ATTACHMENT 3

Detector Response to an RCS Sample

- Fleet Calculation RA-0059, Detector Response to an RCS Sample for EAL Classification of Fuel Clad Degradation and Barrier Loss

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Fleet Calculation RA-0059, Detector Response to an RCS Sample for EAL Classification of Fuel Clad Degradation and Barrier Loss

The following pertinent information has been extracted from Fleet Calculation RA-0059, Detector Response to an RCS Sample for EAL Classification of Fuel Clad Degradation and Barrier Loss. 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 determine the detector response to various depressurized RCS samples measured with a gamma detector at a distance of 1 ft. This calculation supports the Emergency Action Levels (EALs) for NAPS, SPS, MPS2 and MPS3. 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. SEAL MATRICES Rev. 4, "Surry Power Station Emergency Action Level Matrix".
2. NEAL MATRICES Rev. 5, "North Anna Power Station Emergency Action Level Matrix."
3. MP-26-EPI-FAP06-002 Rev. 9, "Millstone Unit 2 Emergency Action Levels."
4. MP-26-EPI-FAP06-003 Rev. 8, "Millstone Unit 3 Emergency Action Levels."
5. NUREG-1228, "Source Term Estimation during Incident Response to Severe Nuclear Power Plant Accidents."
6. Federal Guidance Report 12, EPA-402-R-93-081, "External Exposure to Radionuclides in Air, Water and Soil."
7. 1304952001-UR-0001 Rev. 0 Add. A, "Primary Coolant Design / Technical Specification Activity Concentrations."
8. RA-0008 Rev. 0 Add. 0, "Core Isotopic Inventories for Surry Dose Consequence Analyses Based on the Alternate Source Term," May 2010.
9. PA-0089 Rev. 0 through Add. B, "Surry Steam Generator Tube Rupture [SGTR] Dose Calculations at the EAB, the LPZ and in Control Room," August 2000.
10. Robert C. Weast, ed., "CRC Handbook of Chemistry and Physics 60th edition," pg. F-324, CRC Press, Inc.
11. PA-0194 Rev. 0 Add. 0, "Radiological Consequences of a Steam Generator Tube Rupture at North Anna Based on the Alternate Source Term," April 2003.
12. PA-0186 Rev. 0 Add. 0, "Containment High Range Radiation Monitor Accident Response Curves for North Anna and Surry."
13. PA-0081 Rev. 0 Add. 0, "North Anna SGTR Doses at the EAB, LPZ, and in Control Room," February 1991.
14. 06-ENG-04217R3 Rev. 0 CCN 1, "MP3 SPU Primary Coolant Design and Technical Specification Activity Concentrations etc."
15. M3AST-01942R3 Rev. 1 CCN 1, "Millstone 3 Alternate Source Term," May 2006.
16. M3ASTSGTR-04072R3 Rev. 1, "MP3 Uprated AST Steam Generator Tube Rupture Dose Consequences Analysis," April 2007.

17. M2AST-04080R2 Rev. 0 Add. 1, "MP2 Coolant Activity for Accident Analyses," March 2005.
18. M2AST-03105R2 Rev 0, "Millstone 2 Alternate Source Term," December 2002.
19. SEALTB Rev. 4, "Emergency Action Level Technical Bases Document," December 2013.
20. NEALTBD Rev. 5, "Emergency Action Level Technical Bases Document," December 2013.
21. MP-26-EPA-REF02 Rev. 022, "Millstone Unit 2 Emergency Action Level (EAL) Technical Basis Document."
22. MP-26-EPA-REF03 Rev. 018, "Millstone Unit 3 Emergency Action Level (EAL) Technical Basis Document."
23. NEI 99-01 Rev. 6, "Development of Emergency Action Levels for Non-Passive Reactors," November 2012.

Computer Codes Used:
MICROSHIELD Version 7.02
WATPROP Version 4

Method of Analysis:
The Technical Specification DE I-131 spike iodine concentrations and core inventory iodine activity along with the RCS mass will be used to determine the sources for the various sample volumes. This source is then modeled in the code Microshield 7.02 with a dose point one foot from the source.

Results and Conclusions:
In summary, dose rate responses have been determined for SPS, NAPS, MPS3 and MPS2 for TS coolant activity spikes and 5% cladding failure, which are used to develop EALs for Fuel Clad Degradation and Fuel Clad Barrier Loss, respectively, in various sample sizes and at several times after shutdown. A summary of conservative values representative of the expected detector response for Fuel Clad Degradation and Fuel Clad Barrier Loss in terms of mR/hr/ml vs. decay post-shutdown are presented Tables 1 and 2 below.

Table 1: Summary of Unpressurized RCS Sample Dose Rates Taken at 1 foot for Fuel Clad Degradation vs. Decay Post-Shutdown

Station/Unit	1 hr (mR/hr/ml)	2 hr (mR/hr/ml)	4 hr (mR/hr/ml)	8 hr (mR/hr/ml)	12 hr (mR/hr/ml)	24 hr (mR/hr/ml)
SPS	0.15	0.13	0.10	0.07	0.06	0.04
NAPS	0.76	0.66	0.54	0.40	0.33	0.21
MPS2	0.76	0.66	0.54	0.40	0.33	0.21
MPS3	0.76	0.66	0.54	0.40	0.33	0.21

Table 2: Summary of Unpressurized RCS Sample Dose Rates Taken at 1 foot for Fuel Barrier Loss vs. Decay Post-Shutdown

Station/Unit	1 hr (mR/hr/ml)	2 hr (mR/hr/ml)	4 hr (mR/hr/ml)	8 hr (mR/hr/ml)	12 hr (mR/hr/ml)	24 hr (mR/hr/ml)
SPS	17	12.7	8.5	5.4	4.0	2.2
NAPS	17	12.7	8.5	5.4	4.0	2.2
MPS2	17	12.7	8.5	5.4	4.0	2.2
MPS3	17	12.7	8.5	5.4	4.0	2.2

The scale of the response factors in the tables above is normalized to 1 ml. Samples when obtained in the plant will likely consist of greater volume (e.g., 120 or 250 ml). Plant sampling procedures will direct to take a reading from 1foot and divide by the actual collection volume and report the reading as (mR/hr per ml).