Ingestion MDC calc

Parent ROC	Contributing Progeny	Slope factor	Risk Limit	pCi	contact area ft2	contact area m2	contact area cm2	pCi/cm2	dpm/100cm2
^{241}Am		1.84E-10	1.00E-04	5.43E+05	3691	343	3429050	1.58E-01	3.52E+01
^{60}Co		3.81E-11	1.00E-04	2.62E+06	3691	343	3429050	7.65E-01	1.70E+02
^{137}Cs	^{137m}Ba	4.26E-11	1.00E-04	2.35E+06	3691	343	3429050	6.85E-01	1.52E+02
^{152}Eu		1.46E-11	1.00E-04	6.85E+06	3691	343	3429050	2.00E+00	4.43E+02
^{154}Eu		2.54E-11	1.00E-04	3.94E+06	3691	343	3429050	1.15E+00	2.55E+02
^{3}H		8.99E-14	1.00E-04	1.11E+09	3691	343	3429050	3.24E+02	7.20E+04
^{239}Pu	^{235m}U	2.28E-10	1.00E-04	4.39E+05	3691	343	3429050	1.28E-01	2.84E+01
^{226}Ra	^{222}Rn+D	6.77E-10	1.00E-04	1.48E+05	3691	343	3429050	4.31E-02	9.56E+00
^{90}Sr	^{90}Y	1.35E-10	1.00E-04	7.41E+05	3691	343	3429050	2.16E-01	4.80E+01
^{232}Th	^{228}Ra+D	2.17E-09	1.00E-04	4.61E+04	3691	343	3429050	1.34E-02	2.98E+00
^{235}U	^{231}Th	1.48E-10	1.00E-04	6.76E+05	3691	343	3429050	1.97E-01	4.37E+01

Contact area = walls to 8 ft and floors

floor	2187	ft2
Walls	1504	ft2
sum	**3691**	ft2

Decay progeny		gross alpha	gross beta	gross alpha	gross beta	USN gross	USN gross
# Alpha	# Beta						
1	0	3.52E+01					
0	1		1.70E+02				97.3
0	1		1.52E+02				90.6
0	1		4.43E+02				
0	1		2.55E+02				
0	1		7.20E+04				
1	0	2.84E+01				23.5	
3.2	1.6	3.06E+01	1.53E+01			7.67	84.2
0	2		9.59E+01				47.8
4.05	2.05	1.21E+01	6.12E+00	**12**	**6**	5.73	95.9
1	1	4.37E+01	4.37E+01				

Decay progeny from USN workplan

Plan limiting isotope

Th-232		Estimated MDC reduction
MDC	**count time**	**1.41**
68	2 min	
48	4 min	
34	8 min	
24	16 min	
17	32 min	
12	64 min	
9	128 min	
6	256 min	

Ra-226		Estimated MDC reduction
MDC	**count time**	**1.41**
60	2 min	
42	4 min	
30	8 min	
21	16 min	
15	32 min	
11	64 min	
8	128 min	
5	256 min	

Ingestion MDC calc

Parent ROC	Contributing Progeny	Slope factor	Risk Limit	pCi	contact area ft2	contact area m2	contact area cm2	pCi/cm2	dpm/100cm2
^{241}Am		1.84E-10	1.00E-04	5.43E+05	2939	273	2730419	1.99E-01	4.42E+01
^{60}Co		3.81E-11	1.00E-04	2.62E+06	2939	273	2730419	9.61E-01	2.13E+02
^{137}Cs	^{137m}Ba	4.26E-11	1.00E-04	2.35E+06	2939	273	2730419	8.60E-01	1.91E+02
^{152}Eu		1.46E-11	1.00E-04	6.85E+06	2939	273	2730419	2.51E+00	5.57E+02
^{154}Eu		2.54E-11	1.00E-04	3.94E+06	2939	273	2730419	1.44E+00	3.20E+02
^{3}H		8.99E-14	1.00E-04	1.11E+09	2939	273	2730419	4.07E+02	9.04E+04
^{239}Pu	^{235m}U	2.28E-10	1.00E-04	4.39E+05	2939	273	2730419	1.61E-01	3.57E+01
^{226}Ra	^{222}Rn+D	6.77E-10	1.00E-04	1.48E+05	2939	273	2730419	5.41E-02	1.20E+01
^{90}Sr	^{90}Y	1.35E-10	1.00E-04	7.41E+05	2939	273	2730419	2.71E-01	6.02E+01
^{232}Th	^{228}Ra+D	2.17E-09	1.00E-04	4.61E+04	2939	273	2730419	1.69E-02	3.75E+00
^{235}U	^{231}Th	1.48E-10	1.00E-04	6.76E+05	2939	273	2730419	2.47E-01	5.49E+01

Contact area = walls to 8 ft and floors

floor	2187	ft2
2 Walls	752	ft2
sum	**2939**	ft2

Decay progeny		gross alpha	gross beta	gross alpha	gross beta	USN gross	USN gross
# Alpha	# Beta						
1	0	4.42E+01					
0	1		2.13E+02				97.3
0	1		1.91E+02				90.6
0	1		5.57E+02				
0	1		3.20E+02				
0	1		9.04E+04				
1	0	3.57E+01				23.5	
3.2	1.6	3.84E+01	1.92E+01			7.67	84.2
0	2		1.20E+02				47.8
4.05	2.05	1.52E+01	7.68E+00	**15**	**8**	5.73	95.9
1	1	5.49E+01	5.49E+01				

Decay progeny from USN workplan

Plan limiting isotope

Th-232		Estimated MDC reduction
MDC	**count time**	**1.41**
68	2 min	
48	4 min	
34	8 min	
24	16 min	
17	32 min	
12	64 min	
9	128 min	
6	256 min	

Ra-226		Estimated MDC reduction
MDC	**count time**	**1.41**
60	2 min	
42	4 min	
30	8 min	
21	16 min	
15	32 min	
11	64 min	
8	128 min	
5	256 min	

Ingestion MDC calc

Parent ROC	Contributing Progeny	Slope factor	Risk Limit	pCi	Exposure	half life	Activity over	contact area ft2
^{241}Am		1.84E-10	1.00E-04	5.43E+05	2.60E+01	4.32E+02	5.55E+05	2939
^{60}Co		3.81E-11	1.00E-04	2.62E+06	2.60E+01	5.27E+00	9.28E+06	2939
^{137}Cs	^{137m}Ba	4.26E-11	1.00E-04	2.35E+06	2.60E+01	3.02E+01	3.12E+06	2939
^{152}Eu		1.46E-11	1.00E-04	6.85E+06	2.60E+01	1.35E+01	1.24E+07	2939
^{154}Eu		2.54E-11	1.00E-04	3.94E+06	2.60E+01	8.59E+00	9.41E+06	2939
^{3}H		8.99E-14	1.00E-04	1.11E+09	2.60E+01	1.23E+01	2.12E+09	2939
^{239}Pu	^{235m}U	2.28E-10	1.00E-04	4.39E+05	2.60E+01	2.41E+04	4.39E+05	2939
^{226}Ra	^{222}Rn+D	5.69E-09	1.00E-04	1.76E+04	2.60E+01	1.60E+03	1.77E+04	2939
^{90}Sr	^{90}Y	1.35E-10	1.00E-04	7.41E+05	2.60E+01	2.88E+01	9.96E+05	2939
^{232}Th	^{228}Ra+D	2.90E-09	1.00E-04	3.45E+04	2.60E+01	1.41E+10	3.45E+04	2939
^{235}U	^{231}Th	1.48E-10	1.00E-04	6.76E+05	2.60E+01	7.04E+08	6.76E+05	2939

Contact area = walls to 8 ft and floors

floor	2187	ft2
2 Walls	752	ft2
sum	**2939**	ft2

SF for Th-232 and Ra-226 are from BPRG sum of individual daughter SF.

contact area m2	contact area cm2	pCi/cm2	dpm/100cm2	Decay progeny		gross alpha	gross beta
				# Alpha	# Beta		
273	2730419	2.03E-01	4.51E+01	1	0	4.51E+01	
273	2730419	3.40E+00	7.54E+02	0	1		7.54E+02
273	2730419	1.14E+00	2.53E+02	0	1		2.53E+02
273	2730419	4.54E+00	1.01E+03	0	1		1.01E+03
273	2730419	3.45E+00	7.65E+02	0	1		7.65E+02
273	2730419	7.76E+02	1.72E+05	0	1		1.72E+05
273	2730419	1.61E-01	3.57E+01	1	0	3.57E+01	
273	2730419	6.47E-03	1.44E+00	3.2	1.6	4.60E+00	2.30E+00
273	2730419	3.65E-01	8.10E+01	0	2		1.62E+02
273	2730419	1.26E-02	2.80E+00	4.05	2.05	1.14E+01	5.75E+00
273	2730419	2.47E-01	5.49E+01	1	1	5.49E+01	5.49E+01

Decay progeny from USN workplan

Plan limiting isotope

gross alpha	gross beta	USN gross	USN gross
			97.3
			90.6
		23.5	
	2	7.67	84.2
			47.8
11	**6**	5.73	95.9

1. NUMBER OF RADON DAUGHTERS (including radon itself)

	100% Rn loss	
	# Alpha	# Beta
^{226}Ra	1	0
^{232}Th	3	1

2. EFFICIENCIES (values from Table 4-6 in Navy Parcel G Workplan)

Ludlum 43-68

	100% Rn loss	
	Alpha eff	Beta eff
^{226}Ra	0.175	0
^{232}Th	0.525	0.2

Ludlum 3030

	100% Rn loss	
	Alpha eff	Beta eff
^{226}Ra	0.32	0
^{232}Th	1.13	0.26

Ludlum 4393

239Pu		

3. OTHER PARAMETERS FOR MDC CALCULATION

	R_B	T_{S+B}	T_B
4368 alpha	2	2	2
4368 beta	350	2	2
3030 alpha	2	2	2
3030 beta	50	2	2
4393 alpha	2	2	2

4. MDC CALCULATIONS

		4368 alp
		e_T

Partial Rn loss(Navy assumption)		No Rn loss	
# Alpha	# Beta	# Alpha	# Beta
3.2	1.6	5	3
4.05	2.05	6	3

Partial Rn loss(Navy assumption)		No Rn loss	
Alpha eff	Beta eff	Alpha eff	Beta eff
0.56	0.24		
0.708	0.211		

Partial Rn loss(Navy assumption)		No Rn loss	
Alpha eff	Beta eff	Alpha eff	Beta eff
1.134	0.312		
1.517	0.274		

Partial Rn loss(Navy assumption)			
Alpha eff	Beta eff		
0.200			

Equation 4-9

Static MDC (dpm/100 c

Where:

R_B = backgrounc
T_{S+B} = SU countin
T_B = backgrounc
ε_T = detector to
π instrume
A = detector pr

A
126
126
20.3
20.3
100

			3030				4393	
ha	beta		alpha		beta		alpha	
MDC	e_T	MDC	e_T	MDC	e_T	MDC	e_T	MDC

$$m^2) = \frac{[3 + 3.29\sqrt{R_B \cdot T_{S+B} \cdot \left(1 + \frac{T_{S+B}}{T_B}\right)}]}{\varepsilon_T \cdot \frac{A}{100} \cdot T_{S+B}}$$

d count rate (cpm)
g time (minutes)
d counting time (minutes)
tal (4-π) efficiency (counts per disintegration), equal to 2-
nt efficiency (ε_i) multiplied by surface efficiency (ε_s)
obe physical (active) area (cm^2)

Ra226	100% loss	0.175
	partial loss	0.56
Th232	100% loss	0.525
	partial loss	0.708
Pu239	partial loss	

27.90369	0		0.32	94.71617334	0		
8.719902	0.24	208.4996	1.134	26.72766796	0.312	390.9911125	
9.301228	0.2		1.13	26.82227918	0.26	469.189335	
6.897097	0.211	237.1559	1.517	19.9796806	0.274	445.2161573	
							0.200 30.7638131

Ingestion MDC calc

Parent ROC	Contributing Progeny	Slope factor	Risk Limit	pCi	Exposure	half life	Activity over	contact area ft2
^{241}Am		1.84E-10	1.00E-04	5.43E+05	2.60E+01	4.32E+02	5.55E+05	2939
^{60}Co		3.81E-11	1.00E-04	2.62E+06	2.60E+01	5.27E+00	9.28E+06	2939
^{137}Cs	^{137m}Ba	4.26E-11	1.00E-04	2.35E+06	2.60E+01	3.02E+01	3.12E+06	2939
^{152}Eu		1.46E-11	1.00E-04	6.85E+06	2.60E+01	1.35E+01	1.24E+07	2939
^{154}Eu		2.54E-11	1.00E-04	3.94E+06	2.60E+01	8.59E+00	9.41E+06	2939
^{3}H		8.99E-14	1.00E-04	1.11E+09	2.60E+01	1.23E+01	2.12E+09	2939
^{239}Pu	^{235m}U	2.28E-10	1.00E-04	4.39E+05	2.60E+01	2.41E+04	4.39E+05	2939
^{226}Ra	^{222}Rn+D	6.77E-10	1.00E-04	1.48E+05	2.60E+01	1.60E+03	1.49E+05	2939
^{90}Sr	^{90}Y	1.35E-10	1.00E-04	7.41E+05	2.60E+01	2.88E+01	9.96E+05	2939
^{232}Th	^{228}Ra+D	2.17E-09	1.00E-04	4.61E+04	2.60E+01	1.41E+10	4.61E+04	2939
^{235}U	^{231}Th	1.48E-10	1.00E-04	6.76E+05	2.60E+01	7.04E+08	6.76E+05	2939

Contact area = walls to 8 ft and floors

floor	2187	ft2
2 Walls	752	ft2
sum	**2939**	ft2

SF for Th-232 and Ra-226 are +E from DCFPak.

contact area m2	contact area cm2	pCi/cm2	dpm/100cm2	Decay progeny		gross alpha	gross beta
				# Alpha	# Beta		
273	2730419	2.03E-01	4.51E+01	1	0	4.51E+01	
273	2730419	3.40E+00	7.54E+02	0	1		7.54E+02
273	2730419	1.14E+00	2.53E+02	0	1		2.53E+02
273	2730419	4.54E+00	1.01E+03	0	1		1.01E+03
273	2730419	3.45E+00	7.65E+02	0	1		7.65E+02
273	2730419	7.76E+02	1.72E+05	0	1		1.72E+05
273	2730419	1.61E-01	3.57E+01	1	0	3.57E+01	
273	2730419	5.44E-02	1.21E+01	3.2	1.6	3.86E+01	1.93E+01
273	2730419	3.65E-01	8.10E+01	0	2		1.62E+02
273	2730419	1.69E-02	3.75E+00	4.05	2.05	1.52E+01	7.68E+00
273	2730419	2.47E-01	5.49E+01	1	1	5.49E+01	5.49E+01

Decay progeny from USN workplan

Plan limiting isotope

gross alpha	gross beta	USN gross	USN gross
			97.3
			90.6
		23.5	
		7.67	84.2
			47.8
15	**8**	5.73	95.9

Th-232		**Estimated MDC reduction**
MDC	**count time**	**1.414214**
67.8	2 min	
48.0	4 min	
33.9	8 min	
24.0	16 min	
17.0	32 min	
12.0	64 min	
8.5	128 min	
6.0	256 min	

Ra-226		**Estimated MDC reduction**
MDC	**count time**	**1.41**
60	2 min	
42	4 min	
30	8 min	
21	16 min	
15	32 min	
11	64 min	
7	128 min	
5	256 min	

Ingestion MDC calc

Parent ROC	Contributing Progeny	Slope factor	Risk Limit	pCi	contact area m2	contact area cm2	pCi/cm2	dpm/100cm2
^{241}Am		1.84E-10	1.00E-04	5.43E+05	320	3200400	1.70E-01	3.77E+01
^{60}Co		3.81E-11	1.00E-04	2.62E+06	320	3200400	8.20E-01	1.82E+02
^{137}Cs	^{137m}Ba	4.26E-11	1.00E-04	2.35E+06	320	3200400	7.33E-01	1.63E+02
^{152}Eu		1.46E-11	1.00E-04	6.85E+06	320	3200400	2.14E+00	4.75E+02
^{154}Eu		2.54E-11	1.00E-04	3.94E+06	320	3200400	1.23E+00	2.73E+02
^{3}H		8.99E-14	1.00E-04	1.11E+09	320	3200400	3.48E+02	7.72E+04
^{239}Pu	^{235m}U	2.28E-10	1.00E-04	4.39E+05	320	3200400	1.37E-01	3.04E+01
^{226}Ra	^{222}Rn+D	6.77E-10	1.00E-04	1.48E+05	320	3200400	4.62E-02	1.02E+01
^{90}Sr	^{90}Y	1.35E-10	1.00E-04	7.41E+05	320	3200400	2.31E-01	5.14E+01
^{232}Th	^{228}Ra+D	2.17E-09	1.00E-04	4.61E+04	320	3200400	1.44E-02	3.20E+00
^{235}U	^{231}Th	1.48E-10	1.00E-04	6.76E+05	320	3200400	2.11E-01	4.69E+01

Decay progeny		gross alpha	gross beta	gross alpha	gross beta	USN gross	USN gross
# Alpha	# Beta						
1	0	3.77E+01					
0	1		1.82E+02				97.3
0	1		1.63E+02				90.6
0	1		4.75E+02				
0	1		2.73E+02				
0	1		7.72E+04				
1	0	3.04E+01				23.5	
3.2	1.6	3.28E+01	1.64E+01			7.67	84.2
0	2		1.03E+02				47.8
4.05	2.05	1.29E+01	6.55E+00	**13**	**7**	5.73	95.9
1	1	4.69E+01	4.69E+01				

Decay progeny from USN workplan

Plan limiting isotope

ED	26
ln2	0.693
T/2	5.27
decay 26y	9277488.9
	2.898852932

Th-232		Estimated MDC reduction
MDC	**count time**	**1.41**
68	2 min	
48	4 min	
34	8 min	
24	16 min	
17	32 min	
12	64 min	
9	128 min	
6	256 min	

Ra-226		Estimated MDC reduction
MDC	**count time**	**1.41**
60	2 min	
42	4 min	
30	8 min	
21	16 min	
15	32 min	
11	64 min	
8	128 min	
5	256 min	

643.5453509

Ingestion MDC calc with decay

Parent ROC	Contributing Progeny	Slope factor	Risk Limit	pCi	Exposure duration	half life	Activity over	contact area m2
^{241}Am		1.84E-10	1.00E-04	5.43E+05	2.60E+01	4.32E+02	5.55E+05	320
^{60}Co		3.81E-11	1.00E-04	2.62E+06	2.60E+01	5.27E+00	9.28E+06	320
^{137}Cs	^{137m}Ba	4.26E-11	1.00E-04	2.35E+06	2.60E+01	3.02E+01	3.12E+06	320
^{152}Eu		1.46E-11	1.00E-04	6.85E+06	2.60E+01	1.35E+01	1.24E+07	320
^{154}Eu		2.54E-11	1.00E-04	3.94E+06	2.60E+01	8.59E+00	9.41E+06	320
^{3}H		8.99E-14	1.00E-04	1.11E+09	2.60E+01	1.23E+01	2.12E+09	320
^{239}Pu	^{235m}U	2.28E-10	1.00E-04	4.39E+05	2.60E+01	2.41E+04	4.39E+05	320
^{226}Ra	^{222}Rn+D	5.69E-09	1.00E-04	1.76E+04	2.60E+01	1.60E+03	1.77E+04	320
^{90}Sr	^{90}Y	1.35E-10	1.00E-04	7.41E+05	2.60E+01	2.88E+01	9.96E+05	320
^{232}Th	^{228}Ra+D	2.90E-09	1.00E-04	3.45E+04	2.60E+01	1.41E+10	3.45E+04	320
^{235}U	^{231}Th	1.48E-10	1.00E-04	6.76E+05	2.60E+01	7.04E+08	6.76E+05	320

Check

BPRG reported **ingestion** BPRG pCi/cm2		above calc with decay	no decay
Co-60	2.90E+00	2.90E+00	8.20E-01
Cs-137	9.76E-01	9.74E-01	7.33E-01
Sr-90	3.11E-01	3.11E-01	2.31E-01

Sr90/Y90 BPRG combined 1/(1/Sr90 + 1/Y-90)

All show good agrement between calculator and spreadsheet with decay

ingestion BPRG used

SF for Th-232 and Ra-226 are from BPRG sum of individual daughter SF.

contact area cm2	pCi/cm2	dpm/100cm2		Decay progeny		gross alpha	gross beta	gross alpha
				# Alpha	# Beta			
3200400	1.73E-01	3.85E+01		1	0	3.85E+01		
3200400	2.90E+00	6.44E+02		0	1		6.44E+02	
3200400	9.74E-01	2.16E+02		0	1		2.16E+02	
3200400	3.88E+00	8.61E+02		0	1		8.61E+02	
3200400	2.94E+00	6.53E+02		0	1		6.53E+02	
3200400	6.62E+02	1.47E+05		0	1		1.47E+05	
3200400	1.37E-01	3.04E+01		1	0	3.04E+01		
3200400	5.52E-03	1.23E+00		3.2	1.6	3.92E+00	1.96E+00	
3200400	3.11E-01	6.91E+01		0	2		1.38E+02	
3200400	1.08E-02	2.39E+00		4.05	2.05	9.69E+00	4.90E+00	**10**
3200400	2.11E-01	4.69E+01		1	1	4.69E+01	4.69E+01	

Decay progeny from USN workplan

Plan limiting isotope

gross beta	USN gross	USN gross
		97.3
		90.6
	23.5	
	7.67	84.2
		47.8
5	5.73	95.9

ln2 0.693

Ingestion MDC calc

Parent ROC	Contributing Progeny	Slope factor	Risk Limit	pCi	contact area m2	contact area cm2	pCi/cm2	dpm/100cm2
^{241}Am		1.84E-10	1.00E-04	5.43E+05	200	2000000	2.72E-01	6.03E+01
^{60}Co		3.81E-11	1.00E-04	2.62E+06	200	2000000	1.31E+00	2.91E+02
^{137}Cs	^{137m}Ba	4.26E-11	1.00E-04	2.35E+06	200	2000000	1.17E+00	2.61E+02
^{152}Eu		1.46E-11	1.00E-04	6.85E+06	200	2000000	3.42E+00	7.60E+02
^{154}Eu		2.54E-11	1.00E-04	3.94E+06	200	2000000	1.97E+00	4.37E+02
^{3}H		8.99E-14	1.00E-04	1.11E+09	200	2000000	5.56E+02	1.23E+05
^{239}Pu	^{235m}U	2.28E-10	1.00E-04	4.39E+05	200	2000000	2.19E-01	4.87E+01
^{226}Ra	^{222}Rn+D	6.77E-10	1.00E-04	1.48E+05	200	2000000	7.39E-02	1.64E+01
^{90}Sr	^{90}Y	1.35E-10	1.00E-04	7.41E+05	200	2000000	3.70E-01	8.22E+01
^{232}Th	^{228}Ra+D	2.17E-09	1.00E-04	4.61E+04	200	2000000	2.30E-02	5.12E+00
^{235}U	^{231}Th	1.48E-10	1.00E-04	6.76E+05	200	2000000	3.38E-01	7.50E+01

Decay progeny		gross alpha	gross beta	gross alpha	gross beta	USN gross	USN gross
# Alpha	# Beta						
1	0	6.03E+01					
0	1		2.91E+02				97.3
0	1		2.61E+02				90.6
0	1		7.60E+02				
0	1		4.37E+02				
0	1		1.23E+05				
1	0	4.87E+01				23.5	
3.2	1.6	5.25E+01	2.62E+01			7.67	84.2
0	2		1.64E+02				47.8
4.05	2.05	2.07E+01	1.05E+01	**21**	**10**	5.73	95.9
1	1	7.50E+01	7.50E+01				

Decay progeny from USN workplan

Plan limiting isotope

Th-232		Estimated MDC reduction
MDC	**count time**	**1.41**
68	2 min	
48	4 min	
34	8 min	
24	16 min	
17	32 min	
12	64 min	
9	128 min	
6	256 min	

Ra-226		Estimated MDC reduction
MDC	**count time**	**1.41**
60	2 min	
42	4 min	
30	8 min	
21	16 min	
15	32 min	
11	64 min	
8	128 min	
5	256 min	

Ingestion MDC calc

Parent ROC	Contributing Progeny	Slope factor	Risk Limit	pCi	contact area m2	contact area cm2	pCi/cm2	dpm/100cm2
^{241}Am		1.84E-10	1.00E-04	5.43E+05	100	1000000	5.43E-01	1.21E+02
^{60}Co		3.81E-11	1.00E-04	2.62E+06	100	1000000	2.62E+00	5.83E+02
^{137}Cs	^{137m}Ba	4.26E-11	1.00E-04	2.35E+06	100	1000000	2.35E+00	5.21E+02
^{152}Eu		1.46E-11	1.00E-04	6.85E+06	100	1000000	6.85E+00	1.52E+03
^{154}Eu		2.54E-11	1.00E-04	3.94E+06	100	1000000	3.94E+00	8.74E+02
^{3}H		8.99E-14	1.00E-04	1.11E+09	100	1000000	1.11E+03	2.47E+05
^{239}Pu	^{235m}U	2.28E-10	1.00E-04	4.39E+05	100	1000000	4.39E-01	9.74E+01
^{226}Ra	^{222}Rn+D	6.77E-10	1.00E-04	1.48E+05	100	1000000	1.48E-01	3.28E+01
^{90}Sr	^{90}Y	1.35E-10	1.00E-04	7.41E+05	100	1000000	7.41E-01	1.64E+02
^{232}Th	^{228}Ra+D	2.17E-09	1.00E-04	4.61E+04	100	1000000	4.61E-02	1.02E+01
^{235}U	^{231}Th	1.48E-10	1.00E-04	6.76E+05	100	1000000	6.76E-01	1.50E+02

Decay progeny		gross alpha	gross beta	gross alpha	gross beta	USN gross	USN gross
# Alpha	# Beta						
1	0	1.21E+02					
0	1		5.83E+02				97.3
0	1		5.21E+02				90.6
0	1		1.52E+03				
0	1		8.74E+02				
0	1		2.47E+05				
1	0	9.74E+01				23.5	
3.2	1.6	1.05E+02	5.25E+01			7.67	84.2
0	2		3.29E+02				47.8
4.05	2.05	4.14E+01	2.10E+01	**41**	**21**	5.73	95.9
1	1	1.50E+02	1.50E+02				

Decay progeny from USN workplan

Plan limiting isotope

Th-232		Estimated MDC reduction
MDC	**count time**	**1.41**
68	2 min	
48	4 min	
34	8 min	
24	16 min	
17	32 min	
12	64 min	
9	128 min	
6	256 min	

Ra-226		Estimated MDC reduction
MDC	**count time**	**1.41**
60	2 min	
42	4 min	
30	8 min	
21	16 min	
15	32 min	
11	64 min	
8	128 min	
5	256 min	

Ingestion MDC calc

Parent ROC	Contributing Progeny	Slope factor	Risk Limit	pCi	contact area m2	contact area cm2	pCi/cm2	dpm/100cm2
^{241}Am		1.84E-10	1.00E-04	5.43E+05	43	430000	1.26E+00	2.81E+02
^{60}Co		3.81E-11	1.00E-04	2.62E+06	43	430000	6.10E+00	1.36E+03
^{137}Cs	^{137m}Ba	4.26E-11	1.00E-04	2.35E+06	43	430000	5.46E+00	1.21E+03
^{152}Eu		1.46E-11	1.00E-04	6.85E+06	43	430000	1.59E+01	3.54E+03
^{154}Eu		2.54E-11	1.00E-04	3.94E+06	43	430000	9.16E+00	2.03E+03
^{3}H		8.99E-14	1.00E-04	1.11E+09	43	430000	2.59E+03	5.74E+05
^{239}Pu	^{235m}U	2.28E-10	1.00E-04	4.39E+05	43	430000	1.02E+00	2.26E+02
^{226}Ra	^{222}Rn+D	6.77E-10	1.00E-04	1.48E+05	43	430000	3.44E-01	7.63E+01
^{90}Sr	^{90}Y	1.35E-10	1.00E-04	7.41E+05	43	430000	1.72E+00	3.82E+02
^{232}Th	^{228}Ra+D	2.17E-09	1.00E-04	4.61E+04	43	430000	1.07E-01	2.38E+01
^{235}U	^{231}Th	1.48E-10	1.00E-04	6.76E+05	43	430000	1.57E+00	3.49E+02

Decay progeny		gross alpha	gross beta	gross alpha	gross beta	USN gross	USN gross
# Alpha	# Beta						
1	0	2.81E+02					
0	1		1.36E+03				97.3
0	1		1.21E+03				90.6
0	1		3.54E+03				
0	1		2.03E+03				
0	1		5.74E+05				
1	0	2.26E+02				23.5	
3.2	1.6	2.44E+02	1.22E+02			7.67	84.2
0	2		7.65E+02				47.8
4.05	2.05	9.64E+01	4.88E+01	**96**	**49**	5.73	95.9
1	1	3.49E+02	3.49E+02				

Decay progeny from USN workplan

Plan limiting isotope

Th-232		Estimated MDC reduction
MDC	**count time**	**1.41**
68	2 min	
48	4 min	
34	8 min	
24	16 min	
17	32 min	
12	64 min	
9	128 min	
6	256 min	

Ra-226		Estimated MDC reduction
MDC	**count time**	**1.41**
60	2 min	
42	4 min	
30	8 min	
21	16 min	
15	32 min	
11	64 min	
8	128 min	
5	256 min	

Ingestion MDC calc

Parent ROC	Contributing Progeny	Slope factor	Risk Limit	pCi	contact area m2	contact area cm2	pCi/cm2	dpm/100cm2
^{241}Am		1.84E-10	1.00E-04	5.43E+05	32	320000	1.70E+00	3.77E+02
^{60}Co		3.81E-11	1.00E-04	2.62E+06	32	320000	8.20E+00	1.82E+03
^{137}Cs	^{137m}Ba	4.26E-11	1.00E-04	2.35E+06	32	320000	7.34E+00	1.63E+03
^{152}Eu		1.46E-11	1.00E-04	6.85E+06	32	320000	2.14E+01	4.75E+03
^{154}Eu		2.54E-11	1.00E-04	3.94E+06	32	320000	1.23E+01	2.73E+03
^{3}H		8.99E-14	1.00E-04	1.11E+09	32	320000	3.48E+03	7.72E+05
^{239}Pu	^{235m}U	2.28E-10	1.00E-04	4.39E+05	32	320000	1.37E+00	3.04E+02
^{226}Ra	^{222}Rn+D	6.77E-10	1.00E-04	1.48E+05	32	320000	4.62E-01	1.02E+02
^{90}Sr	^{90}Y	1.35E-10	1.00E-04	7.41E+05	32	320000	2.31E+00	5.14E+02
^{232}Th	^{228}Ra+D	2.17E-09	1.00E-04	4.61E+04	32	320000	1.44E-01	3.20E+01
^{235}U	^{231}Th	1.48E-10	1.00E-04	6.76E+05	32	320000	2.11E+00	4.69E+02

Decay progeny		gross alpha	gross beta	gross alpha	gross beta	USN gross	USN gross
# Alpha	# Beta						
1	0	3.77E+02					
0	1		1.82E+03				97.3
0	1		1.63E+03				90.6
0	1		4.75E+03				
0	1		2.73E+03				
0	1		7.72E+05				
1	0	3.04E+02				23.5	
3.2	1.6	3.28E+02	1.64E+02			7.67	84.2
0	2		1.03E+03				47.8
4.05	2.05	1.29E+02	6.55E+01	**129**	**66**	5.73	95.9
1	1	4.69E+02	4.69E+02				

Decay progeny from USN workplan

Plan limiting isotope

Th-232		Estimated MDC reduction
MDC	**count time**	**1.41**
68	2 min	
48	4 min	
34	8 min	
24	16 min	
17	32 min	
12	64 min	
9	128 min	
6	256 min	

Ra-226		Estimated MDC reduction
MDC	**count time**	**1.41**
60	2 min	
42	4 min	
30	8 min	
21	16 min	
15	32 min	
11	64 min	
8	128 min	
5	256 min	

Ingestion MDC calc

Parent ROC	Contributing Progeny	Slope factor	Risk Limit	pCi	contact area m2	contact area cm2	pCi/cm2	dpm/100cm2
^{241}Am		1.84E-10	1.00E-04	5.43E+05	20	200000	2.72E+00	6.03E+02
^{60}Co		3.81E-11	1.00E-04	2.62E+06	20	200000	1.31E+01	2.91E+03
^{137}Cs	^{137m}Ba	4.26E-11	1.00E-04	2.35E+06	20	200000	1.17E+01	2.61E+03
^{152}Eu		1.46E-11	1.00E-04	6.85E+06	20	200000	3.42E+01	7.60E+03
^{154}Eu		2.54E-11	1.00E-04	3.94E+06	20	200000	1.97E+01	4.37E+03
^{3}H		8.99E-14	1.00E-04	1.11E+09	20	200000	5.56E+03	1.23E+06
^{239}Pu	^{235m}U	2.28E-10	1.00E-04	4.39E+05	20	200000	2.19E+00	4.87E+02
^{226}Ra	^{222}Rn+D	6.77E-10	1.00E-04	1.48E+05	20	200000	7.39E-01	1.64E+02
^{90}Sr	^{90}Y	1.35E-10	1.00E-04	7.41E+05	20	200000	3.70E+00	8.22E+02
^{232}Th	^{228}Ra+D	2.17E-09	1.00E-04	4.61E+04	20	200000	2.30E-01	5.12E+01
^{235}U	^{231}Th	1.48E-10	1.00E-04	6.76E+05	20	200000	3.38E+00	7.50E+02

Decay progeny		gross alpha	gross beta	gross alpha	gross beta	USN gross	USN gross
# Alpha	# Beta						
1	0	6.03E+02					
0	1		2.91E+03				97.3
0	1		2.61E+03				90.6
0	1		7.60E+03				
0	1		4.37E+03				
0	1		1.23E+06				
1	0	4.87E+02				23.5	
3.2	1.6	5.25E+02	2.62E+02			7.67	84.2
0	2		1.64E+03				47.8
4.05	2.05	2.07E+02	1.05E+02	**207**	**105**	5.73	95.9
1	1	7.50E+02	7.50E+02				

Decay progeny from USN workplan

Plan limiting isotope

Th-232		Estimated MDC reduction
MDC	count time	1.41
68	2 min	
48	4 min	
34	8 min	
24	16 min	
17	32 min	
12	64 min	
9	128 min	
6	256 min	

Ra-226		Estimated MDC reduction
MDC	count time	1.41
60	2 min	
42	4 min	
30	8 min	
21	16 min	
15	32 min	
11	64 min	
8	128 min	
5	256 min	