
Ce141	CeGrp	La141	NONE	4.75E+04	2.51E-07	94.35	0	0	0	0	8954	0	0	0	0	0
Ce143	CeGrp	NONE	Pr143	4.73E+04	6.03E-06	23.051	0	0	0	0	3389.2	0	0	0	0	0
Ce144	CeGrp	NONE	NONE	3.73E+04	2.77E-08	1080.4	0	0	0	0	373700	0	0	0	0	0
Np239	CeGrp	NONE	NONE	7.67E+05	3.44E-06	28.194	0	0	0	0	2508.6	0	0	0	0	0
Pu238	CeGrp	NONE	NONE	3.93E+02	2.40E-10	3559.4	0	0	0	0	3.9E+08	0	0	0	0	0
Pu239	CeGrp	NONE	NONE	1.47E+01	9.00E-13	3341.1	0	0	0	0	4.3E+08	0	0	0	0	0
Pu240	CeGrp	NONE	NONE	3.11E+01	3.30E-12	3348.5	0	0	0	0	4.3E+08	0	0	0	0	0
Pu241	CeGrp	NONE	NONE	6.57E+03	1.67E-09	45.88	0	0	0	0	8251000	0	0	0	0	0
Sr89	SrGrp	NONE	NONE	3.45E+04	1.59E-07	1539.2	0	0	0	0	6512	0	0	0	0	0
Sr90	SrGrp	NONE	Y90	4.10E+03	8.00E-10	9768	0	0	0	0	239390	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
Sr92	SrGrp	NONE	Y92	4.61E+04	7.29E-05	81.03	0	0	0	0	629	0	0	0	0	0

Attachment A-2
STARDOSE Library File for Case 2a (LIBFILE1CASE 2A.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	0	6.68E-07	0	0.00136	0	0	0.02	0	0.04	0	0	0	0
0																
Xe133m	N_Gas	NONE	NONE	0	3.49E-06	0	0.00472	0	0	0.03	0	0.13	0	0	0	0
0																
Xe133	N_Gas	I133Elem	NONE	0	1.52E-06	0	0.00558	0	0	0.01	0	0.04	0	0	0	0
0																
Xe135m	N_Gas	NONE	NONE	0	7.40E-04	0	0.0682	0	0	0.02	0	0.09	0	0	0	0
0																
Xe135	N_Gas	I135Elem	NONE	0	2.09E-05	0	0.0396	0	0	0.06	0	0.26	0	0	0	0
0																
Xe137	N_Gas	NONE	NONE	0	2.96E-03	0	0.0303	0	0	0.46	0	2	0	0	0	0
0																
Xe138	N_Gas	NONE	NONE	0	6.80E-04	0	0.199	0	0	0.15	0	0.65	0	0	0	0
0																
I131Org	Org_I	NONE	NONE	0	9.96E-07	1080400	0.0606	0	0	0.03	32893	0.13	0	0	0	0
0																
I132Org	Org_I	NONE	NONE	0	8.27E-05	6438	0.377	0	0	0.11	381.1	0.48	0	0	0	0
0																
I133Org	Org_I	NONE	NONE	0	9.22E-06	179820	0.0973	0	0	0.09	5846	0.39	0	0	0	0
0																
I134Org	Org_I	NONE	NONE	0	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	0	2.86E-05	31302	0.264	0	0	0.08	1228.4	0.35	0	0	0	0
0																
I131Elem	Elm_I	Te131m	NONE	0	9.96E-07	1080400	0.0606	0	0	0.03	32893	0.13	0	0	0	0
0																

I132Elem	Elm_I	Te132	NONE	0	8.27E-05	6438	0.377	0	0	0.11	381.1	0.48	0	0	0	0
0																
I133Elem	Elm_I	NONE	Xe133	0	9.22E-06	179820	0.0973	0	0	0.09	5846	0.39	0	0	0	0
0																
I134Elem	Elm_I	NONE	NONE	0	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	0	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
Ba140	BaGrp	NONE	La140	5.15E+04	6.27E-07	947.2	0	0	0	0	3737	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
Tc99m	NMtls	Mo99	NONE	4.64E+04	3.18E-05	185.37	0	0	0	0	32.56	0	0	0	0	0
Ru103	NMtls	NONE	NONE	5.07E+04	2.03E-07	950.9	0	0	0	0	8954	0	0	0	0	0
Ru105	NMtls	NONE	Rh105	4.02E+04	4.22E-05	15.355	0	0	0	0	455.1	0	0	0	0	0
Ru106	NMtls	NONE	NONE	2.85E+04	2.20E-08	6364	0	0	0	0	477300	0	0	0	0	0
Rh105	NMtls	Ru105	NONE	3.68E+04	5.40E-06	10.656	0	0	0	0	954.6	0	0	0	0	0
Y90	LaGrp	Sr90	NONE	4.29E+03	2.99E-06	1.9129	0	0	0	0	8436	0	0	0	0	0
Y91	LaGrp	Sr91	NONE	4.24E+04	1.38E-07	31.45	0	0	0	0	48840	0	0	0	0	0
Y92	LaGrp	Sr92	NONE	4.62E+04	5.35E-05	3.885	0	0	0	0	780.7	0	0	0	0	0
Y93	LaGrp	NONE	NONE	5.05E+04	1.91E-05	3.4262	0	0	0	0	2153.4	0	0	0	0	0
Zr95	LaGrp	NONE	Nb95	4.95E+04	1.27E-07	4292	0	0	0	0	23347	0	0	0	0	0
Zr97	LaGrp	NONE	NONE	4.92E+04	1.13E-05	85.47	0	0	0	0	4329	0	0	0	0	0
Nb95	LaGrp	Zr95	NONE	4.96E+04	2.29E-07	1324.6	0	0	0	0	5809	0	0	0	0	0
La140	LaGrp	Ba140	NONE	5.17E+04	4.77E-06	254.19	0	0	0	0	4847	0	0	0	0	0
La141	LaGrp	NONE	Ce141	4.91E+04	4.94E-05	9.065	0	0	0	0	562.4	0	0	0	0	0
La142	LaGrp	NONE	NONE	4.81E+04	1.26E-04	18.167	0	0	0	0	203.5	0	0	0	0	0
Pr143	LaGrp	Ce143	NONE	4.71E+04	5.85E-07	6.2E-06	0	0	0	0	8103	0	0	0	0	0
Nd147	LaGrp	NONE	NONE	1.92E+04	7.10E-07	67.34	0	0	0	0	6845	0	0	0	0	0
Am241	LaGrp	NONE	NONE	8.73E+00	4.80E-11	5920	0	0	0	0	4.4E+08	0	0	0	0	0
Cm242	LaGrp	NONE	NONE	3.42E+03	4.94E-08	3481.7	0	0	0	0	1.7E+07	0	0	0	0	0

Cm244	LaGrp	NONE	NONE	1.21E+03	1.25E-09	3737	0	0	0	0	2.5E+08	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
Ce143	CeGrp	NONE	Pr143	4.73E+04	6.03E-06	23.051	0	0	0	0	3389.2	0	0	0	0	0
Ce144	CeGrp	NONE	NONE	3.73E+04	2.77E-08	1080.4	0	0	0	0	373700	0	0	0	0	0
Np239	CeGrp	NONE	NONE	7.67E+05	3.44E-06	28.194	0	0	0	0	2508.6	0	0	0	0	0
Pu238	CeGrp	NONE	NONE	3.93E+02	2.40E-10	3559.4	0	0	0	0	3.9E+08	0	0	0	0	0
Pu239	CeGrp	NONE	NONE	1.47E+01	9.00E-13	3341.1	0	0	0	0	4.3E+08	0	0	0	0	0
Pu240	CeGrp	NONE	NONE	3.11E+01	3.30E-12	3348.5	0	0	0	0	4.3E+08	0	0	0	0	0
Pu241	CeGrp	NONE	NONE	6.57E+03	1.67E-09	45.88	0	0	0	0	8251000	0	0	0	0	0
Sr89	SrGrp	NONE	NONE	3.45E+04	1.59E-07	1539.2	0	0	0	0	6512	0	0	0	0	0
Sr90	SrGrp	NONE	Y90	4.10E+03	8.00E-10	9768	0	0	0	0	239390	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
Sr92	SrGrp	NONE	Y92	4.61E+04	7.29E-05	81.03	0	0	0	0	629	0	0	0	0	0

-

Attachment A-3
STARDOSE Library File for Case 2b (LIBFILE1CASE 2B.TXT)

n_isotopes 76 n_isotope_groups 11

Kr83m	N_Gas	NONE	NONE	0	1.04E-04	0	1.49E-5	0	0	0	0	0	0	0	0	0
Kr85m	N_Gas	NONE	NONE	0	4.39E-05	0	0.026	0	0	0.05	0	0.22	0	0	0	0
Kr85	N_Gas	NONE	NONE	0	2.04E-09	0	3.55E-4	0	0	0.05	0	0.22	0	0	0	0
Kr87	N_Gas	NONE	NONE	0	1.52E-04	0	0.142	0	0	0.34	0	1.48	0	0	0	0
Kr88	N_Gas	NONE	NONE	0	6.88E-05	0	0.358	0	0	0.08	0	0.35	0	0	0	0
Kr89	N_Gas	NONE	NONE	0	3.63E-03	0	0.323	0	0	0.35	0	1.52	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
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
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
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
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
Xe137	N_Gas	NONE	NONE	5.07E+04	2.96E-03	0	0.0303	0	0	0.46	0	2	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
I131Org	Org_I	NONE	NONE	0	9.96E-07	1080400	0.0606	0	0	0.03	32893	0.13	0	0	0	0
I132Org	Org_I	NONE	NONE	0	8.27E-05	6438	0.377	0	0	0.11	381.1	0.48	0	0	0	0
I133Org	Org_I	NONE	NONE	0	9.22E-06	179820	0.0973	0	0	0.09	5846	0.39	0	0	0	0
I134Org	Org_I	NONE	NONE	0	2.23E-04	1065.6	0.438	0	0	0.14	131.35	0.61	0	0	0	0
I135Org	Org_I	NONE	NONE	0	2.86E-05	31302	0.264	0	0	0.08	1228.4	0.35	0	0	0	0
I131Elem	Elm_I	Te131m	NONE	0	9.96E-07	1080400	0.0606	0	0	0.03	32893	0.13	0	0	0	0

I132Elem	Elm_I	Te132	NONE	0	8.27E-05	6438	0.377	0	0	0.11	381.1	0.48	0	0	0	0
0																
I133Elem	Elm_I	NONE	Xe133	0	9.22E-06	179820	0.0973	0	0	0.09	5846	0.39	0	0	0	0
0																
I134Elem	Elm_I	NONE	NONE	0	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	0	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
Ba140	BaGrp	NONE	La140	5.15E+04	6.27E-07	947.2	0	0	0	0	3737	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
Tc99m	NMtls	Mo99	NONE	4.64E+04	3.18E-05	185.37	0	0	0	0	32.56	0	0	0	0	0
Ru103	NMtls	NONE	NONE	5.07E+04	2.03E-07	950.9	0	0	0	0	8954	0	0	0	0	0
Ru105	NMtls	NONE	Rh105	4.02E+04	4.22E-05	15.355	0	0	0	0	455.1	0	0	0	0	0
Ru106	NMtls	NONE	NONE	2.85E+04	2.20E-08	6364	0	0	0	0	477300	0	0	0	0	0
Rh105	NMtls	Ru105	NONE	3.68E+04	5.40E-06	10.656	0	0	0	0	954.6	0	0	0	0	0
Y90	LaGrp	Sr90	NONE	4.29E+03	2.99E-06	1.9129	0	0	0	0	8436	0	0	0	0	0
Y91	LaGrp	Sr91	NONE	4.24E+04	1.38E-07	31.45	0	0	0	0	48840	0	0	0	0	0
Y92	LaGrp	Sr92	NONE	4.62E+04	5.35E-05	3.885	0	0	0	0	780.7	0	0	0	0	0
Y93	LaGrp	NONE	NONE	5.05E+04	1.91E-05	3.4262	0	0	0	0	2153.4	0	0	0	0	0
Zr95	LaGrp	NONE	Nb95	4.95E+04	1.27E-07	4292	0	0	0	0	23347	0	0	0	0	0
Zr97	LaGrp	NONE	NONE	4.92E+04	1.13E-05	85.47	0	0	0	0	4329	0	0	0	0	0
Nb95	LaGrp	Zr95	NONE	4.96E+04	2.29E-07	1324.6	0	0	0	0	5809	0	0	0	0	0
La140	LaGrp	Ba140	NONE	5.17E+04	4.77E-06	254.19	0	0	0	0	4847	0	0	0	0	0
La141	LaGrp	NONE	Ce141	4.91E+04	4.94E-05	9.065	0	0	0	0	562.4	0	0	0	0	0
La142	LaGrp	NONE	NONE	4.81E+04	1.26E-04	18.167	0	0	0	0	203.5	0	0	0	0	0
Pr143	LaGrp	Ce143	NONE	4.71E+04	5.85E-07	6.2E-06	0	0	0	0	8103	0	0	0	0	0
Nd147	LaGrp	NONE	NONE	1.92E+04	7.10E-07	67.34	0	0	0	0	6845	0	0	0	0	0
Am241	LaGrp	NONE	NONE	8.73E+00	4.80E-11	5920	0	0	0	0	4.4E+08	0	0	0	0	0
Cm242	LaGrp	NONE	NONE	3.42E+03	4.94E-08	3481.7	0	0	0	0	1.7E+07	0	0	0	0	0

Cm244	LaGrp	NONE	NONE	1.21E+03	1.25E-09	3737	0	0	0	0	2.5E+08	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
Ce143	CeGrp	NONE	Pr143	4.73E+04	6.03E-06	23.051	0	0	0	0	3389.2	0	0	0	0	0
Ce144	CeGrp	NONE	NONE	3.73E+04	2.77E-08	1080.4	0	0	0	0	373700	0	0	0	0	0
Np239	CeGrp	NONE	NONE	7.67E+05	3.44E-06	28.194	0	0	0	0	2508.6	0	0	0	0	0
Pu238	CeGrp	NONE	NONE	3.93E+02	2.40E-10	3559.4	0	0	0	0	3.9E+08	0	0	0	0	0
Pu239	CeGrp	NONE	NONE	1.47E+01	9.00E-13	3341.1	0	0	0	0	4.3E+08	0	0	0	0	0
Pu240	CeGrp	NONE	NONE	3.11E+01	3.30E-12	3348.5	0	0	0	0	4.3E+08	0	0	0	0	0
Pu241	CeGrp	NONE	NONE	6.57E+03	1.67E-09	45.88	0	0	0	0	8251000	0	0	0	0	0
Sr89	SrGrp	NONE	NONE	3.45E+04	1.59E-07	1539.2	0	0	0	0	6512	0	0	0	0	0
Sr90	SrGrp	NONE	Y90	4.10E+03	8.00E-10	9768	0	0	0	0	239390	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
Sr92	SrGrp	NONE	Y92	4.61E+04	7.29E-05	81.03	0	0	0	0	629	0	0	0	0	0

–

Attachment A-4
STARDOSE Main Input File for Case 1

```
edit_time
0 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 0.97
organic_iodine_frac 0.03
particulate_iodine_frac 0.0
release_frac
to_control_volume CONDENSER
Time N_Gas I_Grp CsGrp TeGrp BaGrp NMtls CeGrp LaGrp SrGrp
0.001 5.78 5.78e-2 6.93e-4 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 CONDENSER
air_volume 144000
water_volume 0
surface_area 0
has_recirc_filter false
end_control_volume

control_volume
obj_type OBJ_CR
name CONTROL_ROOM
air_volume 41534
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                     CONDENSER
has_filter                     false
flow_rate
Time (hr)      Rate (cfm)
720            1
end_flow_rate
has_filter                     false
end_junction


junction
junction_type                  AIR_JUNCTION
downstream_location            AIR_SPACE
upstream                       CONDENSER
downstream                     environment
has_filter                     false
flow_rate
Time (hr)      Rate (cfm)
24                     1
720            0
end_flow_rate

X_over_Q_4_site_boundary
Time (hr)      Value (s/m*3)
2              0.0017
720            0.0
end_X_over_Q_4_site_boundary

X_over_Q_4_low_population_zone
Time (hr)      Value (s/m*3)
1                      2.74e-5
2              1.75e-5
8              8.01e-6
24             1.00e-6
96             0
720            0
end_X_over_Q_4_low_population_zone

X_over_Q_4_ctrl_room
Time (hr)      Value (s/m*3)
1                      3.665e-3
2              2.187e-3
8              7.572e-4
24             3.934e-4
96             0
720            0
end_X_over_Q_4_ctrl_room
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)
2             0.00035
720           0.0
end_breathing_rate_sb

breathing_rate_lpz
Time (hr)     Value (cms)
8             0.00035
24            0.00018
720           0.00023
end_breathing_rate_lpz
end_environment
```

Attachment A-5
STARDOSE Main Input File for Case 2a

```
edit_time
0 48 120 744
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 0.97
organic_iodine_frac 0.03
particulate_iodine_frac 0.0
release_frac
to_control_volume CONDENSER
Time N_Gas I_Grp CsGrp TeGrp BaGrp NMtls CeGrp LaGrp SrGrp
0.001 5.78 0 0 0 0 0 0 0 0
744 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 CONDENSER
air_volume 144000
water_volume 0
surface_area 0
has_recirc_filter false
end_control_volume

control_volume
obj_type OBJ_CR
name CONTROL_ROOM
air_volume 41534
water_volume 0
surface_area 0
has_recirc_filter false
breathing_rate
Time (hr) Value (cms)
744 0.00035
end_breathing_rate
occupancy_factor
```

```
Time (hr)     Value (frac)
48          1
120         0.6
744         0.4
end_occupancy_factor
end_control_volume

junction
junction_type                AIR_JUNCTION
downstream_location          AIR_SPACE
upstream                     CORE
downstream                   CONDENSER
has_filter                   false
flow_rate
Time (hr)     Rate (cfm)
744                    1
end_flow_rate
has_filter                 false
end_junction


junction
junction_type                AIR_JUNCTION
downstream_location          AIR_SPACE
upstream                     CONDENSER
downstream                   environment
has_filter                   false
flow_rate
Time (hr)     Rate (cfm)
24                           0
744           144000
end_flow_rate

X_over_Q_4_site_boundary
Time (hr)     Value (s/m*3)
24.5                2.03e-4
25                  1.54e-4
26                  9.17e-5
744         0.0
end_X_over_Q_4_site_boundary

X_over_Q_4_low_population_zone
Time (hr)     Value (s/m*3)
25                  2.55e-5
26          1.87e-5
32          1.01e-5
48          1.09e-6
120         6.90e-7
744         4.61e-7
end_X_over_Q_4_low_population_zone

X_over_Q_4_ctrl_room
Time (hr)     Value (s/m*3)
24.5       2.39E-4
25          1.05e-6
26          8.70e-7
32          4.79e-7
48          2.34e-7
120         1.23e-7
744         6.90e-8
end_X_over_Q_4_ctrl_room
```

```
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)
744           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)
744           3700
end_flow_rate
X_over_Q_4_ctrl_room
Time (hr)     Value (s/m*3)
744           0
end_X_over_Q_4_ctrl_room

X_over_Q_4_site_boundary
Time (hr)     Value (s/m*3)
744           0
end_X_over_Q_4_site_boundary

X_over_Q_4_low_population_zone
Time (hr)     Value (s/m*3)
744           0
end_X_over_Q_4_low_population_zone
end_junction

environment
breathing_rate_sb
Time (hr)     Value (cms)
26            0.00035
744           0.0
end_breathing_rate_sb

breathing_rate_lpz
Time (hr)     Value (cms)
32            0.00035
120           0.00018
744           0.00023
end_breathing_rate_lpz
end_environment
```

Attachment A-6
STARDOSE Main Input File for Case 2b

```
edit_time
0 422 494 1118
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 0.97
organic_iodine_frac 0.03
particulate_iodine_frac 0.0
release_frac
to_control_volume CONDENSER
Time N_Gas I_Grp CsGrp TeGrp BaGrp NMtls CeGrp LaGrp SrGrp
0.001 5.78 0 0 0 0 0 0 0 0
1118 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 CONDENSER
air_volume 144000
water_volume 0
surface_area 0
has_recirc_filter false
end_control_volume

control_volume
obj_type OBJ_CR
name CONTROL_ROOM
air_volume 41534
water_volume 0
surface_area 0
has_recirc_filter false
breathing_rate
Time (hr) Value (cms)
1118 0.00035
end_breathing_rate
occupancy_factor
Time (hr) Value (frac)
```

```
422             1
494             0.6
1118            0.4
end_occupancy_factor
end_control_volume

junction
junction_type                   AIR_JUNCTION
downstream_location             AIR_SPACE
upstream                        CORE
downstream                      CONDENSER
has_filter                      false
flow_rate
Time (hr)       Rate (cfm)
1118            1
end_flow_rate
has_filter                      false
end_junction


junction
junction_type                   AIR_JUNCTION
downstream_location             AIR_SPACE
upstream                        CONDENSER
downstream                      environment
has_filter                      false
flow_rate
Time (hr)       Rate (cfm)
398                     0
1118            144000
end_flow_rate

X_over_Q_4_site_boundary
Time (hr)       Value (s/m*3)
398.5                   2.03e-4
399                     1.54e-4
400                     9.17e-5
1118                    0.0
end_X_over_Q_4_site_boundary

X_over_Q_4_low_population_zone
Time (hr)       Value (s/m*3)
399             2.55e-5
400             1.87e-5
406             1.01e-5
422             1.09e-6
494             6.90e-7
1118            4.61e-7
end_X_over_Q_4_low_population_zone

X_over_Q_4_ctrl_room
Time (hr)       Value (s/m*3)
398.5           2.39e-4
399             1.05e-6
400             8.70e-7
406             4.79e-7
422             2.34e-7
494             1.23e-7
1118            6.90e-8
end_X_over_Q_4_ctrl_room
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)
1118          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)
1118          3700
end_flow_rate
X_over_Q_4_ctrl_room
Time (hr)     Value (s/m*3)
1118          0
end_X_over_Q_4_ctrl_room

X_over_Q_4_site_boundary
Time (hr)     Value (s/m*3)
1118          0
end_X_over_Q_4_site_boundary

X_over_Q_4_low_population_zone
Time (hr)     Value (s/m*3)
1118          0
end_X_over_Q_4_low_population_zone
end_junction

environment
breathing_rate_sb
Time (hr)     Value (cms)
400           0.00035
1118          0.0
end_breathing_rate_sb

breathing_rate_lpz
Time (hr)     Value (cms)
406           0.00035
422           0.00018
1118          0.00023
end_breathing_rate_lpz
end_environment
```

Attachment A-7
STARDOSE Main Input File for Case 3

```
edit_time
0 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 0.97
organic_iodine_frac 0.03
particulate_iodine_frac 0.0
release_frac
to_control_volume CONDENSER
Time N_Gas I_Grp CsGrp TeGrp BaGrp NMtls CeGrp LaGrp SrGrp
0.001 0 5.77 0 0 0 0 0 0 0 0
720 0 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 COOLANT
air_volume 6311
water_volume 0
surface_area 0
has_recirc_filter false
end_control_volume

control_volume
obj_type OBJ_CR
name CONTROL_ROOM
air_volume 41534
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                   COOLANT
has_filter                   false
flow_rate
Time (hr)      Rate (cfm)
720            1
end_flow_rate
has_filter                   false
end_junction

junction
junction_type                AIR_JUNCTION
downstream_location          AIR_SPACE
upstream                     COOLANT
downstream                   environment
has_filter                   true
flow_rate
Time (hr)      Rate (cfm)
720            0.0713
end_flow_rate
filter_efficiency
Time      NobleGas      ElemIodine      OrgIodine      PartIodine      Solubles      Insolubles
720       0             0.9             0.9            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            0.0             0.0           0.0
end_frac_4_daughter_resusp

X_over_Q_4_site_boundary
Time (hr)      Value (s/m*3)
0.5                 2.03e-4
1                   1.54e-4
2                   9.17e-5
720                 0.0
end_X_over_Q_4_site_boundary

X_over_Q_4_low_population_zone
Time (hr)      Value (s/m*3)
1           2.55e-5
2           1.87e-5
8           1.01e-5
24          1.09e-6
96          6.90e-7
720         4.61e-7
end_X_over_Q_4_low_population_zone

X_over_Q_4_ctrl_room
Time (hr)      Value (s/m*3)
0.5         2.39e-4
1           1.05e-6
```

```
2          8.70e-7
8          4.79e-7
24         2.34e-7
96         1.23e-7
72         6.90e-8
end_X_over_Q_4_ctrl_room
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)
2              0.00035
720            0.0
end_breathing_rate_sb

breathing_rate_lpz
Time (hr)      Value (cms)
8              0.00035
24             0.00018
720            0.00023
end_breathing_rate_lpz
end_environment_
```