ATTACHMENT 2

CALCULATIONS FOR CONTAINMENT HIGH RANGE RADIATION MONITOR RESPONSES TO A LOCA

- Surry Calculation RA-0063, Expected Containment High Range Radiation Monitor Response to a LOCA Based on Fuel Rod Gap Fractions Defined in NUREG 1228
- North Anna Calculation RA-0064, Expected Containment High Range Radiation Monitor Response to a LOCA Based on Fuel Rod Gap Fractions Defined in NUREG 1228
- Calculation RA-0074, Millstone Unit 2 Expected Containment High Range Radiation Monitor Response to a LOCA Based on Fuel Rod Gap Fractions Defined in NUREG 1228
- Calculation RA-0075, Millstone Unit 3 Expected Containment High Range Radiation Monitor Response to a LOCA Based on Fuel Rod Gap Fractions Defined in NUREG 1228

Dominion Energy Nuclear Connecticut, Inc. (DENC)

Virginia Electric and Power Company
(Dominion Energy Virginia)

Surry Calculation RA-0063, "Expected Containment High Range Radiation Monitor Response to a LOCA Based on Fuel Rod Gap Fractions Defined in NUREG 1228"

The following pertinent information has been extracted from Surry Calculation RA-0063, Expected Containment High Range Radiation Monitor Response to a LOCA Based on Fuel Rod Gap Fractions Defined in NUREG 1228. It is provided to assist technical reviewers that will be evaluating the Fission Product Barrier matrix portion of this license amendment request.

Purpose:
The purpose of this calculation is to define the expected containment high range radiation monitor response to a large break LOCA with containment and recirculation spray based on fuel gap fractions defined in NUREG 1228 for Emergency Action Level (EAL) values developed in accordance with NEI 99-01, Rev. 6. These detector responses will be used for event classification based upon Fuel Clad Degradation EALs and as a radiation indicator for Fuel Clad Barrier Loss.

References:

1. NEI 99-01, Rev. 6, "Development of Emergency Action Levels for Non-Passive Reactors," November 2012.
2. NUREG-1228, "Source Term Estimation during Incident Response to Severe Nuclear Power Plant Accidents," October 1988.
3. Drawing 11448-FM-1E, Rev. 13, Sheet 1, "Mach. Loc. – Reactor Cont. Sections "A-A", "E-E" & "Z-Z" Surry Power Station – Unit 1.
4. Drawing 11448-FE-46C, Rev. 16, "Conduit Plan Reactor Containment El. 47' – 4" Surry Power Station – Unit 1."
5. PA-0163, Rev, 0, Add. D, "Calculation of the Surry AST LOCA Dose Consequences to Support the Gothic Containment Reanalysis for GSI-191."
6. RA-0008, Rev. 0 thru Add. B, Core Isotopic Inventories for Surry Dose Consequence Analyses Based on the Alternate Source Term, May, 2010.
7. Drawing 11448-FE-46D, Rev. 12, "Conduit Plan Reactor Containment El. 47' – 4" Surry Power Station – Unit 1."
8. SEALTB Rev. 4, "Emergency Action Level Technical Bases Document," December 2013.
9. Drawing 11448-FP-13D, Rev. 14, Sheet 4, "Containment & Recirc Spray System Sh 4."
10. Radiological Health Handbook, January 1970.
11. Drawing 11448-FM-1G, Rev. 14, Sheet 1, "Mach. Loc. – Reactor Cont. Sections "C-C" & "D-D" Surry Power Station – Unit 1."
12. SEAL MATRICES Rev. 4, "Surry Power Station Emergency Action Level Matrix."

Computer Code Used:
Microshield Version 7.02

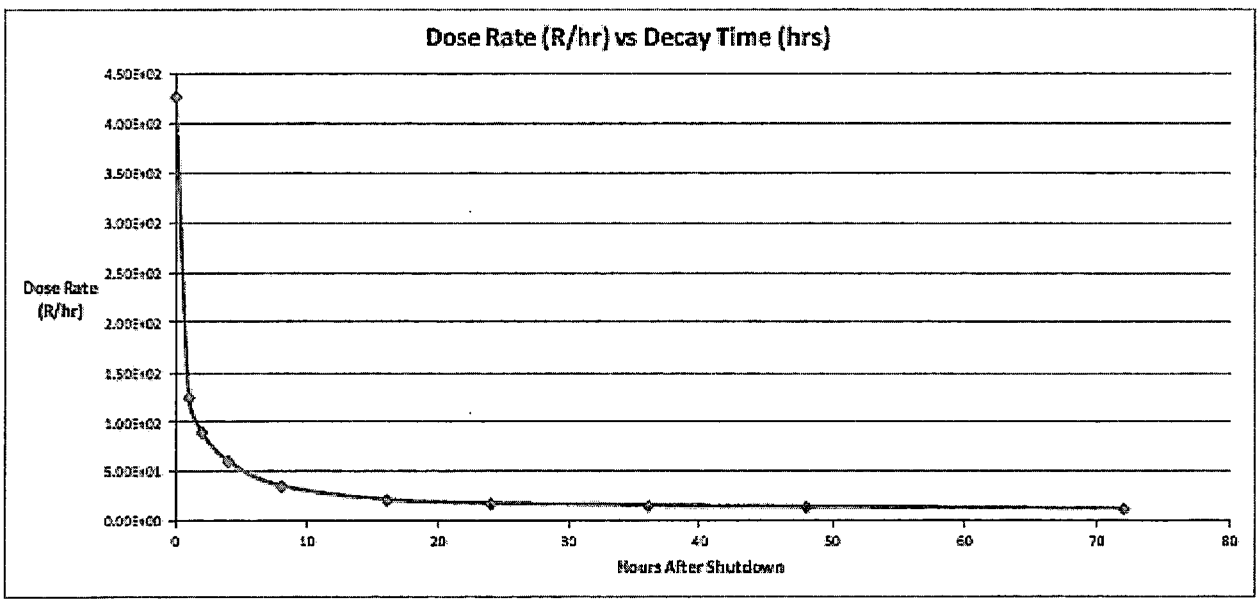
Methodology:
Microshield is used in this analysis to calculate the expected response from the Containment High Range Monitors.

Results and/or Conclusions:

Dose Rates vs Decay Time for the 5% Clad Damage

Decay time (hrs)	Dose Rate (R/hr)
0	4.27E+02
1	1.24E+02
2	8.97E+01
4	6.05E+01
8	3.52E+01
16	2.12E+01
24	1.76E+01
36	1.53E+01
48	1.40E+01
72	1.20E+01

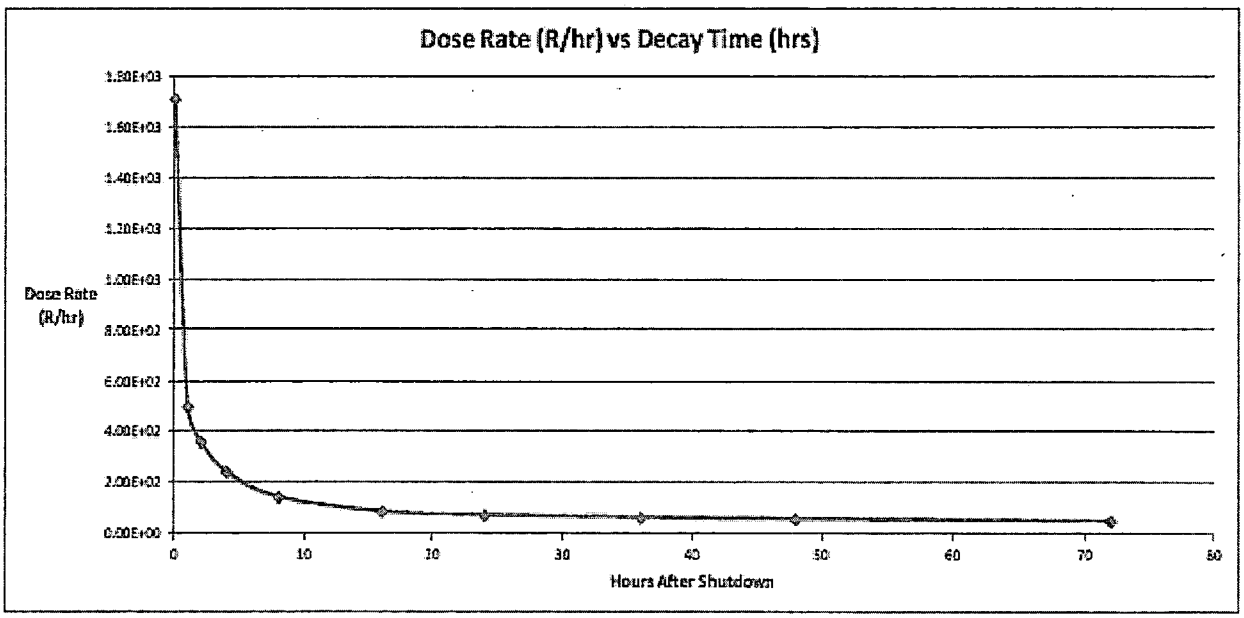
Figure 1: Dose Rate vs Decay Time for the 5% Clad Damage



Dose Rates vs Decay Time for the 20% Clad Failure

Decay time (hrs)	Dose Rate (R/hr)
0	1.71E+03
1	4.97E+02
2	3.59E+02
4	2.42E+02
8	1.41E+02
16	8.45E+01
24	7.02E+01
36	6.11E+01
48	5.57E+01
72	4.79E+01

Figure 2: Dose Rate vs Decay Time for the 20% Clad Failure



North Anna Calculation RA-0064, Expected Containment High Range Radiation Monitor Response to a LOCA Based on Fuel Rod Gap Fractions Defined in NUREG 1228

The following pertinent information has been extracted from North Anna Calculation RA-0064, Expected Containment High Range Radiation Monitor Response to a LOCA Based on Fuel Rod Gap Fractions Defined in NUREG 1228. It is provided to assist technical reviewers that will be evaluating the Fission Product Barrier matrix portion of this license amendment request.

Purpose:
The purpose of this calculation is to define the expected containment high range radiation monitor response to a large break LOCA with quench (containment) and recirculation spray based on fuel gap fractions defined in NUREG 1228 for Emergency Action Level (EAL) values developed in accordance with NEI 99-01, Rev. 6. This calculation supports a revision to the North Anna EALs. These detector responses will be used for event classification based upon Fuel Clad Degradation EALs and as a radiation indicator for Fuel Clad Barrier Loss.

References:
1. NEI 99-01, Rev. 6, "Development of Emergency Action Levels for Non-Passive Reactors," November 2012.
2. NUREG-1228, "Source Term Estimation during Incident Response to Severe Nuclear Power Plant Accidents," October 1988.
3. Drawing 12050-FM-1A, Rev. 19, Mach. Loc. – Reactor Cont. Sh. 1 Plan EL 291'-10" North Anna Power Station – Unit 2."
4. NEAL MATRICES Rev. 7, "North Anna Power Station Emergency Action Level Matrix."
5. PA-0186, Rev. 0, "Containment High Range Radiation Monitor Accident Response Curves for North Anna and Surry," March 4, 2002.
6. PA-0186, Rev. 0, Add. A, "Containment High Range Radiation Monitor Accident Response Curves for North Anna and Surry," Sept. 7, 2006.
7. Calculation 11715-ES-017, Rev. 0, "North Anna 1 & 2 Containment Free Volume," Aug. 31, 1971.
8. Drawing 12050-FM-1C, Rev. 18, "Mach. Loc. – Reactor Cont. Sh. 3, Plan - El. 241' – 0" North Anna Power Station – Unit 2."
9. NEALTBD Rev. 7, "Emergency Action Level Technical Bases Document," March 2015.
10. Radiological Health Handbook, January 1970.
11. NA-WO-000-00426795-01, Work Order Task for Reactor Containment Elevation 291 Area High Rad Monitor, March 18, 2000.
12. Drawing 11715-FM-1G, Rev. 18, Sheet 1, "Mach. Loc. – Reactor Cont. SH7 Sections 3-3 & 4-4 North Anna Power Station."

Computer Codes Used:
Microshield version 7.02

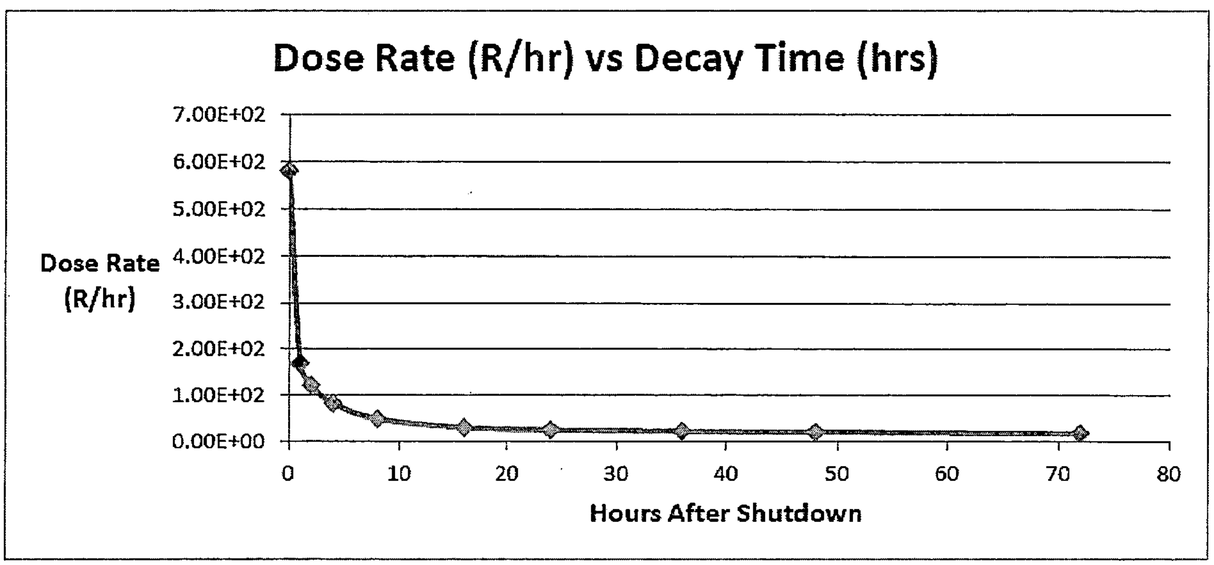
Methodology:
Microshield is used in this analysis to calculate the expected response from the Containment High Range Monitors.

Results and/or Conclusions:

Dose Rates vs Decay Time for the 5% Clad Damage

Decay time (hrs)	Dose Rate (R/hr)
0	5.81E+02
1	1.69E+02
2	1.22E+02
4	8.29E+01
8	4.91E+01
16	3.04E+01
24	2.56E+01
36	2.26E+01
48	2.07E+01
72	1.78E+01

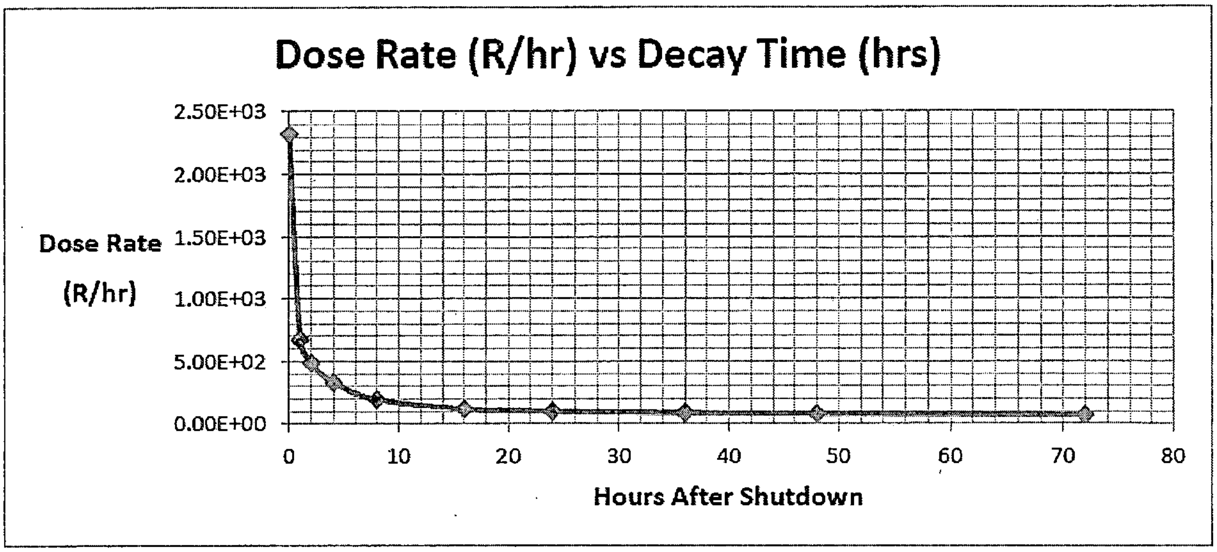
Figure 1: Dose Rate vs Decay Time for the 5% Clad Damage



Dose Rates vs Decay Time for the 20% Clad Failure

Decay time (hrs)	Dose Rate (R/hr)
0	2.32E+03
1	6.75E+02
2	4.88E+02
4	3.31E+02
8	1.96E+02
16	1.21E+02
24	1.03E+02
36	9.01E+01
48	8.29E+01
72	7.16E+01

Figure 2: Dose Rate vs Decay Time for the 20% Clad Failure



Calculation RA-0074, Millstone Unit 2 Expected Containment High Range Radiation Monitor Response to a LOCA Based on Fuel Rod Gap Fractions Defined in NUREG 1228

The following pertinent information has been extracted from Calculation RA-0074, Millstone Unit 2 Expected Containment High Range Radiation Monitor Response to a LOCA Based on Fuel Rod Gap Fractions Defined in NUREG 1228. It is provided to assist technical reviewers that will be evaluating the Fission Product Barrier matrix portion of this license amendment request.

Purpose:
The purpose of this calculation is to define the expected containment high range radiation monitor system response for Millstone Unit 2 to a large break LOCA with containment and recirculation spray based on fuel gap fractions defined in NUREG 1228 for Emergency Action Level (EAL) values developed in accordance with NEI 99-01, Rev. 6. This calculation supports a revision to the Millstone Unit 2 EALs. These detector responses will be used for event classification based upon Fuel Clad Degradation EALs and as a radiation indicator for Fuel Clad Barrier Loss.

References:
1. Vendor Calculation 3D00-005, Rev. 3, "Millstone Unit 2 Containment Heat Sinks," December 2006.
2. Nuclear Energy Institute Document NEI 99-01, Rev. 6, "Development of Emergency Actions Levels for Non-Passive Reactors," November 2012.
3. Reference Manual MP-26-EPA-REF02, Rev. 24, "Millstone Unit 2 Emergency Action Level (EAL) Technical Basis Document," March 2016.
4. NUREG-1228, "Source Term Estimation during Incident Response to Severe Nuclear Power Plant Accidents," October 1988.
5. Drawing 25203-28014, Rev. 15, "Millstone Unit 2 Instrument Location Containment Plan El. 14'-6" & 38'-6."
6. Drawing 25203-27021, Rev. 3, "Millstone Nuclear Power Station Unit No. 2 General Arrgt – Containment & Aux. Bldg. Section A-A."
7. Engineering Calculation M2AST-03105R2, Rev. 0, "Millstone 2 Alternate Source Term," January 2002.
8. Radiological Health Handbook, January 1970.
9. Computer Code MicroShield, Version 7.02, Grove Software, Inc.
10. Millstone Unit 2 EALs MP-26-EPI-FAP06-002, Rev. 7.
11. Drawing 25203-20104, Rev. 3, "Millstone Nuclear Power Station Unit No. 2 Area 5 Piping Containment Spray % H2 Purge."
12. Drawing 25203-27022, Rev. 9, "General Arrangement Containment & Aux. Bldg. Section B-B."
13. Engineering Calculation NUC-181, Rev. 1, "MP-2 Design-Basis Loss of Coolant Accident – Radiation Source Terms," June 1998.

14. Vendor Technical Manual VTM-303-007A, "Energy Response Test & Dose Rate Calibration of Model RD-23 Det.," June 1986.

Computer Codes Used:
MicroShield 7.02

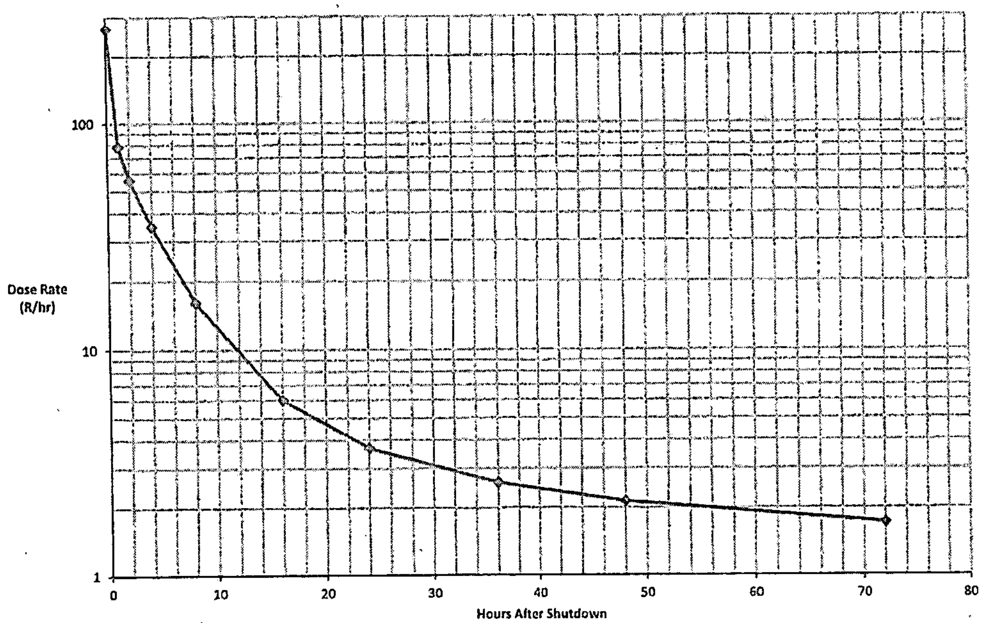
Methodology:
The region of containment measured by each of the radiation monitors is modeled using a simplified rectangular box configuration. This geometry is used in MicroShield Version 7.02 [Reference 9] with the receptor location being the radiation monitor location. MicroShield is used in this analysis to calculate the expected response from the Containment High Range Radiation Monitors.

Results and Conclusions
The following results depict the expected CHRRMS response in terms of the dose rates at the various times for 5% clad damage.

5% Clad Damage Table

Decay Time(hrs)	Dose Rate (R/hr)
0	266
1	78
2	55
4	34
8	16
16	6.0
24	3.7
36	2.6
48	2.1
72	1.7

Figure 13.2
5% Fuel Clad Damage
Dose Rate (R/hr) vs. Decay Time (hrs)



The following results depict the expected CHRRMS response in terms of the dose rates at the various times for 5% clad damage. These results were generated by multiplying the 5% fuel clad damage by a factor of 4, since the concentrations of dispersed nuclides are 4 times greater between the 20% and 5% calculations.

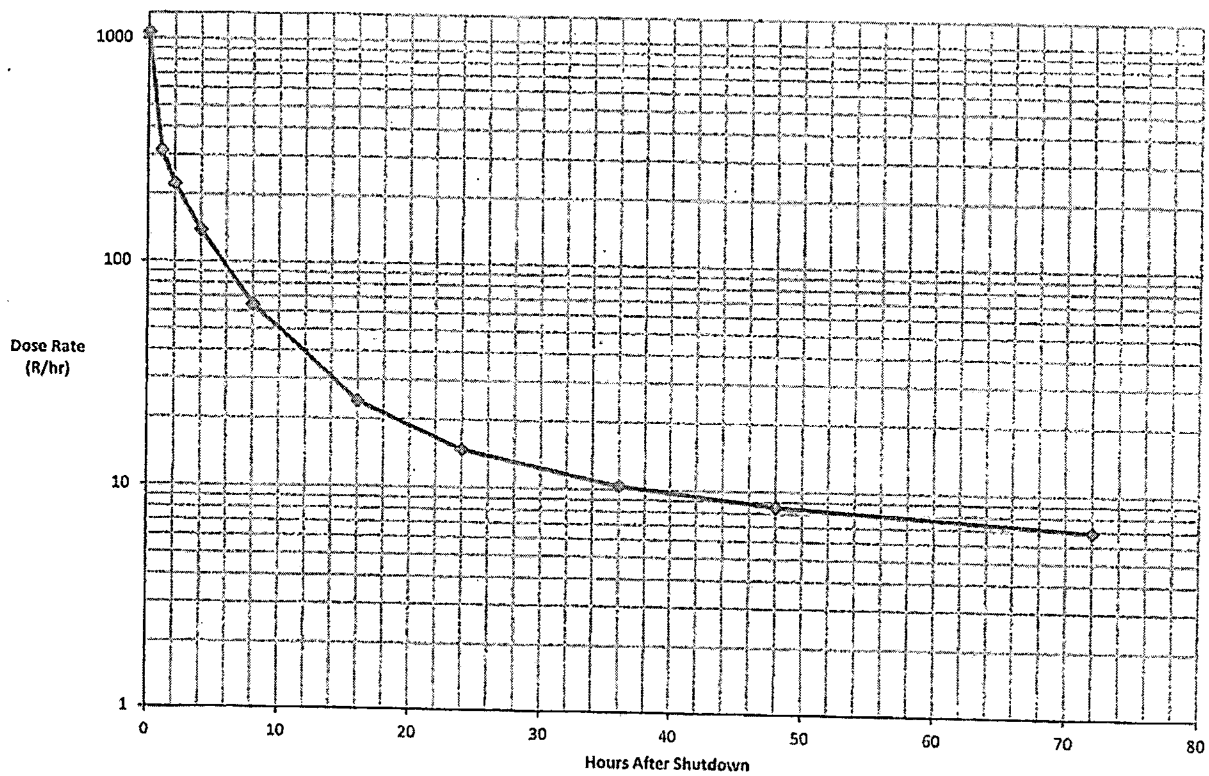
20% Clad Damage Table

Decay Time(hrs)	Dose Rate (R/hr)
0	1065
1	314
2	223
4	138
8	64
16	23
24	14
36	10
48	8.5
72	6.9

Figure 13.4

20% Fuel Clad Damage

Dose Rate (R/hr) vs. Decay Time (hrs)



Calculation RA-0075, Millstone Unit 3 Expected Containment High Range Radiation Monitor Response to a LOCA Based on Fuel Rod Gap Fractions Defined in NUREG 1228

The following pertinent information has been extracted from Calculation RA-0075, Millstone Unit 3 Expected Containment High Range Radiation Monitor Response to a LOCA Based on Fuel Rod Gap Fractions Defined in NUREG 1228. It is provided to assist technical reviewers that will be evaluating the Fission Product Barrier matrix portion of this license amendment request.

Purpose:
The purpose of this calculation is to define the expected containment high range radiation monitor system response for Millstone Unit 3 to a large break LOCA with containment and recirculation spray based on fuel gap fractions defined in NUREG 1228 for Emergency Action Level (EAL) values developed in accordance with NEI 99-01, Rev. 6. This calculation supports a revision to the Millstone Unit 3 EALs. These detector responses will be used for event classification based upon Fuel Clad Degradation EALs and as a radiation indicator for Fuel Clad Barrier Loss.

References:
1. Vendor Calculation ES-227, Rev. 0, “Containment Structure Free Volume,” November 1979.
2. Millstone Unit 3 EALs MP-26-EPI-FAP06-003, Rev. 11.
3. Computer Code MicroShield, Version 7.02, Grove Software, Inc.
4. Engineering Calculation RERM-04345R3, Rev. 0, “Millstone Unit 3 Containment High Range Radiation Monitors' Accident Responses to a LOCA,” April 2008.
5. Nuclear Energy Institute Document NEI 99-01, Rev. 6, “Development of Emergency Actions Levels for Non-Passive Reactors,” November 2012.
6. Reference Manual MP-26-EPA-REF03, Rev. 21, “Millstone Unit 3 Emergency Action Level (EAL) Technical Basis Document,” May 2016.
7. NUREG-1228, “Source Term Estimation during Incident Response to Severe Nuclear Power Plant Accidents,” October 1988.
8. Drawing 25212-27012, Rev. 16, “Millstone Nuclear Power Station Unit No. 3 Machine Location – Containment Structure – Plan El 51'-4.”
9. Engineering Calculation NUC-181, Rev. 1, ‘MP-2 Design-Basis Loss of Coolant Accident – Radiation Source Terms,” June 1998.
10. Radiological Health Handbook, January 1970.
11. Drawing 25212-27015, Rev. 12, “Millstone Nuclear Power Station Unit No. 3 Machine Location – Containment Structure – Section 3-3.”
12. Engineering Calculation M3AST-01942R3, Rev. 1, “Millstone 3 Alternate Source Term,” May 2006.
13. Vendor Technical Manual VTM-303-007A, “Energy Response Test & Dose Rate Calibration of Model RD-23 Det.,” June 1986.

Computer Codes Used:
MicroShield 7.02

Methodology:
The source volume bounded by the annular crane wall is modeled using two right cylinder volumes, with a rectangular volume representing the pressurizer cubicle black body. This geometry is used in MicroShield Version 7.02 [Reference 3] with the receptor locations being the radiation monitor locations. MicroShield is used in this analysis to calculate the expected response from the Containment High Range Monitors.

Results and Conclusions:
The following results depict the expected CHRRMS response in terms of the dose rates at the various times for 5% clad damage.

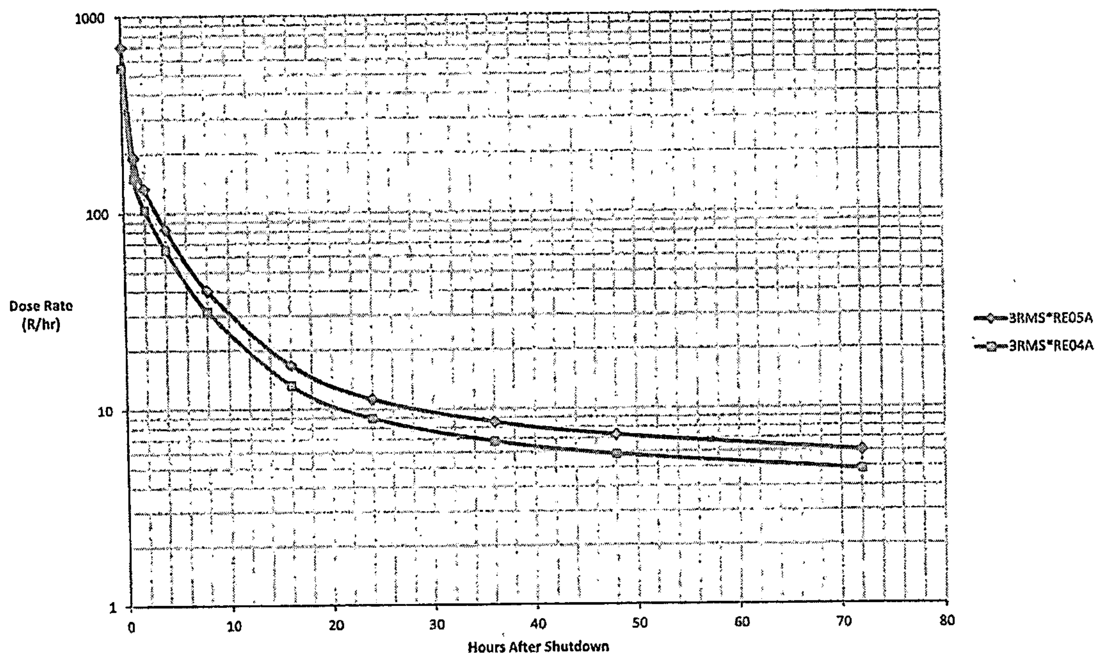
5% Clad Damage Table

Decay Time	Dose Rate (R/hr)	Dose Rate (R/hr)
(hrs)	(3RMS*RE05A)	(3RMS*RE04A)
0	703	550
1	191	149
2	132	103
4	83	65
8	40	31
16	16	13
24	8.5	6.8
48	7.3	5.8
72	6.0	4.8

Figure 13.2

5% Fuel Clad Damage

Dose Rate (R/hr) vs. Decay Time (hrs)



The following results depict the expected CHRRMS response in terms of the dose rates at the various times for 20% clad damage. These results were generated by multiplying the 5% fuel clad damage by a factor of 4, since the concentrations of dispersed nuclides are 4 times greater between the 20% and 5% calculations.

20% Clad Damage Table

Decay Time (hrs)	Dose Rate (R/hr) (3RMS*RE05A)	Dose Rate (R/hr) (3RMS*RE04A)
0	2814	2202
1	764	599
2	530	415
4	332	260
8	160	126
16	66	53
24	44	35
36	34	27
48	29	23
72	24	19

Figure 13.4

20% Fuel Clad Damage
Dose Rate (R/hr) vs. Decay Time (hrs)