ATTACHMENT 4

POST-ACCIDENT RADIATION RESPONSE FOR PRIMARY SAMPLE LINE

- Fleet Calculation RA-0079, Post- Accident Radiation Response Curves for Primary Hot Leg Sample Lines

Dominion Energy Nuclear Connecticut, Inc. (DENC)

Virginia Electric and Power Company
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Fleet Calculation RA-0079, Post- Accident Radiation Response Curves for Primary Hot Leg Sample Lines

The following pertinent information has been extracted from Fleet Calculation RA-0079, Post- Accident Radiation Response Curves for Primary Hot Leg Sample Lines. It is provided to assist technical reviewers that will be evaluating the Fission Product Barrier matrix portion of this license amendment request.

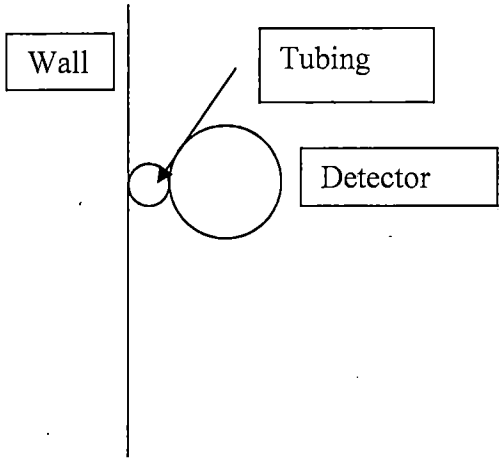
Purpose:
The purpose of this calculation is to document the generation of radiation response curves for primary hot leg sample lines assuming an intact RCS. The accident scenario analyzed modeled 5% failed fuel (gap release).

References:
1. ORNL/TM-2005/39, Version 6.2.2, "SCALE Code System."
2. PA-0219, Rev. 0, "Post-Accident Radiation Response Curves for North Anna Primary Hot Leg Sample Lines."
3. ET-NAF-05-0013, Rev 0, "Post-Accident Radiation Measurement and Accident Classification Based on PA-0219."
4. Memorandum MP-CHEM-13-01 dated March 19, 2013, "Bases for Proposed M2 and M3 EALs."
5. MGP Instruments Document # 15-00031, Revision 5, "Area Monitor Probes AMP 50-100-200 Operations and Maintenance Manual."

Computer Codes Used:
SCALE 6.2 (Reference 1)
Microshield 7.02

Methodology:
Source Term
The initial source term for 5% failed fuel (gap release) was determined by multiplying the 1% failed fuel source term by a factor of 5. The results were then scaled down by the ratio of the water volume in the tubing to the RCS liquid inventory. The resulting source term in the tubing was decayed and converted to a photon spectrum using the ORIGEN code from the SCALE 6.2.2 code package.

Shielding Model – Scenario 1
The sample line tubing was modeled as straight length of tubing running vertically up a concrete wall. The shielding model included the wall, tubing, and water within the tubing. The SCALE module MAVRIC was used to perform the photon transport. This is an improvement over the QADS model in that scattering/reflection from the concrete surfaces will be included and a dose rate measurement volume can be used in lieu of a point location. A tally volume comprised of air will be used to calculate the dose rate based on SCALE-supplied ANSI-77 flux-to-dose conversion factors.

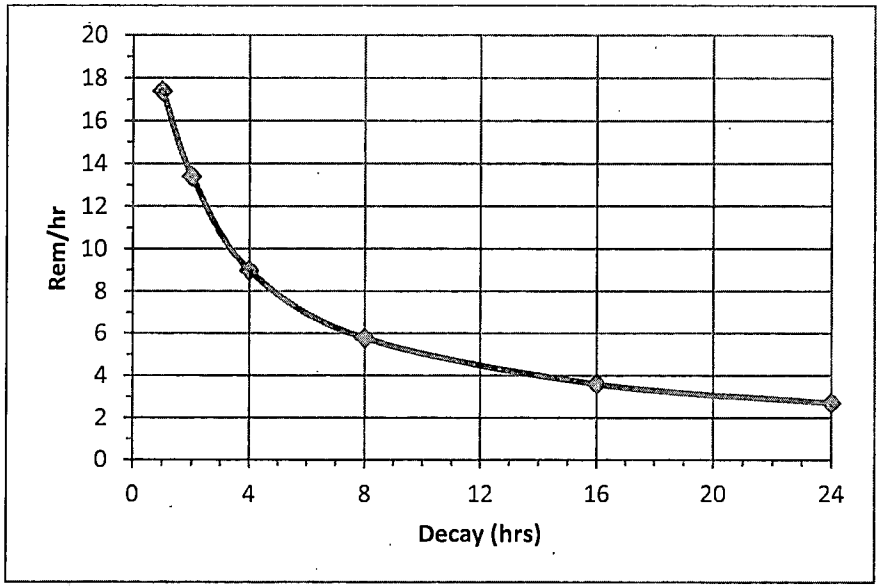


Shielding Model – Scenario 2

The sample line tubing was modeled as straight length of tubing. The shielding model included the tubing and water within the tubing. Microshield was used to determine the dose rate at a point 2 inches from the outside of the tubing. This scenario is designed to support a broad spectrum of possible sample line locations and geometries.

Results & Conclusions:

Dose rates from a primary hot leg sample line assuming an intact RCS and 5% failed fuel were calculated. Tabular results and an associated radiation response curve are provided below. An adjustment factor to correct for a range of tubing sizes is provided. These results are valid for North Anna, Surry and Millstone Power Stations.



In some instances the tubing diameter may be larger than 3/8" tubing. In those instances the results can be scaled up by the ratio of tubing cross sectional area. The following scaling factors should be used:

Tubing size (Nominal OD)	Liquid Area (in^2)	Scaling Factor
3/8"	0.110	1.0
1/2"	0.196	1.8
3/4"	0.442	4.0

Note that the tubing size scaling factors are first-order approximations. Tubing wall thickness can vary somewhat, and the changing solid-angle between source and detector will also vary. However, the table is considered a reasonable indicator of the dose rate changing with tubing size.

Shielding - Scenario 2

The source term determined was used as a source term in MicroShield to determine the dose rate at a location 2" from the outside edge of a sample line. The sample line was modelled as a cylinder of water. The MicroShield output shows following results.

Decay Step (hrs)	Dose Rate (R/hr)
1	4.5
2	3.45
4	2.35
8	1.5
16	0.95
24	0.7