



## CALCULATION SHEET

Subject: ESTIMATE OF RM-G-6 & 7 READING WITH DECREASED VESSEL LEVEL		Calc No.  6612-96-031	Rev. No.  0
Originator: PARFITT <i>PARFITT</i>	Date 11/05/96	Reviewed by: <i>D. David Shiner</i>	Date 11-6-96

1. Problem Statement

The minimum RM-G-6 or 7 reading when a spent fuel assembly in the reactor vessel is almost uncovered is being estimated.

2. Results Summary

Based on the assumptions made in this calculation, RM-G-6 or 7 will read 1.5 to 2.0 R/hr, if the water level in the reactor vessel drops to within 6 inches of the top a single spent fuel assembly.

3. References

3.1 RAF 6612-90-014

3.2 Microshield 4

3.3 RAF 6612-96-022

4. Assumptions

4.1 The isotopic activity of a fresh fuel assembly (72 hr post shutdown) was taken from Reference 3.1.

4.2 It is assumed that there is one spent fuel assembly left in the reactor vessel when the water level drops to within six inches of the top of the assembly. Typically there would be many more assemblies in the vessel at any given time.

4.3 It is assumed the age of the fuel assembly is 28 days post shutdown or close to the end of a typical refueling shutdown.

4.4 It is assumed that the fuel handling bridge is parked at the end of the fuel canal, farthest away from the fuel, approximately 50 feet away in the horizontal direction.

4.5 The distance from the fuel assembly to the monitor is assumed to be 35 feet in the vertical direction.

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4.6 The composition and density of the source material (fuel assembly) was derived using the volume fractions and densities in Reference 3.1. The weighted densities are as follows:

	VOL FRAC	DENSITY (g/cc)	WEIGHTED DENSITY (g/cc)
UO <sub>2</sub>	0.303	18.75	5.68
WATER	0.592	1	0.59
ZIRCALOY	0.102	6.5	0.66
STAINLESS	0.003	7.86	0.02

## 5. Data and Calculations

5.1 The activity of a 72 hr old fuel assembly was calculated and input into the Microshield Model. The mix was then decayed by Microshield to 25 days. The results for 0.5 feet of water shielding were calculated. The results are attached.

5.2 The Microshield model warns that when the buildup reference material is a mixed material with a high atomic number element, the model can give incorrect results for energies less than 100 keV. The results may also be suspect for energies between 100 to 500 keV. Review of the Microshield input shows insignificant dose rate contribution from these energy ranges when either the source or water is used as the buildup reference material. As a result, the results of these dose rate calculations are felt to be accurate.

GPU

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File Ref: \_\_\_\_\_

DOS File: SF50.MS4

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Run Date: November 5, 1996

By: \_\_\_\_\_

Run Time: 4:12 p.m. Tuesday

Checked: \_\_\_\_\_

Duration: 0:00:38

Case Title: &lt;None&gt;

## GEOMETRY 13 - Rectangular Volume

	centimeters	feet and inches	
Dose point coordinate X:	1524.0	50.0	.0
Dose point coordinate Y:	1524.0	50.0	.0
Dose point coordinate Z:	10.91184	0.0	4.3
Rectangular volume width :	21.82368	0.0	8.6
Rectangular volume length:	426.72	14.0	.0
Rectangular volume height:	21.82368	0.0	8.6
Shield 1:	15.24	0.0	6.0
Air Gap:	1082.04	35.0	6.0

Source Volume: 203235. cm<sup>3</sup> 7.17718 cu ft. 12402.2 cu in.MATERIAL DENSITIES (g/cm<sup>3</sup>)

Material	Source Shield	Shield 1 Slab	Air Gap	Immersion Shield
Air			0.00122	
Iron	0.02			
Uranium	5.68			
Water	0.59	1.0		1.0
Zirconium	0.66			

## BUILDUP

Method: Buildup Factor Tables  
The material reference is Source

## \*\*\*\*\* CAUTION \*\*\*\*\*

This buildup reference material is a mixed material with a high atomic number element (91). Buildup Factors less than and somewhat greater than 113 keV may be incorrect. Please understand your results!

\*\*\*\*\*

## INTEGRATION PARAMETERS

	Quadrature Order
X Direction	10
Y Direction	20
Z Direction	20

## SOURCE NUCLIDES

Nuclide	curies	$\mu\text{Ci}/\text{cm}^3$	Nuclide	curies	$\mu\text{Ci}/\text{cm}^3$
Ba-137m	2.6635e+004	1.3106e+005	Ba-140	1.5452e+005	7.6028e+005
Ce-144	3.9611e+005	1.9490e+006	Cs-134	7.0167e+003	3.4525e+004
Cs-135	2.2276e-007	1.0961e-006	Cs-136	1.0372e+003	5.1032e+003
Cs-137	2.8156e+004	1.3854e+005	I-129	1.0200e-002	5.0188e-002
I-131	4.6695e+004	2.2976e+005	I-133	1.3573e-004	6.6786e-004

Kr-85	2.9768e+003	1.4647e+004	La-140	1.7780e+005	8.7485e+005
Mo-99	7.6618e+002	3.7699e+003	Pr-144	3.9612e+005	1.9491e+006
Pr-144m	5.6644e+003	2.7871e+004	Rh-106	1.5074e+005	7.4168e+005
Ru-106	1.5074e+005	7.4168e+005	Sr-89	3.5063e+005	1.7252e+006
Sr-90	2.2463e+004	1.1053e+005	Sr-91	2.7891e-016	1.3723e-015
Tc-99	1.6027e-002	7.8860e-002	Tc-99m	7.4634e+002	3.6753e+003
Xe-131m	1.6623e+003	8.1792e+003	Xe-133	2.2489e+006	1.1066e+005
Xe-133m	3.4762e+000	1.7104e+001	Xe-135	7.3536e-018	3.6163e-017
Y-90	2.2453e+004	1.1048e+005	Y-91	3.9936e+005	1.9650e+006
Y-91m	1.7539e-016	8.6299e-016			

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===== RESULTS =====					
Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.1	1.680e+013	8.927e-003	3.175e-002	1.366e-005	4.857e-005
0.15	2.056e+015	2.204e+000	1.401e+001	3.630e-003	2.307e-002
0.2	4.065e+013	2.075e-001	1.712e+000	3.662e-004	3.021e-003
0.3	1.777e+015	6.761e+001	6.431e+002	1.282e-001	1.220e+000
0.4	1.896e+015	2.749e+002	2.540e+003	5.356e-001	4.949e+000
0.5	5.623e+015	2.144e+003	1.830e+004	4.207e+000	3.592e+001
0.6	2.134e+015	1.721e+003	1.355e+004	3.360e+000	2.644e+001
0.8	2.548e+015	6.353e+003	4.371e+004	1.208e+001	8.313e+001
1.0	9.316e+014	5.392e+003	3.276e+004	9.939e+000	6.038e+001
1.5	6.375e+015	1.475e+005	6.885e+005	2.481e+002	1.158e+003
2.0	1.694e+014	8.815e+003	3.479e+004	1.363e+001	5.379e+001
3.0	2.342e+014	3.219e+004	1.019e+005	4.367e+001	1.383e+002
TOTAL:	2.380e+016	2.044e+005	9.367e+005	3.356e+002	1.563e+003

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Zirconium	0.66			

## BUILDUP

Method: Buildup Factor Tables

The material reference is Immersion

## INTEGRATION PARAMETERS

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90	2.2463e+004	1.1053e+005	Sr-91	2.7891e-016	1.3723e-015

Tc-99	1.6027e-002	7.8860e-002	Tc-99m	7.4694e+002	3.6753e+003
Xe-131m	1.6623e+003	8.1792e+003	Xe-133	2.2489e+004	1.1066e+005
Xe-133m	3.4762e+000	1.7104e+001	Xe-135	7.3536e-018	3.6183e-017
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0.2	4.065e+013	2.075e-001	1.448e+001	3.662e-004	2.556e-002
0.3	1.777e+015	6.761e+001	2.549e+003	1.282e-001	4.635e+000
0.4	1.896e+015	2.749e+002	6.756e+003	5.356e-001	1.316e+001
0.5	5.623e+015	2.144e+003	3.875e+004	4.207e+000	7.605e+001
0.6	2.134e+015	1.721e+003	2.489e+004	3.360e+000	4.859e+001
0.8	2.548e+015	6.353e+003	6.743e+004	1.208e+001	1.283e+002
1.0	9.316e+014	5.392e+003	4.555e+004	9.939e+000	8.397e+001
1.5	6.375e+015	1.475e+005	8.389e+005	2.481e+002	1.411e+003
2.0	1.694e+014	8.815e+003	3.953e+004	1.363e+001	6.113e+001
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TOTAL:	2.380e+016	2.044e+005	1.174e+006	3.356e+002	1.976e+003