



Enclosure 3

CALCULATION SHEET

Subject: ESTIMATE OF RM-G-9 READING WITH DECREASED SFP LEVEL		Calc No. 6612-96-022	Rev. No. 0
Originator: PARFITT <i>PARFITT</i>	Date 9/05/96	Reviewed by: <i>D. David Shuman</i>	Date 9/6/96

1. Problem Statement

The minimum RM-G-9 reading when the spent fuel in the spent fuel pool is almost uncovered is being estimated.

2. Results Summary

Based on the assumptions made in this calculation, RM-G-9 will read at least 1.5 to 2.0 R/hr, if the water level in the spent fuel pool drops to within 6 inches of the top of the spent fuel.

3. References

- 3.1 RAF 6612-90-014
- 3.2 Microshield 4
- 3.3 Drawing No. IE-154-02-009 Rev B

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 are 300 spent fuel assemblies stored in a 24' by 18.8' area at the south end of Spent Fuel Pool A, and that this fuel is the only contribution to dose rate at RM-G-9. This is a very conservative assumption since at present there are over 600 fuel assemblies in the spent fuel pool.
- 4.3 It is assumed the average age of the 300 fuel assemblies assumed to be stored in the fuel pool was 3 years to eliminate contribution by short lived isotopes that would not be present after the fuel was stored for more than one fuel cycle.
- 4.4 It is assumed that the fuel handling bridge is parked at the northern most end of the fuel pool, farthest away from the fuel, approximately 60 feet away in the horizontal direction.
- 4.5 The normal fuel pool water level is 23' above the fuel (TMI-1 FSAR). Per Reference 3.3, RM-G-9 is approximately 7' above the normal water level. As a result, it is



CALCULATION SHEET

Subject: ESTIMATE OF RM-G-9 READING WITH DECREASED SFP LEVEL		Calc No. 6612-96-022	Rev. No. 0
Originator: PARFITT	Date 9/05/96	Reviewed by:	Date

assumed that RM-G-9 is 30' from the fuel in the vertical direction.

4.6 The composition and density of the source material (stored fuel assemblies) was taken from Reference 3.1.

4.7 The composition and density of the source material (stored fuel assemblies) was taken from Reference 3.1.

5. Data and Calculations

5.1 The activity of 300 72 hr old fuel assemblies was calculated and input into the Microshield Model. The mix was then decayed by Microshield to three years. The results for 23, 4, 2, and 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.

ASSUMED SPENT FUEL ACTIVITY

NUMBER OF FUEL ASSEMBLIE

300

ISOTOPE	ACTIVITY	
	PER	SFP
	ASSEMBLY	ACTIVITY
	(Ci)	(Ci)
KR-85	2.99E+03	8.97E+05
SR-89	4.94E+05	1.48E+08
SR-90	2.25E+04	6.75E+06
SR-91	2.87E+03	8.61E+05
Y-90	1.22E+04	3.66E+06
Y-91	5.37E+05	1.61E+08
MO-99	4.17E+05	1.25E+08
TC-99M	4.07E+05	1.22E+08
RU-106	1.58E+05	4.74E+07
RH-106	1.58E+05	4.74E+07
XE-131M	2.56E+03	7.68E+05
XE-133	5.93E+05	1.78E+08
XE-133M	8.26E+03	2.48E+06
XE-135	4.93E+02	1.48E+05
I-129	1.02E-02	3.06E+00
I-131	4.03E+05	1.21E+08
I-133	6.55E+04	1.97E+07
CS-134	7.18E+03	2.15E+06
CS-136	3.87E+03	1.16E+06
CS-137	2.82E+04	8.46E+06
BA-140	5.99E+05	1.80E+08
LA-140	2.07E+05	6.21E+07
CE-144	4.21E+05	1.26E+08
PR-144	4.21E+05	1.26E+08

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DOS File: SFP.MS4
Run Date: September 5, 1996
Run Time: 9:43 a.m. Thursday
Duration: 0:00:48

File Ref: _____
Date: ____/____/____
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Checked: _____

Case Title: 300, 3 YR OLD ASSEMBLIES, 23' WATER

GEOMETRY 13 - Rectangular Volume

	centimeters	feet	inches
Dose point coordinate X:	1341.12	44.0	.0
Dose point coordinate Y:	1828.8	60.0	.0
Dose point coordinate Z:	0.0	0.0	.0
Rectangular volume width :	731.25	23.0	11.9
Rectangular volume length:	426.72	14.0	.0
Rectangular volume height:	574.36512	18.0	10.1
Shield 1:	701.04	23.0	.0
Air Gap:	213.36	7.0	.0

Source Volume: 1.79224e+8 cm³ 6329.25 cu ft. 1.09369e+7 cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap	Immersion Shield
Air			0.00122	
Aluminum	0.034			
Iron	0.613			
Uranium	4.125			
Water	0.601	1.0		1.0
Zirconium	0.481			

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	μCi/cm ³	Nuclide	curies	μCi/cm ³
Ba-137	7.4701e+006	4.1680e+004	Ba-140	2.9060e-018	1.6214e-020
Ce-144	8.7124e+006	4.8612e+004	Cs-134	7.8428e+005	4.3760e+003
Cs-135	6.6873e-005	3.7312e-007	Cs-136	9.9906e-020	5.5744e-022
Cs-137	7.8965e+006	4.4060e+004	I-129	3.0600e+000	1.7074e-002
I-131	1.1382e-033	6.3507e-036	I-133	0.0000e+000	0.0000e+000
Kr-85	7.3884e+005	4.1224e+003	La-140	3.3442e-018	1.8659e-020
Mo-99	1.5363e-112	8.5719e-115	Pr-144	8.7127e+006	4.8614e+004
Pr-144m	1.2459e+005	6.9516e+002	Rh-106	6.0245e+006	3.3615e+004
Ru-106	6.0245e+006	3.3615e+004	Sr-89	4.4154e+001	2.4636e-001
Sr-90	6.2766e+006	3.5021e+004	Sr-91	0.0000e+000	0.0000e+000
Tc-99	4.8131e+000	2.6855e-002	Tc-99m	1.4977e-112	8.3568e-115
Xe-131m	4.9064e-022	2.7375e-024	Xe-133	2.3719e-055	1.3234e-057
Xe-133m	6.8706e-145	3.8335e-147	Xe-135	0.0000e+000	0.0000e+000
Y-90	6.2782e+006	3.5030e+004	Y-91	3.7092e+002	2.0696e+000
Y-91m	0.0000e+000	0.0000e+000			

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***** RESULTS *****					
Energy	Activity	Energy Fluence Rate		Exposure Rate In Air	
(MeV)	(photons/sec)	(MeV/sq cm/sec)		(mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.1	3.282e-010	3.828e-118	1.659e-043	5.856e-121	2.539e-046
0.15	3.481e+016	3.134e-085	1.821e-016	5.160e-088	2.998e-019
0.2	1.055e-009	2.309e-098	1.687e-041	4.075e-101	2.977e-044
0.3	1.027e+013	1.607e-063	4.467e-019	3.048e-066	8.473e-022
0.4	9.274e-009	5.433e-077	5.295e-040	1.059e-079	1.032e-042
0.5	4.646e+016	5.443e-047	2.919e-015	1.068e-049	5.729e-018
0.6	3.121e+017	4.488e-042	1.844e-014	8.760e-045	3.600e-017
0.8	2.824e+016	4.841e-037	1.364e-015	9.208e-040	2.595e-018
1.0	5.617e+015	2.459e-033	2.558e-016	4.533e-036	4.715e-019
1.5	3.492e+015	3.009e-026	1.210e-016	5.063e-029	2.036e-019
2.0	2.495e+015	6.895e-022	8.495e-017	1.066e-024	1.314e-019
3.0	4.406e-009	3.125e-040	1.694e-038	4.240e-043	2.298e-041
TOTAL:	4.333e+017	6.896e-022	2.337e-014	1.066e-024	4.543e-017

GPU

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 Duration: 0:00:45

File Ref: _____
 Date: ____/____/____
 By: _____
 Checked: _____

Case Title: 300, 3 YR OLD ASSEMBLIES, 4' WATER

GEOMETRY 13 - Rectangular Volume

	centimeters	feet and inches	
Dose point coordinate X:	1341.12	44.0	.0
Dose point coordinate Y:	1828.8	60.0	.0
Dose point coordinate Z:	0.0	0.0	.0
Rectangular volume width :	731.25	23.0	11.9
Rectangular volume length:	426.72	14.0	.0
Rectangular volume height:	574.36512	18.0	10.1
Shield 1:	121.92	4.0	.0
Air Gap:	792.48	26.0	.0

Source Volume: 1.79224e+8 cm³ 6329.25 cu ft. 1.09369e+7 cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap	Immersion Shield
Air			0.00122	
Aluminum	0.034			
Iron	0.613			
Uranium	4.125			
Water	0.601	1.0		1.0
Zirconium	0.481			

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	$\mu\text{Ci/cm}^3$	Nuclide	curies	$\mu\text{Ci/cm}^3$
Ba-137m	7.4701e+006	4.1680e+004	Ba-140	2.9060e-018	1.6214e-020
Ce-144	8.7124e+006	4.8612e+004	Ce-134	7.8428e+005	4.3760e+003
Cs-135	6.6873e-005	3.7312e-007	Cs-136	9.9906e-020	5.5744e-022
Cs-137	7.8965e+006	4.4060e+004	I-129	3.0600e+000	1.7074e-002
I-131	1.1382e-033	6.3507e-036	I-133	0.0000e+000	0.0000e+000
Kr-85	7.3884e+005	4.1224e+003	La-140	3.3442e-018	1.8659e-020
Mo-99	1.5363e-112	8.5719e-115	Pr-144	8.7127e+006	4.8614e+004
Pr-144m	1.2459e+005	6.9516e+002	Rh-106	6.0245e+006	3.3615e+004
Ru-106	6.0245e+006	3.3615e+004	Sr-89	4.4154e+001	2.4636e-001
Sr-90	6.2766e+006	3.5021e+004	Sr-91	0.0000e+000	0.0000e+000
Tc-99	4.8131e+000	2.6855e-002	Tc-99m	1.4977e-112	8.3568e-115
Xe-131m	4.9064e-022	2.7375e-024	Xe-133	2.3719e-055	1.3234e-057
Xe-133m	6.8706e-145	3.8335e-147	Xe-135	0.0000e+000	0.0000e+000
Y-90	6.2782e+006	3.5030e+004	Y-91	3.7092e+002	2.0696e+000
Y-91m	0.0000e+000	0.0000e+000			

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 Title : 300, 3 YR OLD ASSEMBLIES, 4' WATER

***** 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	3.282e-010	1.206e-046	1.691e-043	1.845e-049	2.587e-046
0.15	3.481e-016	1.239e-021	1.823e-016	2.041e-024	3.001e-019
0.2	1.055e-009	3.443e-040	8.796e-038	6.077e-043	1.552e-040
0.3	1.027e-013	5.904e-013	1.384e-010	1.120e-015	2.626e-013
0.4	9.274e-009	1.042e-031	1.819e-029	2.030e-034	3.544e-032
0.5	4.646e-016	1.211e-005	1.683e-003	2.573e-008	3.304e-006
0.6	3.121e-017	9.515e-004	9.435e-002	1.857e-006	1.842e-004
0.8	2.824e-016	2.993e-003	1.947e-001	3.692e-006	3.704e-004
1.0	5.617e-015	7.924e-003	3.592e-001	1.461e-005	6.621e-004
1.5	3.492e-015	3.175e-001	7.570e+000	5.342e-004	1.274e-002
2.0	2.495e-015	2.635e+000	4.271e+001	4.075e-003	6.604e-002
3.0	4.406e-009	8.314e-023	8.364e-022	1.128e-025	1.135e-024
TOTAL:	4.333e+017	2.965e+000	5.093e+001	4.631e-003	8.000e-002

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Run Time: 10:20 a.m. Thursday
Duration: 0:00:45

File Ref: _____
Date: ____/____/____
By: _____
Checked: _____

Case Title: 300, 3 YR OLD ASSEMBLIES, 2' WATER

GEOMETRY 13 - Rectangular Volume

	centimeters	feet	and inches
Dose point coordinate X:	1341.12	44.0	.0
Dose point coordinate Y:	1828.8	60.0	.0
Dose point coordinate Z:	0.0	0.0	.0
Rectangular volume width :	731.25	23.0	11.9
Rectangular volume length:	426.72	14.0	.0
Rectangular volume height:	574.36512	18.0	10.1
Shield 1:	60.96	2.0	.0
Air Gap:	853.44	28.0	.0

Source Volume: 1.79224e+8 cm³ 6329.25 cu ft. 1.09369e+7 cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap	Immersion Shield
Air			0.00122	
Aluminum	0.034			
Iron	0.613			
Uranium	4.125			
Water	0.601	1.0		1.0
Zirconium	0.481			

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	μCi/cm ³	Nuclide	curies	μCi/cm ³
Ba-137m	7.4701e+006	4.1680e+004	Ba-140	2.9060e-018	1.6214e-020
Ce-144	8.7124e+006	4.8612e+004	Cs-134	7.8428e+005	4.3760e+003
Cs-135	6.6873e+005	3.7312e+007	Cs-136	9.9906e-020	5.5744e-022
Cs-137	7.8965e+006	4.4060e+004	I-129	3.0600e+000	1.7074e-002
I-131	1.1382e-033	6.3507e-036	I-133	0.0000e+000	0.0000e+000
Kr-85	7.3884e+005	4.1224e+003	La-140	3.3442e-018	1.8659e-020
Mo-99	1.5363e-112	8.5719e-115	Pr-144	8.7127e+006	4.8614e+004
Pr-144m	1.2459e+005	6.9516e+002	Rh-106	6.0245e+006	3.3615e+004
Ru-106	6.0245e+006	3.3615e+004	Sr-89	4.4154e+001	2.4636e-001
Sr-90	6.2766e+006	3.5021e+004	Sr-91	0.0000e+000	0.0000e+000
Tc-99	4.8131e+000	2.6855e-002	Tc-99m	1.4977e-112	8.3568e-115
Xe-131m	4.9064e-022	2.7375e-024	Xe-133	2.3719e-055	1.3234e-057
Xe-133m	6.8706e-145	3.8335e-147	Xe-135	0.0000e+000	0.0000e+000
Y-90	6.2782e+006	3.5030e+004	Y-91	3.7092e+002	2.0696e+000
Y-91m	0.0000e+000	0.0000e+000			

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 Run Time: 10:20 a.m. Thursday
 Title : 300, 3 YR OLD ASSEMBLIES, 2' WATER

***** RESULTS *****					
Energy	Activity	Energy Fluence Rate		Exposure Rate In Air	
(MeV)	(photons/sec)	(MeV/sq cm/sec)		(mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.1	3.282e-010	4.535e-039	9.684e-038	6.937e-042	1.481e-040
0.15	3.481e-016	6.707e-015	8.762e-013	1.104e-017	1.443e-015
0.2	1.055e-009	5.155e-034	6.447e-032	9.099e-037	1.138e-034
0.3	1.027e-013	1.425e-007	1.285e-005	2.704e-010	2.438e-008
0.4	9.274e-009	6.995e-027	4.443e-025	1.363e-029	8.656e-028
0.5	4.646e-016	3.445e-001	1.673e+001	6.762e-004	3.285e-002
0.6	3.121e-017	1.231e+001	5.020e+002	2.403e-002	9.799e-001
0.8	2.824e-016	1.405e+001	4.262e+002	2.673e-002	8.106e-001
1.0	5.617e-015	1.756e+001	3.953e+002	3.236e-002	7.287e-001
1.5	3.492e-015	1.879e+002	2.454e+003	3.162e-001	4.128e+000
2.0	2.495e-015	6.617e+002	6.210e+003	1.023e+000	9.604e+000
3.0	4.406e-009	7.289e-021	4.574e-020	9.889e-024	6.205e-023
TOTAL:	4.333e+017	8.939e+002	1.000e+004	1.423e+000	1.628e+001

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Run Time: 10:21 a.m. Thursday
Duration: 0:00:44

File Ref: _____
Date: ____/____/____
By: _____
Checked: _____

Case Title: 300, 3 YR OLD ASSEMBLIES, 1' WATER

GEOMETRY 13 - Rectangular Volume

	centimeters	feet	and inches
Dose point coordinate X:	1341.12	44.0	.0
Dose point coordinate Y:	1828.8	60.0	.0
Dose point coordinate Z:	0.0	0.0	.0
Rectangular volume width:	731.25	23.0	11.9
Rectangular volume length:	426.72	14.0	.0
Rectangular volume height:	574.36512	18.0	10.1
Shield 1:	30.48	1.0	.0
Air Gap:	883.92	29.0	.0

Source Volume: 1.79224e+8 cm³ 6329.25 cu ft. 1.09369e+7 cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap	Immersion Shield
Air			0.00122	
Aluminum	0.034			
Iron	0.613			
Uranium	4.125			
Water	0.601	1.0		1.0
Zirconium	0.481			

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	μCi/cm ³	Nuclide	curies	μCi/cm ³
Ba-137m	7.4701e+006	4.1680e+004	Ba-140	2.9060e-018	1.6214e-020
Ce-144	8.7124e+006	4.8612e+004	Ce-134	7.8428e+005	4.3760e+003
Cs-135	6.6873e-005	3.7312e-007	Cs-136	9.9906e-020	5.5744e-022
Cs-137	7.8965e+006	4.4060e+004	I-129	3.0600e+000	1.7074e-002
I-131	1.1382e-033	6.3507e-036	I-133	0.0000e+000	0.0000e+000
Kr-85	7.3884e+005	4.1224e+003	La-140	3.3442e-018	1.8659e-020
Mo-99	1.5363e-112	8.5719e-115	Pr-144	8.7127e+006	4.8614e+004
Pr-144m	1.2459e+005	6.9516e+002	Rh-106	6.0245e+006	3.3615e+004
Ru-106	6.0245e+006	3.3615e+004	Sr-89	4.4154e+001	2.4636e-001
Sr-90	6.2766e+006	3.5021e+004	Sr-91	0.0000e+000	0.0000e+000
Tc-99	4.8131e+000	2.6855e-002	Tc-99m	1.4977e-112	8.3568e-115
Xe-131m	4.9064e-022	3.7375e-024	Xe-133	2.3719e-055	1.3234e-057
Xe-133m	6.8706e-145	3.8335e-147	Xe-135	0.0000e+000	0.0000e+000
Y-90	6.2782e+006	3.5030e+004	Y-91	3.7092e+002	2.0696e+000
Y-91m	0.0000e+000	0.0000e+000			

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 Run Time: 10:21 a.m. Thursday
 Title : 300, 3 YR OLD ASSEMBLIES, 1' WATER

***** 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	3.282e-010	2.859e-035	4.986e-034	4.374e-038	7.628e-037
0.15	3.481e-016	1.590e-011	1.584e-009	2.618e-014	2.608e-012
0.2	1.055e-009	6.478e-011	4.992e-029	1.143e-033	8.811e-032
0.3	1.027e-013	7.209e-005	3.227e-003	1.367e-007	6.122e-006
0.4	9.274e-009	1.862e-024	5.515e-023	3.628e-021	1.075e-025
0.5	4.646e-016	5.755e+001	1.353e+003	1.130e-001	2.655e+000
0.6	3.121e-017	1.467e+003	3.139e+004	2.863e+000	6.126e+001
0.8	2.824e-016	1.039e+003	1.812e+004	1.976e+000	3.446e+001
1.0	5.617e-015	8.972e+002	1.213e+004	1.654e+000	2.236e+001
1.5	3.492e-015	4.907e+003	4.076e+004	8.255e+000	6.859e+001
2.0	2.495e-015	1.111e+004	6.975e+004	1.719e+001	1.079e+002
3.0	4.406e-009	7.119e-020	3.197e-019	9.658e-023	4.337e-022
TOTAL:	4.333e+017	1.948e+004	1.735e+005	3.205e+001	2.972e+002

Page : 1
DCS File: SFP.MS4
Run Date: September 5, 1996
Run Time: 10:31 a.m. Thursday
Duration: 0:00:43

File Ref: _____
Date: ____/____/____
By: _____
Checked: _____

Case Title: 300, 3 YR OLD ASSEMBLIES, 1' WATER, WATER BUILDUP

GEOMETRY 13 - Rectangular Volume

	centimeters	feet	and inches
Dose point coordinate X:	1341.12	44.0	.0
Dose point coordinate Y:	1828.8	60.0	.0
Dose point coordinate Z:	0.0	0.0	.0
Rectangular volume width:	731.25	23.0	11.9
Rectangular volume length:	426.72	14.0	.0
Rectangular volume height:	574.36512	18.0	10.1
Shield 1:	30.48	1.0	.0
Air Gap:	883.92	29.0	.0

Source Volume: 1.79224e+8 cm³ 6329.25 cu ft. 1.09369e+7 cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap	Immersion Shield
Air			0.00122	
Aluminum	0.034			
Iron	0.613			
Uranium	4.125			
Water	0.601	1.0		1.0
Zirconium	0.481			

BUILDUP

Method: Buildup Factor Tables
The material reference is Shield 1

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	7.4701e+006	4.1680e+004	Ba-140	2.9060e-018	1.6214e-020
Ce-144	8.7124e+006	4.8612e+004	Cs-134	7.8428e+005	4.3760e+003
Cs-135	6.6873e-005	3.7312e-007	Cs-136	9.9906e-020	5.5744e-022
Cs-137	7.8965e+006	4.4060e+004	I-129	3.0600e+000	1.7074e-002
I-131	1.1382e-033	6.3507e-036	I-133	0.0000e+000	0.0000e+000
Kr-85	7.3884e+005	4.1224e+003	La-140	3.3442e-018	1.8659e-020
Mo-99	1.5363e-112	8.5719e-115	Pr-144	8.7127e+006	4.8614e+004
Pr-144m	1.2459e+005	6.9516e+002	Rh-106	6.0245e+006	3.3615e+004
Ru-106	6.0245e+006	3.3615e+004	Sr-89	4.4154e+001	2.4636e-001
Sr-90	6.2766e+006	3.5021e+004	Sr-91	0.0000e+000	0.0000e+000
Tc-99	4.8131e+000	2.6855e-002	Tc-99m	1.4977e-112	8.3568e-115
Xe-131m	4.9064e-022	2.7375e-024	Xe-133	2.3719e-055	1.3234e-057
Xe-133m	6.8706e-145	3.8335e-147	Xe-135	0.0000e+000	0.0000e+000
Y-90	6.2782e+006	3.5030e+004	Y-91	3.7092e+002	2.0696e+000
Y-91m	0.0000e+000	0.0000e+000			

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 DOS File: SFP.MS4
 Run Date: September 5, 1996
 Run Time: 10:31 a.m. Thursday
 Title : 300, 3 YR OLD ASEMBLIES, 1' WATER, WATER BUILDUP

***** 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	3.282e-010	2.859e-035	2.222e-031	4.374e-038	3.400e-034
0.15	3.481e-016	1.590e-011	2.068e-007	2.618e-014	3.406e-010
0.2	1.055e-009	6.478e-031	1.124e-027	1.143e-033	1.984e-030
0.3	1.027e-013	7.209e-005	1.659e-002	1.367e-007	3.147e-005
0.4	9.274e-009	1.862e-024	1.595e-022	3.628e-027	3.108e-025
0.5	4.646e-016	5.755e-001	2.993e-003	1.130e-001	5.874e-000
0.6	3.121e-017	1.467e-003	5.959e-004	2.863e-000	1.163e-002
0.8	2.824e-016	1.039e-003	2.823e-004	1.976e-000	5.370e-001
1.0	5.617e-015	8.972e-002	1.679e-004	1.654e-000	3.095e-001
1.5	3.492e-015	4.907e-003	4.908e-004	8.255e-000	8.257e-001
2.0	2.495e-015	1.111e-004	7.827e-004	1.719e-001	1.210e-002
3.0	4.406e-009	7.119e-020	3.367e-019	9.658e-023	4.568e-022
TOTAL:	4.333e-017	1.948e-004	2.350e-005	3.205e-001	4.105e-002

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DOS File: SFP.MS4
Run Date: September 5, 1996
Run Time: 10:28 a.m. Thursday
Duration: 0:00:44

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: 300, 3 YR OLD ASSEMBLIES, .5' WATER, SOURCE BUILDUP

GEOMETRY 13 - Rectangular Volume

	centimeters	feet	and inches
Dose point coordinate X:	1341.12	44.0	.0
Dose point coordinate Y:	1828.6	60.0	.0
Dose point coordinate Z:	0.0	0.0	.0
Rectangular volume width :	731.25	23.0	11.9
Rectangular volume length:	426.72	14.0	.0
Rectangular volume height:	574.36512	18.0	10.1
Shield 1:	15.24	0.0	6.0
Air Gap:	899.16	29.0	6.0

Source Volume: 1.79224e+8 cm³ 6329.25 cu ft. 1.09369e+7 cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap	Immersion Shield
Air			0.00122	
Aluminum	0.034			
Iron	0.613			
Uranium	4.125			
Water	0.601	1.0		1.0
Zirconium	0.481			

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	μCi/cm ³	Nuclide	curies	μCi/cm ³
Ba-137m	7.4701e+006	4.1680e+004	Ba-140	2.9060e-018	1.6214e-020
Ce-144	8.7124e+006	4.8612e+004	Cs-134	7.8428e+005	4.3760e+003
Cs-135	6.6873e+005	3.7312e+007	Cs-136	9.9906e-020	5.5744e-022
Cs-137	7.8965e+006	4.4060e+004	I-129	3.0600e+000	1.7074e+002
I-131	1.1382e-033	6.3507e-036	I-133	0.0000e+000	0.0000e+000
Kr-85	7.3884e+005	4.1224e+003	La-140	3.3442e-018	1.8659e-020
Mo-99	1.5363e-112	8.5719e-115	Pr-144	8.7127e+006	4.8614e+004
Pr-144m	1.2459e+005	6.9516e+002	Rh-106	6.0245e+005	3.3615e+004
Ru-106	6.0245e+006	3.3615e+004	Sr-89	4.4154e+001	2.4636e-001
Sr-90	6.2766e+006	3.5021e+004	Sr-91	0.0000e+000	0.0000e+000
Tc-99	4.8131e+000	2.6855e-002	Tc-99m	1.4977e-112	8.3568e-115
Xe-131m	4.9064e-022	2.7375e-024	Xe-133	2.3719e-055	1.3234e-057
Xe-133m	6.8706e-145	3.8335e-147	Xe-135	0.0000e+000	0.0000e+000
Y-90	6.2782e+006	3.5030e+004	Y-91	3.7092e+002	2.0696e+000
Y-91m	0.0000e+000	0.0000e+000			

Page : 2
 DOS File: SFP.MS4
 Run Date: September 5, 1996
 Run Time: 10:28 a.m. Thursday
 Title : 300, 3 YR OLD ASSEMBLIES, .5' WATER, SOURCE BUILDUP

***** 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	3.282e-010	2.292e-033	3.505e-032	3.507e-036	5.362e-035
0.15	3.481e-016	7.792e-010	6.623e-008	1.283e-012	1.091e-010
0.2	1.055e-009	2.317e-029	1.330e-027	4.089e-032	2.348e-030
0.3	1.027e-013	1.636e-003	4.632e-002	3.103e-006	8.786e-005
0.4	9.274e-009	3.064e-023	5.424e-022	5.969e-026	1.057e-024
0.5	4.646e-016	7.516e-002	1.093e-004	1.475e-000	2.145e-001
0.6	3.121e-017	1.631e-004	2.311e-005	3.183e-001	4.512e-002
0.8	2.824e-016	9.200e-003	1.119e-005	1.750e-001	2.129e-002
1.0	5.617e-015	6.605e-003	6.340e-004	1.217e-001	1.169e-002
1.5	3.492e-015	2.565e-004	1.579e-005	4.315e-001	2.657e-002
2.0	2.495e-015	4.637e-004	2.236e-005	7.171e-001	3.458e-002
3.0	4.406e-009	2.252e-019	8.189e-019	3.055e-022	1.111e-021
TOTAL:	4.333e-017	1.049e-005	7.990e-005	1.778e-002	1.414e-003

Page : 1
DOS File: SFP.MS4
Run Date: September 5, 1996
Run Time: 10:29 a.m. Thursday
Duration: 0:00:41

File Ref: _____
Date: ____/____/____
By: _____
Checked: _____

Case Title: 300, 3 YR OLD ASSEMBLIES, .5' WATER, WATER BUILDUP

GEOMETRY 13 - Rectangular Volume

	centimeters	feet and inches	
Dose point coordinate X:	1341.12	44.0	.0
Dose point coordinate Y:	1828.8	60.0	.0
Dose point coordinate Z:	0.0	0.0	.0
Rectangular volume width :	731.25	23.0	11.9
Rectangular volume length:	426.72	14.0	.0
Rectangular volume height:	574.36512	18.0	10.1
Shield 1:	15.24	0.0	6.0
Air Gap:	899.16	29.0	6.0

Source Volume: 1.79224e+8 cm³ 6329.25 cu ft. 1.09369e+7 cu in.

MATERIAL DENSITIES (g/cm³)

Material	Source Shield	Shield 1 Slab	Air Gap	Immersion Shield
Air			0.00122	
Aluminum	0.034			
Iron	0.613			
Uranium	4.125			
Water	0.601	1.0		1.0
Zirconium	0.481			

BUILDUP

Method: Buildup Factor Tables
The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	10
Y Direction	20
Z Direction	20

SOURCE NUCLIDES

Nuclide	curies	$\mu\text{Ci/cm}^3$	Nuclide	curies	$\mu\text{Ci/cm}^3$
Ba-137m	7.4701e+006	4.1680e+004	Ba-140	2.9060e-018	1.6216e-020
Ce-144	8.7124e+006	4.8612e+004	Cs-134	7.8428e+005	4.3760e+003
Cs-135	6.6873e+005	3.7312e+007	Cs-136	9.9906e+020	5.5744e+022
Cs-137	7.8965e+006	4.4060e+004	I-129	3.0600e+000	1.7074e+002
I-131	1.1382e+033	6.3507e+036	I-133	0.0000e+000	0.0000e+000
Kr-85	7.3884e+005	4.1224e+003	La-140	3.3442e+018	1.8659e+020
Mo-99	1.5363e+112	8.5719e+115	Pr-144	8.7127e+006	4.8614e+004
Pr-144m	1.2459e+005	6.9516e+002	Rh-106	6.0245e+006	3.3615e+004
Ru-106	6.0245e+006	3.3615e+004	Sr-89	4.4154e+001	2.4636e+001
Sr-90	6.2766e+006	3.5021e+004	Sr-91	0.0000e+000	0.0000e+000
Tc-99	4.8131e+000	2.6855e+002	Tc-99m	1.4977e+112	8.3568e+115
Xe-131m	4.9064e+022	2.7375e+024	Xe-133	2.3719e+055	1.3234e+057
Xe-133m	6.8706e+145	3.8335e+147	Xe-135	0.0000e+000	0.0000e+000
Y-90	6.2782e+006	3.5030e+004	Y-91	3.7092e+002	2.0696e+000
Y-91m	0.0000e+000	0.0000e+000			

Page : 2
 DOS File: SFP.MS4
 Run Date: September 5, 1996
 Run Time: 10:29 a.m. Thursday
 Title : 300, 3 YR OLD ASEMBLIES, .5' WATER, WATER BUILDUP

***** 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	3.282e-010	2.292e-033	1.058e-029	3.507e-036	1.618e-032
0.15	3.481e-016	7.792e-010	6.775e-006	1.283e-012	1.116e-008
0.2	1.055e-009	2.317e-029	2.384e-026	4.089e-032	4.208e-029
0.3	1.027e-013	1.636e-003	1.996e-001	3.103e-006	3.786e-004
0.4	9.274e-009	3.064e-023	1.381e-021	5.969e-026	2.690e-024
0.5	4.646e-016	7.516e+002	2.229e+004	1.475e+000	4.376e+001
0.6	3.121e-017	1.631e+004	4.161e+005	3.183e+001	8.123e+002
0.8	2.824e-016	9.200e+003	1.695e+005	1.750e+001	3.223e+002
1.0	5.617e-015	6.605e+003	8.607e+004	1.217e+001	1.587e+002
1.5	3.492e-015	2.565e+004	1.880e+005	4.315e+001	3.162e+002
2.0	2.495e-015	4.637e+004	2.499e+005	7.171e+001	3.865e+002
3.0	4.406e-009	2.252e-019	8.656e-019	3.055e-022	1.174e-021
TOTAL:	4.333e+017	1.049e+005	1.132e+006	1.778e+002	2.040e+003