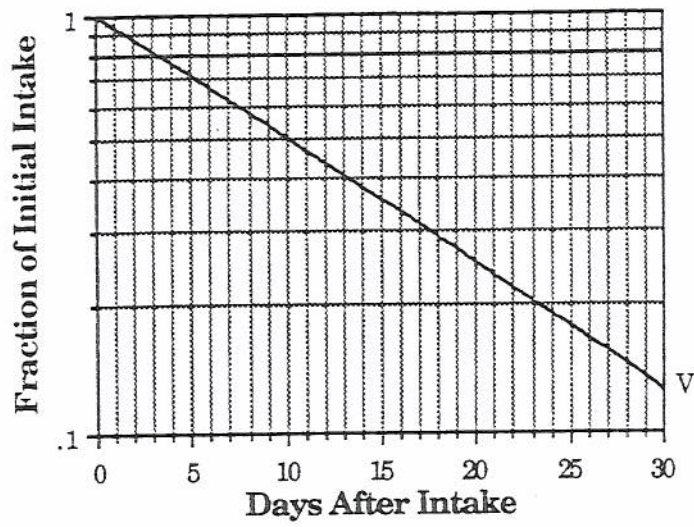
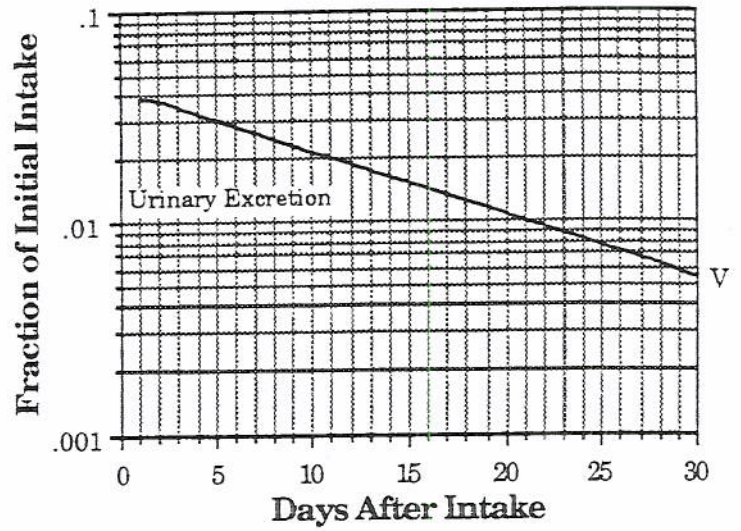


Radionuclide Internal Dose Information

H-3 Retention Fraction



H-3 Excretion Fraction



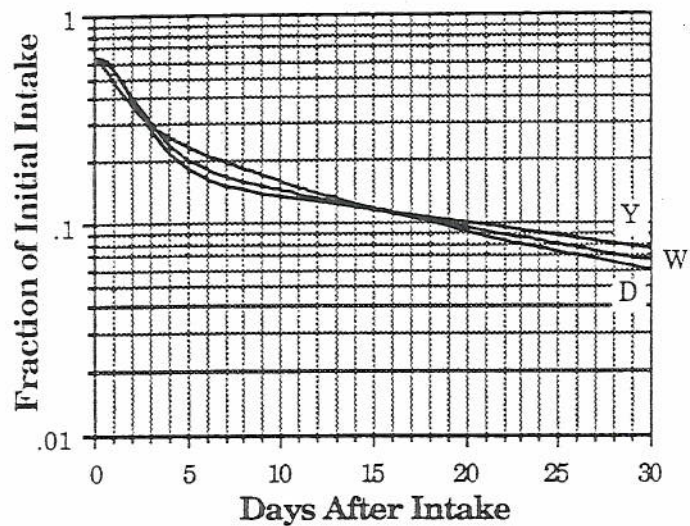
Notes

H-3

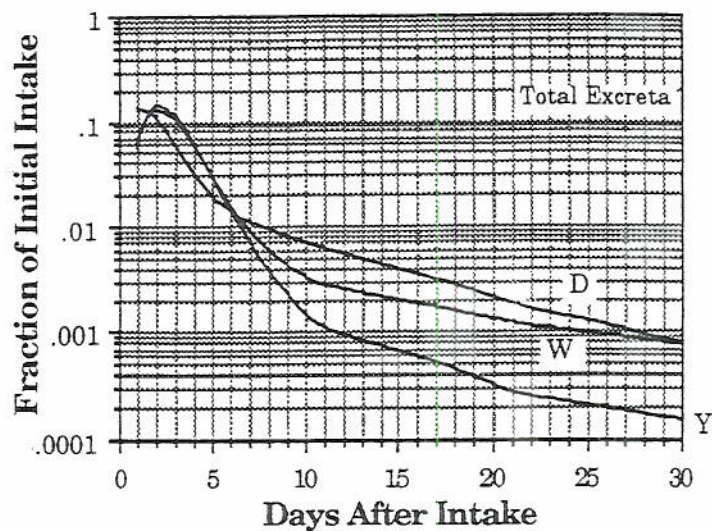
(All CDE and CEDE in mrem; ALI's in μCi)

Class	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
Vapor	1.0	1.73E-11	1.73E-11	1.73E-11	1.73E-11	1.73E-11	1.73E-11	1.73E-11
CDE per μCi Inhaled =		0.06	0.06	0.06	0.06	0.06	0.06	0.06
CEDE per μCi Inhaled =		0.016	0.010	0.008	0.008	0.002	0.002	0.019
			h Based	h Based	10%	10%		
		h eff	(S)ALI	(N)ALI	Rule	Rule		
		1.73E-11	78113	781128	h eff	(S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =		0.06	78113	781128 (All)	0.06	78113	80000	800000
Inhaled/Skin Absorbed				Urinary	DAC (V) = 2E-5			
Retention				Excretion	DAC-hr = 48000 nCi *			
Vapor				Vapor	DAC-hr = 3.0 mrem (ALI)			
Days	Fract			Fract	DAC-hr = 2.88 mrem (h)			
0.1	0.993				* Skin abs + inhalation			
0.2	0.986							
0.3	0.979							
0.4	0.972				"Properly Based ALI/DAC"			
0.5	0.966				ALI = 78000 μCi			
0.6	0.959				DAC (V) = 1.6E-05			
0.7	0.952				DAC-hr = 38400 nCi*			
0.8	0.946				DAC-hr = 2.54 mrem (ALI)			
0.9	0.939				DAC-hr = 2.38 mrem (h)			
1	0.936			3.85E-2	* Skin abs + inhalation			
2	0.873			3.76E-2				
3	0.814			3.51E-2				
4	0.760			3.27E-2				
5	0.709			3.05E-2				
6	0.661			2.85E-2				
7	0.617			2.66E-2				
8	0.575			2.48E-2				
9	0.537			2.31E-2				
10	0.501			2.16E-2				
20	0.250			1.08E-2				
30	0.125			5.37E-3				
40	0.062			2.68E-3				
50	0.031			1.34E-3				
60	0.016			6.69E-4				
70	7.76E-3			3.34E-4				
80	3.87E-3			1.67E-4				
90	1.93E-3			8.33E-5				
100	9.66E-4			4.16E-5				
200	9.30E-7			4.01E-8				
					Misc			
					Data			
					T 1/2 =	12.35 y		
					β^-	18.6	keV	
					γ	..		
					Γ =	0.0		
					mR/hr per Ci at 1 meter			

Cr-51 Retention Fractions



Cr-51 Excretion Fractions



Notes

Cr-51

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
Y	0.1	2.03E-11	1.58E-11	5.34E-10	1.87E-11	1.39E-11	1.08E-11	5.26E-11
CDE per μCi Inhaled =		0.08	0.06	1.98	0.07	0.05	0.04	0.19
CEDE per μCi Inhaled =		0.02	0.01	0.24	0.01	0.00	0.00	0.06

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule h eff	10% Rule (S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =	9.03E-11	14967	25306	0.26	18983	20000	30000
	0.33	14967	25306 (Lung)				

Whole Body Retention			Total Excreta			
Days	D Fract	W Fract	Y Fract	D Fract	W Fract	Y Fract
0.1	0.628	0.635	0.637			
0.2	0.615	0.630	0.635			
0.3	0.601	0.625	0.632			
0.4	0.586	0.620	0.628			
0.5	0.570	0.613	0.623			
0.6	0.554	0.605	0.615			
0.7	0.537	0.596	0.606			
0.8	0.521	0.586	0.595			
0.9	0.505	0.574	0.583			
1	0.489	0.562	0.570	1.34E-1	6.14E-2	5.38E-2
2	0.366	0.419	0.410	1.11E-1	1.30E-1	1.45E-1 f
3	0.298	0.306	0.287	5.88E-2	1.02E-1	1.13E-1 f
4	0.260	0.240	0.218	3.14E-2	5.83E-2	6.19E-2 f
5	0.234	0.204	0.182	1.94E-2	3.05E-2	3.04E-2 f
6	0.214	0.183	0.163	1.40E-2	1.62E-2	1.47E-2
7	0.198	0.169	0.152	1.12E-2	9.26E-3	7.29E-3
8	0.183	0.159	0.144	9.44E-3	5.91E-3	3.88E-3
9	0.171	0.151	0.138	8.15E-3	4.23E-3	2.28E-3
10	0.159	0.144	0.133	7.11E-3	3.33E-3	1.49E-3
20	9.08E-2	9.53E-2	9.88E-2	2.10E-3	1.31E-3	3.19E-4
30	5.98E-2	6.56E-2	7.51E-2	7.77E-4	7.57E-4	1.52E-4
40	4.20E-2	4.58E-2	5.74E-2	3.79E-4	4.90E-4	9.29E-5
50	3.02E-2	3.21E-2	4.40E-2	2.28E-4	3.31E-4	6.45E-5
60	2.19E-2	2.26E-2	3.38E-2	1.53E-4	2.29E-4	4.73E-5
70	1.59E-2	1.59E-2	2.60E-2	1.07E-4	1.59E-4	3.53E-5
80	1.16E-2	1.12E-2	1.99E-2	7.57E-5	1.10E-4	2.65E-5
90	8.46E-3	7.94E-3	1.53E-2	5.40E-5	7.67E-5	2.00E-5
100	6.19E-3	5.62E-3	1.18E-2	3.86E-5	5.35E-5	1.51E-5
200	2.93E-4	1.95E-4	8.57E-4	1.38E-6	1.50E-6	9.60E-7
300	1.62E-5	8.29E-6	6.31E-5	5.18E-8	4.53E-8	6.53E-8
400	1.02E-6	4.38E-7	4.67E-6			

DAC (Y) = $8\text{E-}6$
 DAC-hr = 9600 nCi
 DAC-hr = 2.4 mrem (ALI)
 DAC-hr = 3.16 mrem (h)

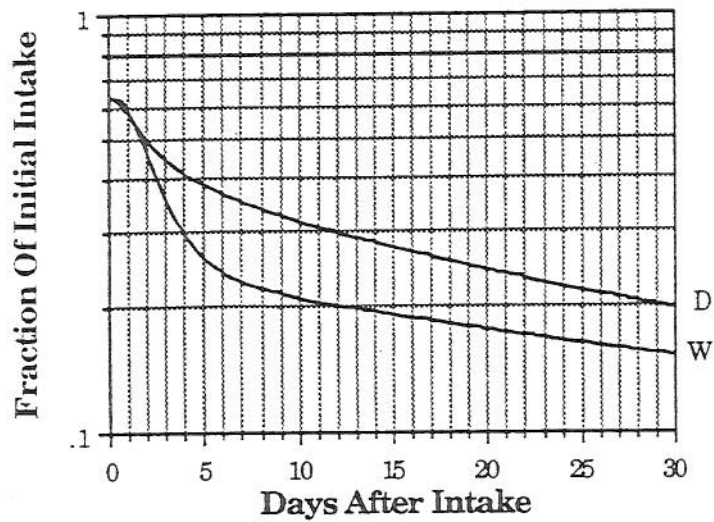
"Properly Based ALI/DAC"
 ALI = 15000 μCi
 DAC (Y) = $6.3\text{E-}6$
 DAC-hr = 7560 nCi
 DAC-hr = 2.52 mrem (ALI)
 DAC-hr = 2.50 mrem (h)

Misc.
 Data
 T 1/2 = 27.7 d
 β 315
 γ 320 9.80%
 Γ = 16
 mR/hr per Ci at 1 meter

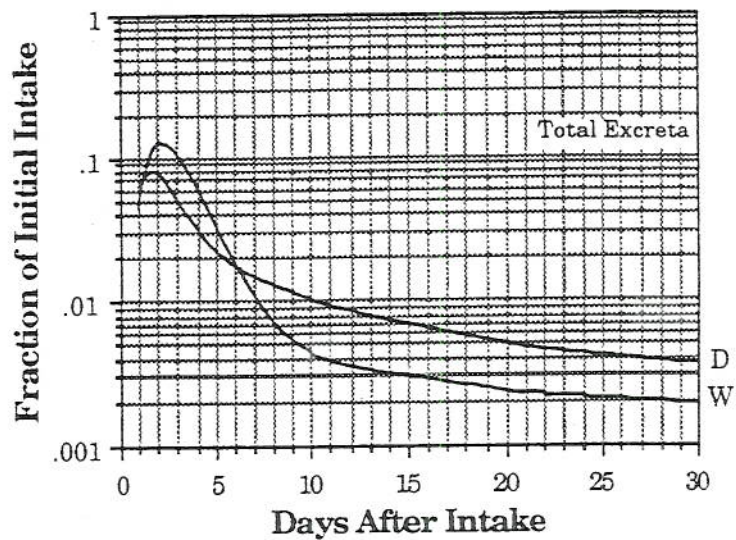
Ingestion Model
f1 is either 0.01 or 0.1 However, h eff is the same for both
h eff = $3.98\text{E-}11$ Sv/Bq 0.15 mrem/ μCi
45% of the Y Class inhalation dose

Note: f - fecal excretion >90%

Mn-54 Retention Fractions



Mn-54 Excretion Fractions



Notes

Mn-54

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
W	0.1	7.09E-10	8.59E-10	6.66E-09	1.10E-09	1.25E-09	7.40E-10	1.72E-09
CDE per μCi Inhaled =		2.6	3.2	24.6	4.1	4.6	2.7	6.4
CEDE per μCi Inhaled =		0.7	0.5	3.0	0.5	0.1	0.1	1.9

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule		
	1.81E-09	745	2029	h eff	(S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =	6.7	745	2029 (Lung)	6.3	790	800	2000

Whole Body Retention			Total Excreta	
Days	D Fract	W Fract	D Fract	W Fract
0.1	0.638	0.639		
0.2	0.635	0.638		
0.3	0.631	0.637		
0.4	0.626	0.634		
0.5	0.619	0.631		
0.6	0.612	0.626		
0.7	0.604	0.620		
0.8	0.595	0.613		
0.9	0.586	0.604		
1	0.577	0.593	6.10E-2	4.42E-2
2	0.496	0.465	7.98E-2	1.28E-1 f
3	0.444	0.357	5.07E-2	1.07E-1 f
4	0.411	0.293	3.20E-2	6.33E-2 f
5	0.388	0.258	2.26E-2	3.42E-2
6	0.369	0.238	1.77E-2	1.88E-2
7	0.353	0.227	1.49E-2	1.11E-2
8	0.339	0.219	1.30E-2	7.30E-3
9	0.327	0.213	1.16E-2	5.39E-3
10	0.316	0.208	1.03E-2	4.36E-3
20	0.242	0.175	5.06E-3	2.35E-3
30	0.196	0.151	3.56E-3	1.90E-3
40	0.160	0.130	2.83E-3	1.61E-3
50	0.132	0.113	2.31E-3	1.39E-3
60	0.108	0.098	1.89E-3	1.20E-3
70	0.089	0.085	1.56E-3	1.04E-3
80	0.073	0.073	1.28E-3	9.00E-4
90	0.060	0.063	1.05E-3	7.79E-4
100	0.050	0.055	8.66E-4	6.74E-4
200	7.02E-3	1.29E-2	1.23E-4	1.60E-4
300	9.95E-4	3.01E-3	1.74E-5	3.75E-5
400	1.41E-4	6.96E-4	2.46E-6	8.75E-6

DAC (W) = $3\text{E-}7$
 DAC-hr = 360 nCi
 DAC-hr = 2.25 mrem (ALI)
 DAC-hr = 2.41 mrem (h)

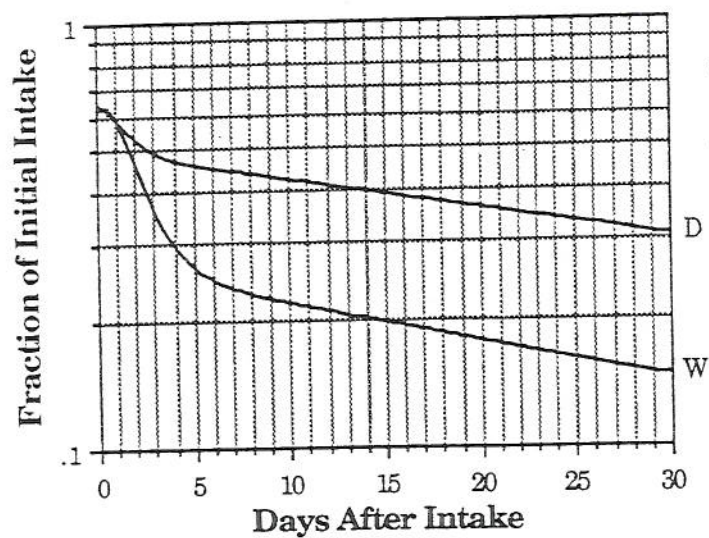
"Properly Based ALI/DAC"
 ALI = 750 μCi
 DAC (W) = $3.1\text{E-}07$
 DAC-hr = 372 nCi
 DAC-hr = 2.48 mrem (ALI)
 DAC-hr = 2.49 mrem (h)

Misc.
 Data
 T 1/2 = 312 d
 EC
 γ 834.8 100%
 Γ = 470
 mR/hr per Ci at 1 meter

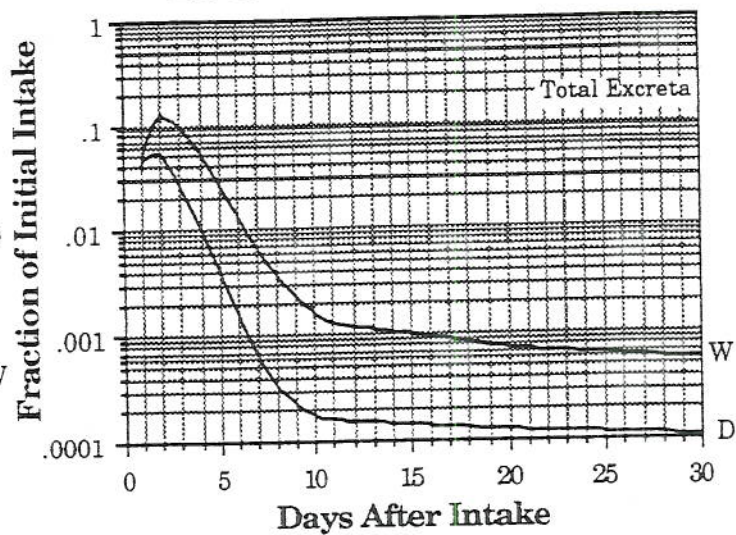
Ingestion Model
f1 is 0.1 for all forms
h eff = $7.48\text{E-}10$ Sv/Bq 2.77 mrem/ μCi
41% of the W Class inhalation dose

Note: f - fecal excretion >90%

Fe-59 Retention Fractions



Fe-59 Excretion Fractions



Notes

Fe 59

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
D	0.1	3.32E-09	3.01E-09	3.50E-09	3.18E-09	2.91E-09	2.95E-09	5.81E-09
CDE per μCi Inhaled =		12.3	11.1	13.0	11.8	10.8	10.9	21.5
CEDE per μCi Inhaled =		3.1	1.7	1.6	1.4	0.3	0.3	6.4

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule		
	4.00E-09	338	2815	h eff	(S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =	14.8	338	2815	14.8	338	300	3000
			(LLI Wall)				

Whole Body Retention			Total Excreta		DAC (D) = 1E-7		
					DAC-hr = 120 nCi		
					DAC-hr = 2.00 mrem (ALI)		
					DAC-hr = 1.78 mrem (h)		
Days	Fract	Fract	Fract	Fract			
0.1	0.638	0.638					
0.2	0.636	0.637					
0.3	0.634	0.635					
0.4	0.629	0.633					
0.5	0.624	0.629					
0.6	0.618	0.624					
0.7	0.611	0.618					
0.8	0.604	0.610					
0.9	0.597	0.601					
1	0.589	0.591	f	4.02E-2	3.87E-2	f	
2	0.526	0.463	f	5.44E-2	1.19E-1	f	
3	0.491	0.358	f	2.69E-2	9.76E-2	f	
4	0.472	0.297	f	1.10E-2	5.56E-2	f	
5	0.461	0.264	f	4.24E-3	2.81E-2	f	
6	0.452	0.246		1.66E-3	1.38E-2	f	
7	0.444	0.235		7.03E-4	7.00E-3	f	
8	0.437	0.228		3.50E-4	3.80E-3	f	
9	0.430	0.222		2.21E-4	2.30E-3	f	
10	0.423	0.217		1.73E-4	1.58E-3	f	
20	0.361	0.177		1.25E-4	7.46E-4	f	
30	0.308	0.146		1.07E-4	5.61E-4	f	
40	0.263	0.120		9.10E-5	4.22E-4	f	
50	0.224	9.95E-2		7.76E-5	3.18E-4	f	
60	0.191	8.26E-2		6.62E-5	2.39E-4	f	
70	0.163	6.88E-2		5.64E-5	1.81E-4	f	
80	0.139	5.74E-2		4.81E-5	1.36E-4		
90	0.118	4.80E-2		4.11E-5	1.04E-4		
100	0.101	4.03E-2		3.50E-5	7.88E-5		
200	2.06E-2	7.49E-3		7.13E-6	6.00E-6		
300	4.19E-3	1.49E-3		1.45E-6	6.94E-7		
400	8.54E-4	3.01E-4		2.96E-7	1.04E-7		

"Properly Based ALI/DAC"
 ALI = 340 μCi
 DAC (D) = 1.4E-07
 DAC-hr = 168 nCi
 DAC-hr = 2.47 mrem (ALI)
 DAC-hr = 2.49 mrem (h)

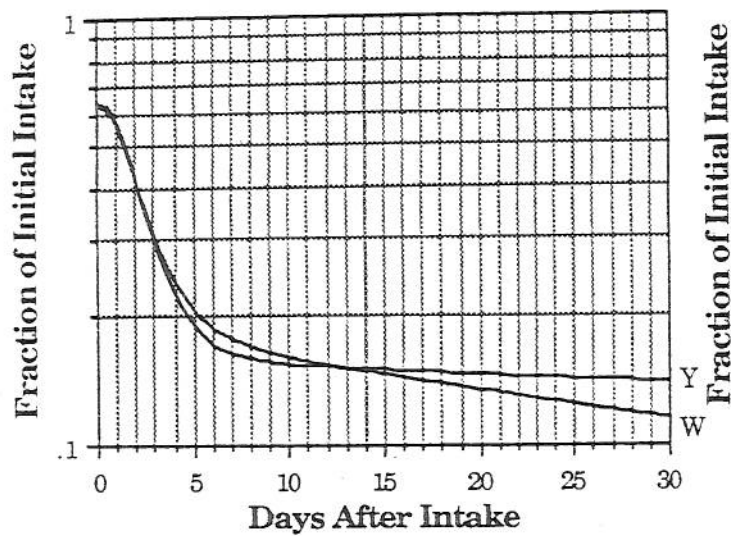
Misc.
 Data
 T 1/2 = 45.1 d
 β 475
 γ 192 3.1%
 1099.2 56.5%
 1291.6 43.2%

Γ = 640
 mR/hr per Ci at 1 meter

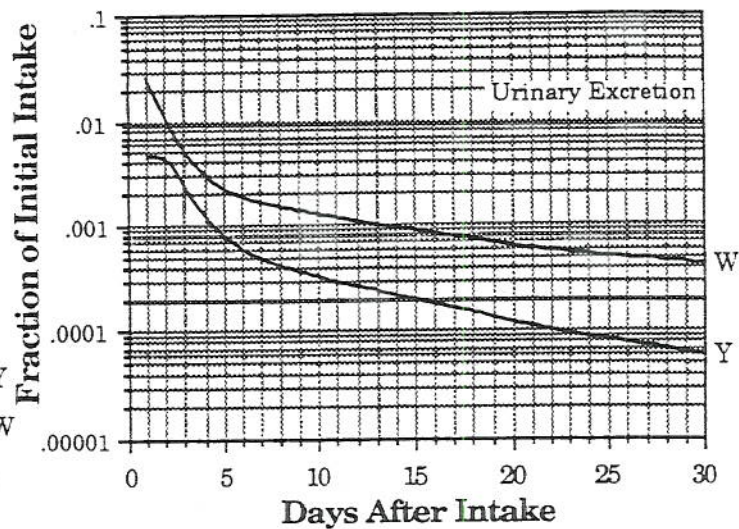
Ingestion Model
f1 is 0.1 for all forms
h eff = 1.81E-9 Sv/Bq 6.7 mrem/ μCi
45% of the D Class inhalation dose

Note: f - fecal excretion >90%

Co-57 Retention Fractions



Co-57 Excretion Fractions



Notes

Co-57

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
Y	0.05	1.24E-10	3.75E-10	1.69E-08	5.88E-10	4.52E-10	2.71E-10	8.22E-10
CDE per μCi Inhaled =		0.5	1.4	62.5	2.2	1.7	1.0	3.0
CEDE per μCi Inhaled =		0.1	0.2	7.5	0.3	0.1	0.0	0.9

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule		
	2.45E-09	551	800	h eff	(S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =	9.1	551	800 (Lung)	7.5	666	700	800

Whole Body Retention			Urinary Excretion	
	W	Y	W	Y
Days	Fract	Fract	Fract	Fract
0.1	0.635	0.639		
0.2	0.630	0.638		
0.3	0.626	0.637		
0.4	0.620	0.634		
0.5	0.613	0.629		
0.6	0.606	0.624		
0.7	0.598	0.616		
0.8	0.588	0.606		
0.9	0.577	0.595		
1	0.565	0.582	2.58E-2	4.64E-3
2	0.421	0.422	1.09E-2	4.63E-3
3	0.306	0.295	5.10E-3	2.38E-3
4	0.240	0.224	3.02E-3	1.27E-3
5	0.204	0.188	2.23E-3	8.08E-4
6	0.185	0.170	1.87E-3	6.00E-4
7	0.175	0.162	1.65E-3	4.89E-4
8	0.168	0.158	1.49E-3	4.18E-4
9	0.163	0.155	1.35E-3	3.66E-4
10	0.159	0.153	1.25E-3	3.26E-4
20	0.134	0.145	6.33E-4	1.23E-4
30	0.115	0.139	4.19E-4	6.02E-5
40	1.00E-1	0.134	3.29E-4	3.94E-5
50	8.76E-2	0.129	2.79E-4	3.16E-5
60	7.68E-2	0.124	2.49E-4	2.85E-5
70	6.74E-2	0.120	2.20E-4	2.61E-5
80	5.94E-2	0.116	1.95E-4	2.43E-5
90	5.24E-2	0.111	1.72E-4	2.27E-5
100	4.63E-2	0.108	1.52E-4	2.14E-5
200	1.57E-2	7.48E-2	5.70E-5	1.66E-5
300	7.22E-3	5.23E-2	1.80E-5	1.16E-5
400	4.26E-3	3.69E-2	6.76E-6	8.52E-6

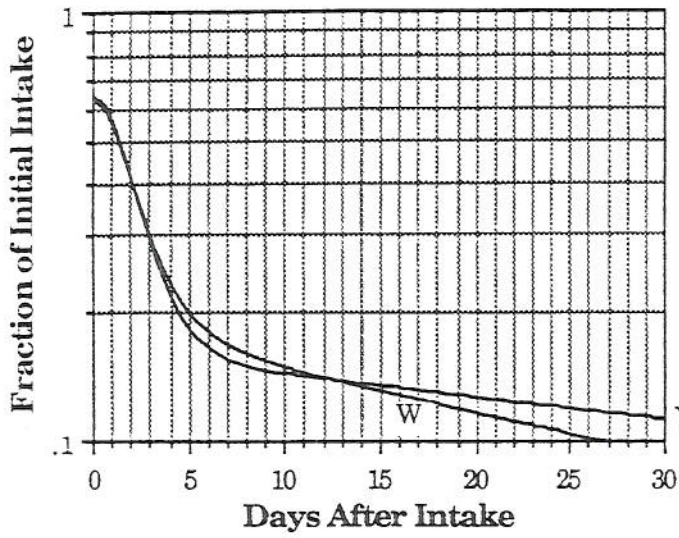
DAC (Y) = $3\text{E-}7$
 DAC-hr = 360 nCi
 DAC-hr = 2.57 mrem (ALI)
 DAC-hr = 3.27 mrem (h)

"Properly Based ALI/DAC"
 ALI = 550 μCi
 DAC (Y) = $2.3\text{E-}07$
 DAC-hr = 276 nCi
 DAC-hr = 2.51 mrem (ALI)
 DAC-hr = 2.51 mrem (h)

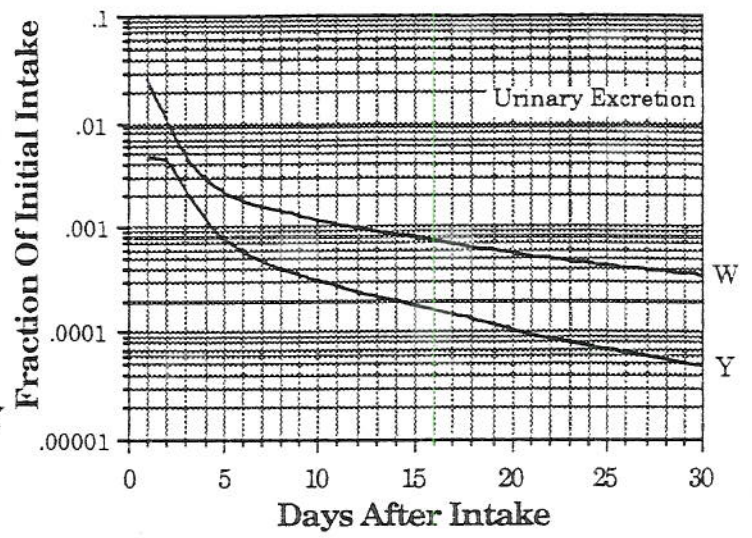
	Misc. Data	
T 1/2 =	270 d	
β	129	
γ	14.4	9.5%
	122.1	85.6%
	136.4	10.6%
Γ =	65	
mR/hr per Ci at 1 meter		

Ingestion Model
f1 is 0.05 for oxides, hydroxides f1 is 0.3 for others
h (.05) = 0.74 mrem/ μCi h (.3) = 1.18 mrem/ μCi
8% & 13% of the Y Class inhalation dose

Co-58 Retention Fractions



Co-58 Excretion Fractions



Notes

Co-58

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
Y	0.05	6.17E-10	9.37E-10	1.60E-08	9.23E-10	6.93E-10	8.72E-10	1.89E-09
CDE per μCi Inhaled =		2.3	3.5	59.2	3.4	2.6	3.2	7.0
CEDE per μCi Inhaled =		0.6	0.5	7.1	0.4	0.1	0.1	2.1

*Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule		
	2.94E-09	460	845	h eff	(S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =	10.9	460	845 (Lung)	7.1	704	700	800

Whole Body Retention			Urinary Excretion	
	W	Y	W	Y
Days	Fract	Fract	Fract	Fract
0.1	0.634	0.638		
0.2	0.629	0.637		
0.3	0.624	0.635		
0.4	0.618	0.632		
0.5	0.611	0.627		
0.6	0.604	0.621		
0.7	0.595	0.612		
0.8	0.584	0.602		
0.9	0.573	0.591		
1	0.560	0.577	2.56E-2	4.60E-3
2	0.415	0.416	1.08E-2	4.56E-3
3	0.300	0.288	4.99E-3	2.33E-3
4	0.233	0.217	2.94E-3	1.23E-3
5	0.197	0.181	2.16E-3	7.79E-4
6	0.178	0.164	1.79E-3	5.74E-4
7	0.166	0.154	1.56E-3	4.65E-4
8	0.159	0.149	1.40E-3	3.95E-4
9	0.153	0.145	1.27E-3	3.44E-4
10	0.148	0.143	1.15E-3	3.03E-4
20	0.116	0.126	5.47E-4	1.06E-4
30	9.27E-2	0.112	3.37E-4	4.84E-5
40	7.51E-2	0.100	2.46E-4	2.95E-5
50	6.10E-2	9.00E-2	1.94E-4	2.20E-5
60	4.98E-2	8.07E-2	1.58E-4	1.80E-5
70	4.07E-2	7.23E-2	1.29E-4	1.54E-5
80	3.33E-2	6.49E-2	1.06E-4	1.33E-5
90	2.73E-2	5.82E-2	8.77E-5	1.16E-5
100	2.25E-2	5.22E-2	7.23E-5	1.01E-5
200	3.70E-3	1.77E-2	1.04E-5	3.02E-6
300	8.29E-4	6.02E-3	1.60E-6	1.03E-6
400	2.37E-4	2.05E-3	2.93E-7	3.66E-7

DAC (Y) = $3\text{E-}7$
 DAC-hr = 360 nCi
 DAC-hr = 2.57 mrem (ALI)
 DAC-hr = 3.92 mrem (h)

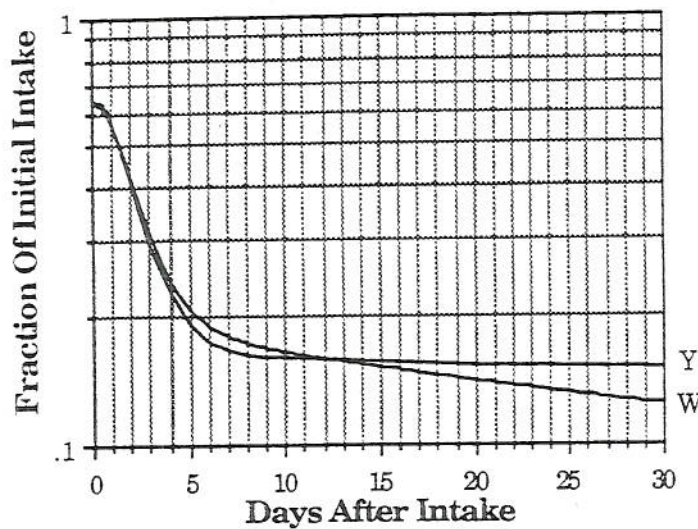
"Properly Based ALI/DAC"

ALI = 460 μCi
 DAC (Y) = $1.9\text{E-}07$
 DAC-hr = 230 nCi
 DAC-hr = 2.50 mrem (ALI)
 DAC-hr = 2.51 mrem (h)

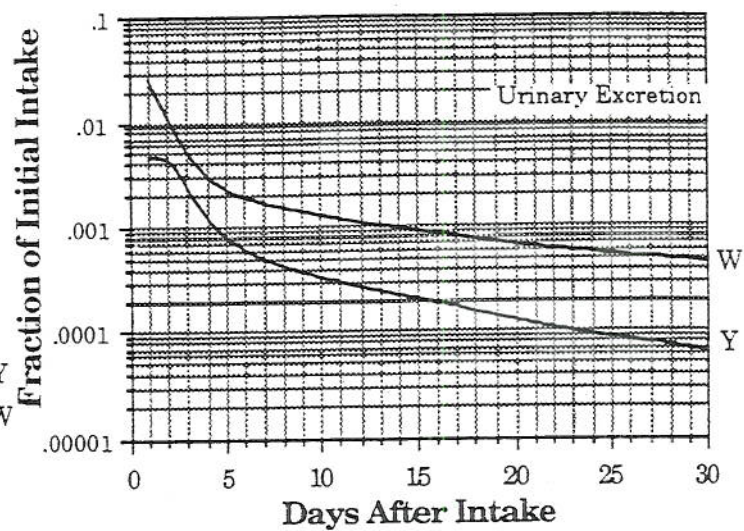
Misc Data		
T 1/2 =	70.8 d	
EC		85%
β^+	474	15%
γ	511	30%
	810	100%
	864	0.69%
	1674.7	0.52%
Γ =	550	
mR/hr per Ci at 1 meter		

Ingestion Model	
f1 is 0.05 for oxides, hydroxides	
f1 is 0.3 for others	
h (.05) = 2.99 mrem/ μCi	
h (.3) = 3.58 mrem/ μCi	
27% & 33% of the Y Class inhalation dose	

Co-60 Retention Fractions



Co-60 Excretion Fractions



Notes

Co-60

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
Y	0.05	4.76E-09	1.84E-08	3.45E-07	1.72E-08	1.35E-08	1.62E-08	3.60E-08
CDE per μCi Inhaled =		17.6	68.1	1276.5	63.6	50.0	59.9	133.2
CEDE per μCi Inhaled =		4.4	10.2	153.2	7.6	1.5	1.8	40.0

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule			
	5.91E-08	23	39	h eff	(S)ALI	(S)ALI	(N)ALI	
CEDE per μCi Inhaled =	218.7	23	39 (Lung)	153.2	33	30	40	

Whole Body Retention			Urinary Excretion	
	W	Y	W	Y
Days	Fract	Fract	Fract	Fract
0.1	0.635	0.639		
0.2	0.630	0.638		
0.3	0.626	0.637		
0.4	0.620	0.634		
0.5	0.614	0.630		
0.6	0.607	0.624		
0.7	0.599	0.617		
0.8	0.589	0.607		
0.9	0.578	0.596		
1	0.566	0.583	2.59E-2	4.64E-3
2	0.423	0.424	1.10E-2	4.64E-3
3	0.308	0.297	5.13E-3	2.40E-3
4	0.242	0.226	3.05E-3	1.28E-3
5	0.206	0.190	2.26E-3	8.17E-4
6	0.188	0.173	1.90E-3	6.08E-4
7	0.177	0.165	1.67E-3	4.97E-4
8	0.171	0.161	1.51E-3	4.26E-4
9	0.166	0.158	1.38E-3	3.74E-4
10	0.163	0.157	1.27E-3	3.33E-4
20	0.140	0.152	6.62E-4	1.28E-4
30	0.123	0.149	4.48E-4	6.43E-5
40	0.109	0.146	3.59E-4	4.30E-5
50	0.098	0.144	3.11E-4	3.52E-5
60	0.088	0.142	2.78E-4	3.17E-5
70	0.079	0.140	2.50E-4	2.97E-5
80	0.071	0.138	2.26E-4	2.83E-5
90	0.064	0.136	2.05E-4	2.70E-5
100	0.058	0.134	1.85E-4	2.60E-5
200	2.44E-2	1.17E-1	6.86E-5	1.99E-5
300	1.40E-2	1.02E-1	2.70E-5	1.74E-5
400	1.03E-2	8.92E-2	1.27E-5	1.59E-5

DAC (Y) = $1\text{E}-8$
 DAC-hr = 12 nCi
 DAC-hr = 2.0 mrem (ALI)
 DAC-hr = 2.62 mrem (h)

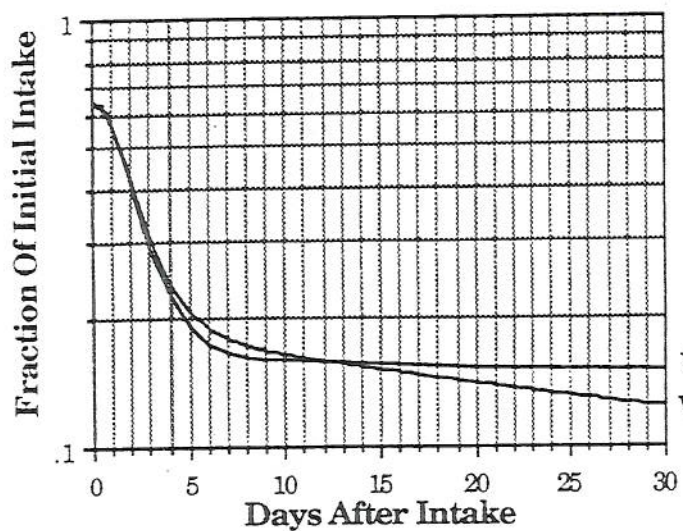
"Properly Based ALI/DAC"

ALI = 23 μCi
 DAC (Y) = $9.6\text{E}-9$
 DAC-hr = 12 nCi
 DAC-hr = 2.50 mrem (ALI)
 DAC-hr = 2.52 mrem (h)

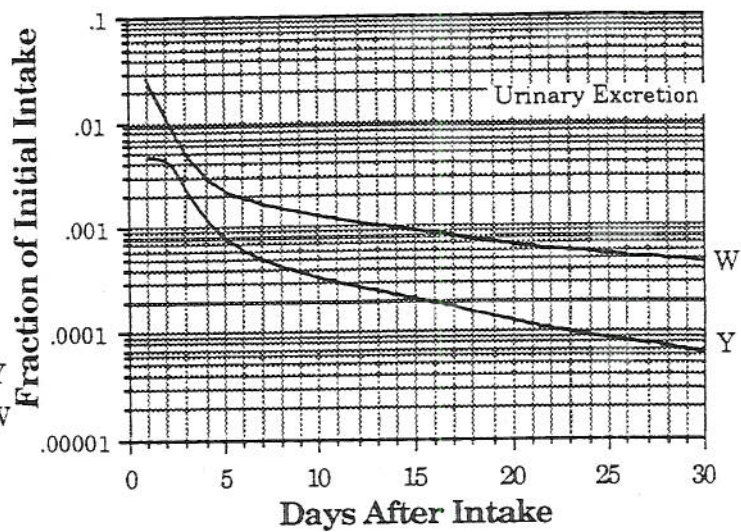
Misc
 Data
 T 1/2 = 5.27 y
 β^- 314
 γ 1173.2 100%
 1332.5 100%
 Γ = 1320
 mR/hr per Ci at 1 meter

Ingestion Model
f1 is 0.05 for oxides, hydroxides f1 is 0.3 for others
h (.05) = 10.25 mrem/ μCi h (.3) = 26.94 mrem/ μCi
5% & 12% of the Y Class inhalation dose

Co-60 Retention Fractions



Co-60 Excretion Fractions



Notes

Co-60

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
W	0.05	4.05E-09	4.16E-09	3.57E-08	4.25E-09	3.54E-09	3.72E-09	7.65E-09
CDE per μCi Inhaled =		15.0	15.4	132.1	15.7	13.1	13.8	28.3
CEDE per μCi Inhaled =		3.7	2.3	15.9	1.9	0.4	0.4	8.5

* Evaluation of W Class for Co-60

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule		
CEDE per μCi Inhaled =	8.94E-09	151	379	h eff	(S)ALI	(S)ALI	(N)ALI
	33.1	151	379 (Lung)	29.4	170	200	400

Whole Body Retention			Urinary Excretion	
	W	Y	W	Y
Days	Fract	Fract	Fract	Fract
0.1	0.635	0.639		
0.2	0.630	0.638		
0.3	0.626	0.637		
0.4	0.620	0.634		
0.5	0.614	0.630		
0.6	0.607	0.624		
0.7	0.599	0.617		
0.8	0.589	0.607		
0.9	0.578	0.596		
1	0.566	0.583	2.59E-2	4.64E-3
2	0.423	0.424	1.10E-2	4.64E-3
3	0.308	0.297	5.13E-3	2.40E-3
4	0.242	0.226	3.05E-3	1.28E-3
5	0.206	0.190	2.26E-3	8.17E-4
6	0.188	0.173	1.90E-3	6.08E-4
7	0.177	0.165	1.67E-3	4.97E-4
8	0.171	0.161	1.51E-3	4.26E-4
9	0.166	0.158	1.38E-3	3.74E-4
10	0.163	0.157	1.27E-3	3.33E-4
20	0.140	0.152	6.62E-4	1.28E-4
30	0.123	0.149	4.48E-4	6.43E-5
40	0.109	0.146	3.59E-4	4.30E-5
50	0.098	0.144	3.11E-4	3.52E-5
60	0.088	0.142	2.78E-4	3.17E-5
70	0.079	0.140	2.50E-4	2.97E-5
80	0.071	0.138	2.26E-4	2.83E-5
90	0.064	0.136	2.05E-4	2.70E-5
100	0.058	0.134	1.85E-4	2.60E-5
200	2.44E-2	1.17E-1	6.86E-5	1.99E-5
300	1.40E-2	1.02E-1	2.70E-5	1.74E-5
400	1.03E-2	8.92E-2	1.27E-5	1.59E-5

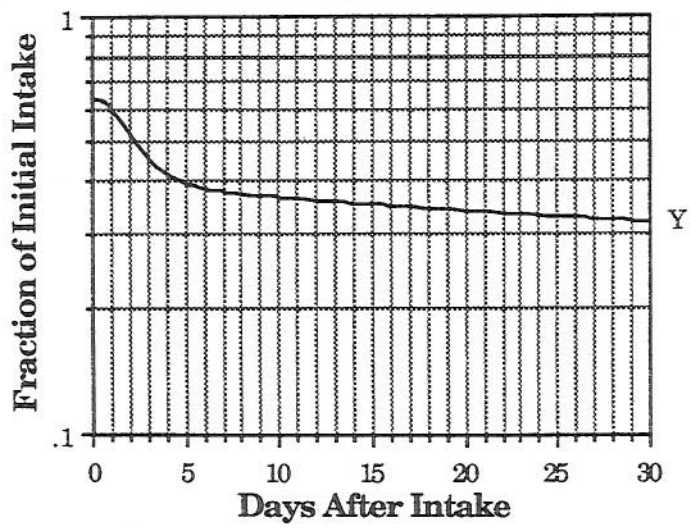
DAC (W) = $7\text{E}-8$
 DAC-hr = 84 nCi
 DAC-hr = 2.1 mrem (ALI)
 DAC-hr = 2.78 mrem (h)

"Properly Based ALI/DAC"
 ALI = $150\ \mu\text{Ci}$
 DAC (W) = $6.3\text{E}-8$
 DAC-hr = 76 nCi
 DAC-hr = 2.52 mrem (ALI)
 DAC-hr = 2.53 mrem (h)

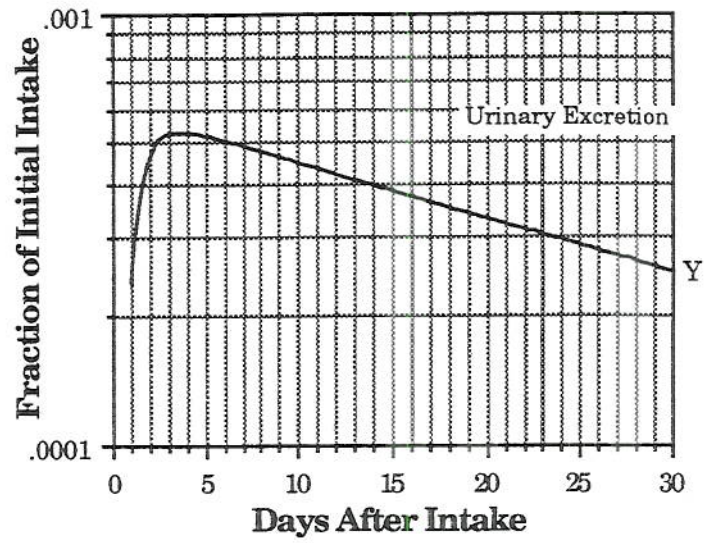
Misc
 Data
 T 1/2 = 5.27 y
 β^- 314
 γ 1173.2 100%
 1332.5 100%
 Γ = 1320
 mR/hr per Ci at 1 meter

Ingestion Model
f1 is 0.05 for oxides, hydroxides f1 is 0.3 for others
h (.05) = 10.25 mrem/ μCi h (.3) = 26.94 mrem/ μCi
31% & 81% of the W Class inhalation dose

Zn-65 Retention Fraction



Zn-65 Excretion Fraction



Notes

Zn-65

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
Y	0.5	2.03E-09	3.08E-09	2.10E-08	3.62E-09	3.36E-09	3.02E-09	4.66E-09
CDE per μCi Inhaled =		7.5	11.4	77.7	13.4	12.4	11.2	17.3
CEDE per μCi Inhaled =		1.9	1.7	9.3	1.6	0.4	0.3	5.2

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule		
	5.51E-09	245	644	h eff	(S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =	20.4	245	644 (Lung)	17.5	285	300	600

Days	Whole Body Retention	Urinary Excretion
	Y Fract	Y Fract
0.1	0.639	
0.2	0.639	
0.3	0.637	
0.4	0.636	
0.5	0.633	
0.6	0.630	
0.7	0.625	
0.8	0.620	
0.9	0.612	
1	0.605	2.36E-4
2	0.520	4.79E-4
3	0.454	5.25E-4
4	0.416	5.28E-4
5	0.396	5.20E-4
6	0.385	5.06E-4
7	0.378	4.93E-4
8	0.373	4.78E-4
9	0.369	4.64E-4
10	0.366	4.49E-4
20	0.340	3.32E-4
30	0.319	2.50E-4
40	0.301	1.92E-4
50	0.285	1.52E-4
60	0.272	1.23E-4
70	0.259	1.03E-4
80	0.247	8.84E-5
90	0.237	7.74E-5
100	0.227	6.95E-5
200	1.50E-1	3.78E-5
300	1.01E-1	2.47E-5
400	6.70E-2	1.63E-5

DAC (Y) = $1\text{E-}7$
 DAC-hr = 120 nCi
 DAC-hr = 2.0 mrem (ALI)
 DAC-hr = 2.45 mrem (h)

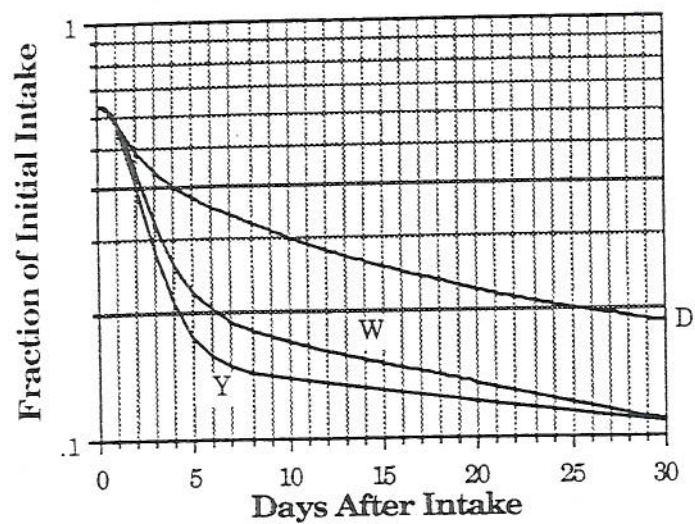
"Properly Based ALI/DAC"

ALI = 250 μCi
 DAC (Y) = $1.0\text{E-}07$
 DAC-hr = 120 nCi
 DAC-hr = 2.40 mrem (ALI)
 DAC-hr = 2.45 mrem (h)

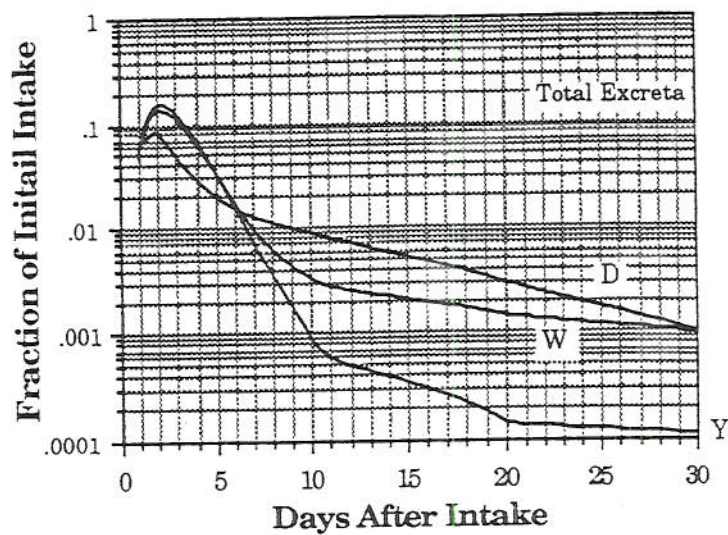
Misc
 Data
 T 1/2 = 243.8 d
 β^+ 327
 γ 511 2.8%
 1115.5 50.8%
 Γ = 270
 mR/hr per Ci at 1 meter

Ingestion Model
f1 is 0.5 for all forms
h eff = $3.9\text{E-}9$ Sv/Bq 14.4 mrem/ μCi
70% of the Y Class inhalation dose

Zr-95 Retention Fractions



Zr-95 Excretion Fractions



Notes

Zr-95

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
D	2E-3	1.88E-09	1.91E-09	2.17E-09	1.30E-08	1.03E-07	1.44E-09	2.28E-09
CDE per μCi Inhaled =		7.0	7.1	8.0	48.1	381.1	5.3	8.4
CEDE per μCi Inhaled =		1.7	1.1	1.0	5.8	11.4	0.2	2.5

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule		
	6.39E-09	211	131	h eff	(S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =	23.7	211	131	18.9	264	300	100

B. Surf.

Whole Body Retention			Total Excreta			
Days	D	W	Y	D	W	Y
	Fract	Fract	Fract	Fract	Fract	Fract
0.1	0.637	0.638	0.638			
0.2	0.635	0.637	0.638			
0.3	0.631	0.635	0.636			
0.4	0.625	0.632	0.633			
0.5	0.619	0.629	0.629			
0.6	0.611	0.624	0.623			
0.7	0.601	0.616	0.615			
0.8	0.593	0.608	0.605			
0.9	0.583	0.598	0.593			
1	0.574	0.588	0.581	5.89E-2	4.49E-2	f 5.16E-2
2	0.487	0.445	0.417	7.96E-2	1.35E-1	f 1.57E-1 f
3	0.434	0.328	0.286	4.87E-2	1.13E-1	f 1.27E-1 f
4	0.401	0.259	0.213	2.91E-2	6.60E-2	f 7.06E-2 f
5	0.376	0.221	0.175	1.98E-2	3.46E-2	f 3.46E-2 f
6	0.356	0.201	0.158	1.54E-2	1.81E-2	1.62E-2 f
7	0.341	0.188	0.148	1.28E-2	1.00E-2	7.65E-3 f
8	0.325	0.180	0.143	1.12E-2	6.12E-3	3.67E-3 f
9	0.313	0.174	0.14	9.90E-3	4.22E-3	1.84E-3 f
10	0.300	0.169	0.138	8.81E-3	3.24E-3	8.93E-4 f
20	0.222	0.134	0.121	2.94E-3	1.45E-3	1.45E-4
30	0.184	0.109	0.107	9.95E-4	9.73E-4	1.13E-4
40	0.159	0.091	0.096	3.40E-4	7.12E-4	9.46E-5
50	0.141	0.076	0.085	1.21E-4	5.40E-4	8.21E-5
60	0.127	0.063	0.076	4.73E-5	4.20E-4	7.23E-5
70	0.113	0.054	0.067	2.19E-5	3.29E-4	6.40E-5
80	0.102	0.045	0.06	1.29E-5	2.59E-4	5.67E-5
90	0.091	0.039	0.054	9.27E-6	2.05E-4	5.02E-5
100	0.082	0.033	0.048	7.54E-6	1.61E-4	4.44E-5
200	2.80E-2	8.00E-3	0.015	2.43E-6	1.54E-5	1.36E-5
300	1.00E-2	3.00E-3	0.005	8.28E-7	1.57E-6	4.12E-6
400	3.00E-3	1.00E-3	0.001	2.82E-7	1.97E-7	1.25E-6

DAC (D) = 5E-8
 DAC-hr = 60 nCi
 DAC-hr = 1.0 mrem (ALI)
 DAC-hr = 1.42 mrem (h)

"Recommended ALI/DAC"

(N)ALI = 130 μCi

(S)ALI = 210 μCi

DAC (Y) = 8.8E-08 *

DAC-hr = 106 nCi

DAC-hr = 2.52 mrem (ALI)

DAC-hr = 2.51 mrem (h)

* Zr-95 limited to 1200 DAC-hrs/yr
 or 1000 DAC-hrs/yr to be conservative

Misc

Data

T 1/2 = 64.4 d

β^- 396

γ 724.2 44.2%

756.7 54.8%

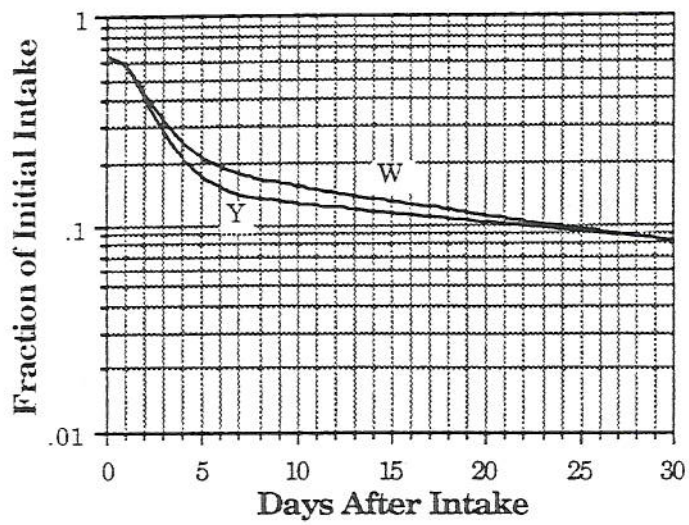
Γ = 410

mR/hr per Ci at 1 meter

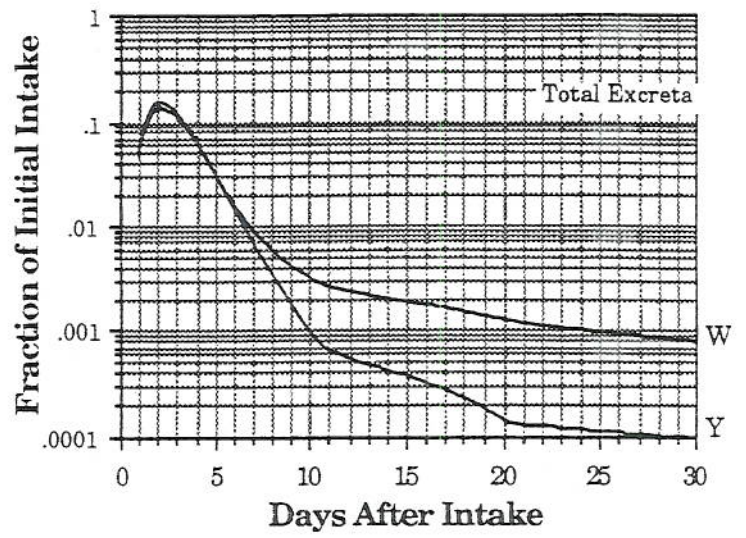
Ingestion Model
f1 is 0.002 for all forms
h eff = 1.02E-9 Sv/Bq 3.77 mrem/ μCi
16% of the D Class inhalation dose

Note: f - fecal excretion >90%

Nb-95 Retention Fractions



Nb-95 Excretion Fractions



Notes

Nb-95

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
Y	0.01	4.32E-10	4.07E-10	8.32E-09	4.42E-10	5.13E-10	3.58E-10	1.07E-09
CDE per μCi Inhaled =		1.6	1.5	30.8	1.6	1.9	1.3	4.0
CEDE per μCi Inhaled =		0.40	0.23	3.69	0.20	0.06	0.04	1.19

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule		
	1.57E-09	862	1624	h eff	(S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =	5.8	862	1624 (Lung)	4.5	1107	1000	2000

Whole Body Retention			Total Excreta		DAC (Y) = 5E-7		
					DAC-hr = 600 nCi		
					DAC-hr = 3.0 mrem (ALI)		
					DAC-hr = 3.48 mrem (h)		
Days	W	Y	W	Y			
	Fract	Fract	Fract	Fract			
0.1	0.637	0.638					
0.2	0.636	0.636					
0.3	0.633	0.634					
0.4	0.630	0.631					
0.5	0.626	0.626					
0.6	0.620	0.620					
0.7	0.612	0.611					
0.8	0.603	0.601					
0.9	0.593	0.589					
1	0.582	0.576	f	4.51E-2	5.10E-2	f	
2	0.438	0.411	f	1.33E-1	1.53E-1	f	
3	0.319	0.280	f	1.10E-1	1.22E-1	f	
4	0.249	0.207	f	6.37E-2	6.76E-2	f	
5	0.211	0.170	f	3.32E-2	3.29E-2	f	
6	0.190	0.152		1.73E-2	1.55E-2	f	
7	0.177	0.141		9.60E-3	7.24E-3	f	
8	0.167	0.135		5.91E-3	3.49E-3	f	
9	0.160	0.131		4.08E-3	1.77E-3		
10	0.154	0.127		3.13E-3	9.66E-4		
20	0.110	0.102		1.27E-3	1.44E-4		
30	0.082	0.083		7.90E-4	9.59E-5		
40	0.061	0.067		5.44E-4	7.23E-5		
50	0.046	0.055		3.89E-4	5.73E-5		
60	0.035	0.044		2.84E-4	4.61E-5		
70	0.026	0.036		2.08E-4	3.73E-5		
80	0.020	0.029		1.53E-4	3.02E-5		
90	0.015	0.024		1.13E-4	2.44E-5		
100	0.012	0.019		8.37E-5	1.98E-5		
200	8.79E-4	2.43E-3		4.65E-6	2.45E-6		
300	7.66E-5	3.07E-4		3.25E-8	3.02E-7		
400	7.17E-6	3.87E-5		2.50E-8			

"Properly Based ALI/DAC"

ALI = 860 μCi

DAC (Y) = 3.6E-07

DAC-hr = 432 nCi

DAC-hr = 2.51 mrem (ALI)

DAC-hr = 2.51 mrem (h)

Misc

Data

T 1/2 = 35.2 d

β^- 160

γ 765.8 99%

Γ = 420

mR/hr per Ci at 1 meter

Ingestion Model

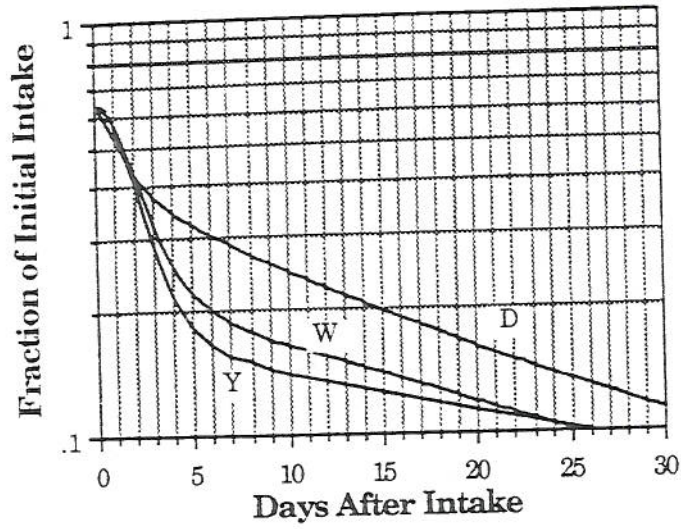
f1 is 0.01 for all forms

h eff = 6.95E-10 Sv/Bq
2.57 mrem/ μCi

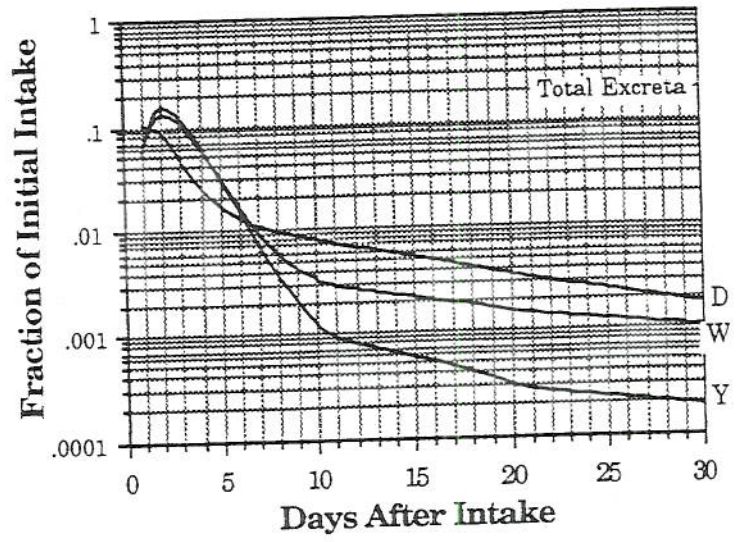
44% of the Y Class inhalation dose

Note: f - fecal excretion >90%

Ru-103 Retention Fractions



Ru-103 Excretion Fractions



Notes

Ru-103

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
Y	0.05	3.07E-10	3.11E-10	1.56E-08	3.19E-10	2.37E-10	2.57E-10	1.25E-09
CDE per μCi Inhaled =		1.1	1.2	57.7	1.2	0.9	1.0	4.6
CEDE per μCi Inhaled =		0.3	0.2	6.9	0.1	0.0	0.0	1.4

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule		
	2.42E-09	558	866	h eff	(S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =	9.0	558	866 (Lung)	7.8	642	600	900

Whole Body Retention			Total Excreta			
Days	D Fract	W Fract	Y Fract	D Fract	W Fract	Y Fract
0.1	0.631	0.636	0.638			
0.2	0.621	0.633	0.637			
0.3	0.611	0.629	0.635			
0.4	0.600	0.625	0.631			
0.5	0.588	0.62	0.626			
0.6	0.576	0.614	0.619			
0.7	0.563	0.606	0.611			
0.8	0.550	0.597	0.601			
0.9	0.538	0.586	0.590			
1	0.527	0.575	0.576	1.02E-1	5.34E-2	5.19E-2 f
2	0.430	0.435	0.416	8.71E-2	1.29E-1 f	1.50E-1
3	0.376	0.322	0.290	4.72E-2	1.05E-1 f	1.19E-1 f
4	0.343	0.254	0.219	2.59E-2	6.12E-2 f	6.57E-2 f
5	0.321	0.218	0.183	1.68E-2	3.21E-2 f	3.22E-2 f
6	0.302	0.198	0.165	1.28E-2	1.67E-2	1.54E-2 f
7	0.286	0.185	0.154	1.08E-2	9.37E-3	7.49E-3
8	0.271	0.176	0.148	9.47E-3	5.87E-3	3.75E-3
9	0.258	0.168	0.143	8.54E-3	4.15E-3	2.05E-3
10	0.246	0.163	0.139	7.80E-3	3.27E-3	1.25E-3
20	0.160	0.118	0.113	3.45E-3	1.56E-3	3.04E-4
30	0.112	8.74E-2	9.27E-2	1.71E-3	1.02E-3	1.84E-4
40	8.30E-2	6.54E-2	7.63E-2	9.47E-4	7.09E-4	1.25E-4
50	6.30E-2	4.95E-2	6.32E-2	5.74E-4	5.07E-4	9.15E-5
60	4.90E-2	3.77E-2	5.20E-2	3.66E-4	3.66E-4	6.98E-5
70	3.80E-2	2.88E-2	4.33E-2	2.46E-4	2.70E-4	5.45E-5
80	3.00E-2	2.20E-2	3.59E-2	1.69E-4	1.99E-4	4.32E-5
90	2.41E-2	1.69E-2	2.97E-2	1.17E-4	1.47E-4	3.44E-5
100	1.94E-2	1.31E-2	2.46E-2	8.20E-5	1.09E-4	2.78E-5
200	2.63E-3	1.18E-3	3.83E-3	3.44E-6	5.62E-6	3.77E-6
300	4.12E-4	1.45E-4	6.05E-4	3.25E-7	3.34E-7	5.69E-7
400	6.63E-5	2.13E-5	9.48E-5	4.69E-8	2.59E-9	8.75E-8

DAC (Y) = $3\text{E-}7$
DAC-hr = 360 nCi
DAC-hr = 3.00 mrem (ALI)
DAC-hr = 3.24 mrem (h)

"Properly Based ALI/DAC"

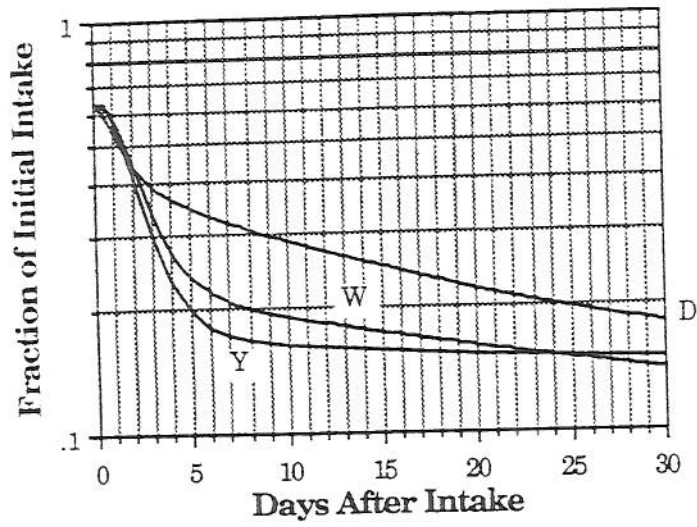
ALI = $560 \mu\text{Ci}$
DAC (Y) = $2.3\text{E-}07$
DAC-hr = 276 nCi
DAC-hr = 2.46 mrem (ALI)
DAC-hr = 2.48 mrem (h)

Misc
Data
T 1/2 = 39.4 d
 β^- 210
 γ 497.1 86.4%
610.3 5.3%
 Γ = 260
mR/hr per Ci at 1 meter

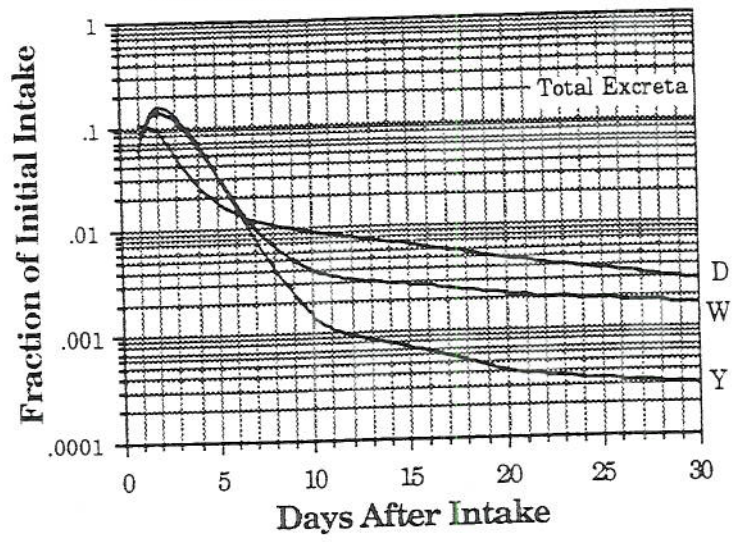
Ingestion Model
f1 is 0.05 for all forms
h eff = $8.24\text{E-}10 \text{ Sv/Bq}$ $3.05 \text{ mrem}/\mu\text{Ci}$
34% of the Y Class inhalation dose

Note: f - fecal excretion >90%

Ru-106 Retention Fractions



Ru-106 Excretion Fractions



Notes

Ru-106

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
Y	0.05	1.30E-09	1.78E-09	1.04E-06	1.76E-09	1.61E-09	1.72E-09	1.20E-08
CDE per μCi Inhaled =		4.8	6.6	3848.0	6.5	6.0	6.4	44.4
CEDE per μCi Inhaled =		1.2	1.0	461.8	0.8	0.2	0.2	13.3

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule h eff	10% Rule (S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =	1.29E-07	10	13	461.8	11	10	10
	478.4	10	13 (Lung)				

Whole Body Retention			Total Excreta			
Days	D Fract	W Fract	Y Fract	D Fract	W Fract	Y Fract
0.1	0.632	0.637	0.639			
0.2	0.623	0.635	0.639			
0.3	0.614	0.632	0.638			
0.4	0.604	0.629	0.635			
0.5	0.592	0.624	0.631			
0.6	0.581	0.619	0.625			
0.7	0.569	0.612	0.618			
0.8	0.557	0.604	0.608			
0.9	0.546	0.594	0.598			
1	0.535	0.584	0.585	1.04E-1	5.42E-2	5.27E-2 f
2	0.443	0.449	0.429	8.99E-2	1.33E-1 f	1.54E-1 f
3	0.394	0.337	0.304	4.94E-2	1.10E-1 f	1.24E-1 f
4	0.365	0.271	0.233	2.76E-2	6.52E-2 f	7.00E-2 f
5	0.347	0.236	0.198	1.81E-2	3.47E-2 f	3.49E-2 f
6	0.331	0.218	0.181	1.40E-2	1.84E-2	1.69E-2 f
7	0.319	0.206	0.172	1.20E-2	1.05E-2	8.36E-3
8	0.307	0.199	0.167	1.07E-2	6.65E-3	4.25E-3
9	0.297	0.194	0.165	9.83E-3	4.78E-3	2.36E-3
10	0.288	0.19	0.163	9.13E-3	3.83E-3	1.46E-3
20	0.219	0.161	0.154	4.72E-3	2.14E-3	4.16E-4
30	0.180	0.14	0.148	2.74E-3	1.63E-3	2.94E-4
40	0.155	0.122	0.143	1.77E-3	1.33E-3	2.35E-4
50	0.138	0.108	0.138	1.26E-3	1.11E-3	2.00E-4
60	0.125	9.60E-2	0.133	9.38E-4	9.38E-4	1.79E-4
70	0.114	8.60E-2	0.130	7.37E-4	8.07E-4	1.63E-4
80	0.106	7.70E-2	0.126	5.90E-4	6.96E-4	1.51E-4
90	9.90E-2	6.90E-2	0.122	4.79E-4	6.02E-4	1.41E-4
100	9.30E-2	6.30E-2	0.118	3.93E-4	5.21E-4	1.33E-4
200	6.00E-2	2.70E-2	8.80E-2	7.89E-5	1.29E-4	8.65E-5
300	4.50E-2	1.60E-2	6.60E-2	3.57E-5	3.67E-5	6.25E-5
400	3.50E-2	1.10E-2	5.00E-2	2.47E-5	1.37E-6	4.60E-5

DAC (Y) = 5E-9
DAC-hr = 6 nCi
DAC-hr = 3.0 mrem (ALI)
DAC-hr = 2.87 mrem (h)

"Properly Based ALI/DAC"

ALI = 10 μCi
DAC (Y) = 4.2E-09
DAC-hr = 5 nCi
DAC-hr = 2.50 mrem (ALI)
DAC-hr = 2.39 mrem (h)

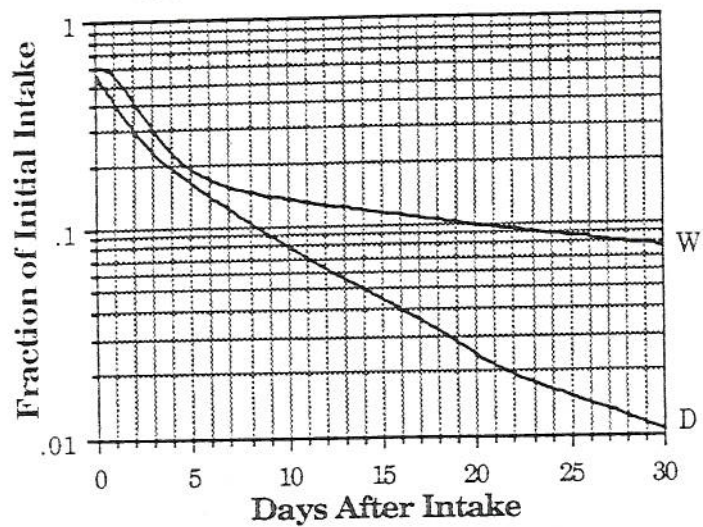
Misc
Data
T 1/2 = 368 d
 β^- 3540
 γ 511.8 20.6%
621.8 9.8%
1050.1 1.5%
 Γ = 170
mR/hr per Ci at 1 meter

B, Gammas from Rh-106 daughters

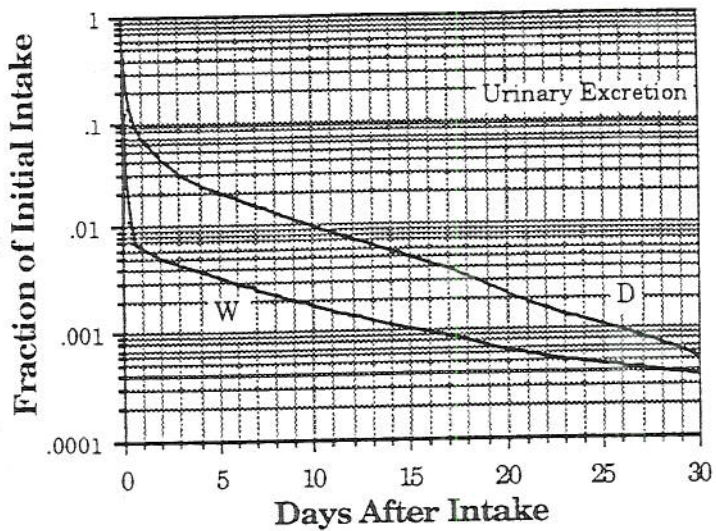
Ingestion Model
f1 is 0.05 for all forms
h eff = 7.40E-9 Sv/Bq 27.38 mrem/ μCi
6% of the Y Class inhalation dose

Note: f - fecal excretion >90%

Sb-124 Retention Fractions



Sb-124 Excretion Fractions



Notes

Sb-124

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
W	0.01	1.04E-09	8.94E-10	4.14E-08	1.09E-09	1.24E-09	6.74E-10	4.18E-09
CDE per μCi Inhaled =		3.8	3.3	153.2	4.0	4.6	2.5	15.5
CEDE per μCi Inhaled =		1.0	0.5	18.4	0.5	0.1	0.1	4.6

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule		
	6.80E-09	199	326	h eff	(S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =	25.2	199	326 (Lung)	20.8	240	200	300

Whole Body Retention			Urinary Excretion	
	D	W	D	W
Days	Fract	Fract	Fract	Fract
0.1	0.562	0.616	0.495	0.122
0.2	0.530	0.610	0.204	2.87E-2
0.3	0.511	0.607	0.135	1.13E-2
0.4	0.495	0.603	0.111	7.93E-3
0.5	0.480	0.600	9.90E-2	7.21E-3
0.6	0.465	0.594	9.10E-2	6.92E-3
0.7	0.449	0.586	8.40E-2	6.72E-3
0.8	0.435	0.578	7.80E-2	6.51E-3
0.9	0.421	0.568	7.30E-2	6.32E-3
1	0.406	0.557	6.90E-2	6.15E-3
2	0.294	0.414	4.20E-2	4.96E-3
3	0.229	0.296	3.00E-2	4.25E-3
4	0.188	0.225	2.40E-2	3.70E-3
5	0.160	0.187	2.00E-2	3.24E-3
6	0.137	0.166	1.74E-2	2.84E-3
7	0.119	0.153	1.50E-2	2.50E-3
8	0.103	0.145	1.29E-2	2.21E-3
9	9.00E-2	0.138	1.11E-2	1.96E-3
10	7.90E-2	0.133	9.53E-3	1.74E-3
20	2.40E-2	9.80E-2	2.17E-3	6.52E-4
30	1.05E-2	7.60E-2	5.21E-4	3.60E-4
40	6.68E-3	6.00E-2	1.46E-4	2.54E-4
50	5.11E-3	4.70E-2	5.78E-5	1.96E-4
60	4.14E-3	3.70E-2	3.37E-5	1.57E-4
70	3.42E-3	2.90E-2	2.48E-5	1.26E-4
80	2.84E-3	2.30E-2	1.99E-5	1.01E-4
90	2.36E-3	1.80E-2	1.64E-5	8.13E-5
100	1.96E-3	1.41E-2	1.36E-5	6.55E-5
200	3.09E-4	1.28E-3	2.14E-6	7.09E-6
300	4.84E-5	1.19E-4	3.38E-7	7.44E-7
400	7.65E-6	1.16E-5	5.31E-8	7.87E-8

DAC (W) = $1\text{E-}7$

DAC-hr = 120 nCi

DAC-hr = 3.0 mrem (ALI)

DAC-hr = 3.02 mrem (h)

"Properly Based ALI/DAC"

ALI = 200 μCi

DAC (W) = $8.3\text{E-}08$

DAC-hr = 100 nCi

DAC-hr = 2.50 mrem (ALI)

DAC-hr = 2.52 mrem (h)

Misc

Data

T 1/2 = 60.2 d

β^- 2310

γ 602.7 98.1%

645.8 7.2%

722.8 11.8%

968.2 1.9%

1045.1 1.9%

1325.5 1.5%

1368.2 2.6%

1691 50.0%

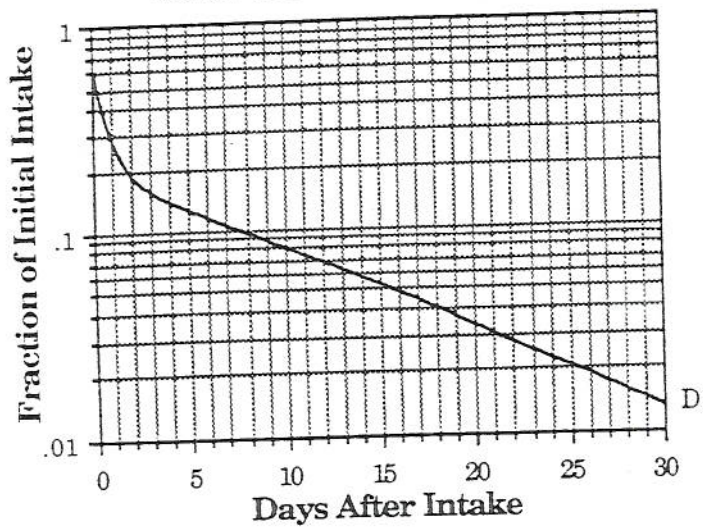
2091.2 6.0%

Γ = 980

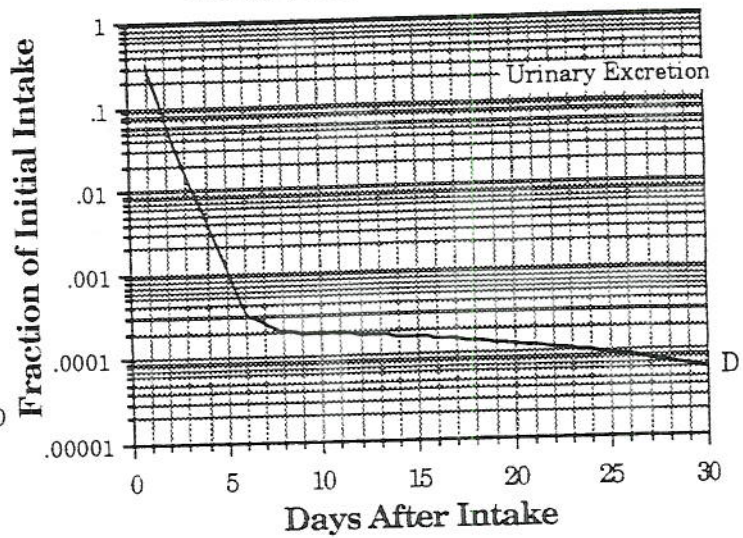
mR/hr per Ci at 1 meter

Ingestion Model
f1 is 0.01 for all forms
h eff = $2.74\text{E-}9$ Sv/Bq
10.14 mrem/ μCi
40% of the W Class inhalation dose

I-131 Retention Fraction



I-131 Excretion Fraction



Notes

I-131

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
D	1.0	2.53E-11	7.88E-11	6.57E-10	6.26E-11	5.73E-11	2.92E-07	8.03E-11
CDE per μCi Inhaled =		0.1	0.3	2.4	0.2	0.2	1080.4	0.3
CEDE per μCi Inhaled =		0.0	0.0	0.3	0.0	0.0	32.4	0.1

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule		
	8.89E-09	152	46	h eff	(S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =	32.9	152	46 (Thy)	32.4	154	200	50

Whole Body Retention		Urinary Excretion	
D		D	
Days	Fract	Days	Fract
0.1	0.584		
0.2	0.521		
0.3	0.468		
0.4	0.425		
0.5	0.388		
0.6	0.357		
0.7	0.331		
0.8	0.309		
0.9	0.290		
1	0.274	3.04E-1	
2	0.187	6.24E-2	
3	0.155	1.62E-2	
4	0.137	4.47E-3	
5	0.125	1.31E-3	
6	0.114	3.29E-4	
7	0.104	2.53E-4	
8	9.55E-2	2.01E-4	
9	8.74E-2	1.90E-4	
10	8.00E-2	1.88E-4	
20	3.27E-2	1.27E-4	
30	1.32E-2	6.25E-5	
40	5.29E-3	2.77E-5	
50	2.11E-3	1.16E-5	
60	8.42E-4	4.78E-6	
70	3.35E-4	1.93E-6	
80	1.33E-4	7.76E-7	
90	5.30E-5	3.11E-7	
100	2.11E-5	1.24E-7	

DAC (D) = $2\text{E}-8$
 DAC-hr = 24 nCi
 DAC-hr = 0.6 mrem (ALI)
 DAC-hr = 0.8 mrem (h)

"Recommended ALI/DAC"

(N)ALI = 46 μCi

(S)ALI = 150 μCi

DAC (D) = $6.3\text{E}-08$ *

DAC-hr = 76 nCi

DAC-hr = 2.52 mrem (ALI)

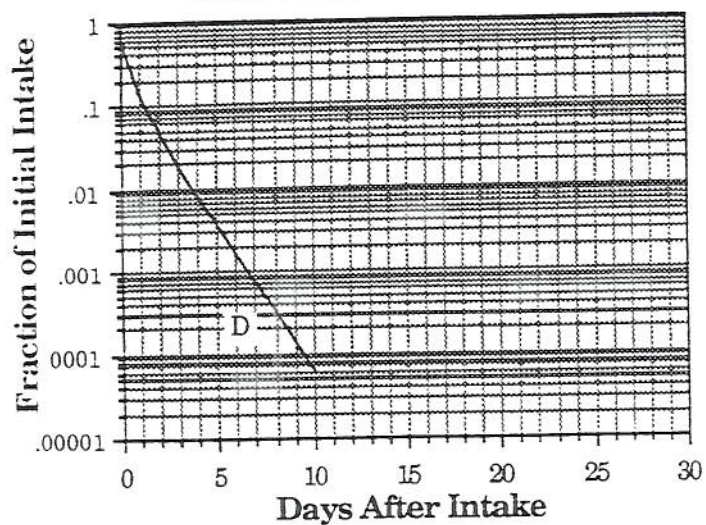
DAC-hr = 2.49 mrem (h)

* I-131 limited to 600 DAC-hrs/yr
 or 500 DAC-hrs/yr to be conservative

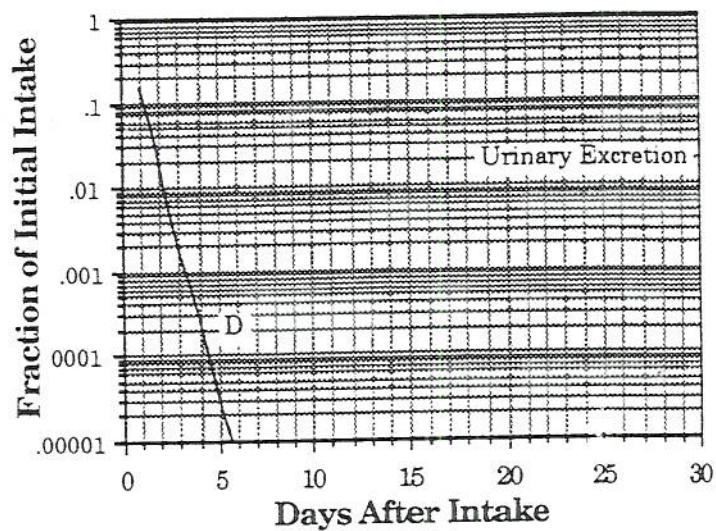
Misc Data		
T 1/2 =	8.04 d	
β^-	606	
γ	80.2	2.6%
	284.3	6.1%
	364.5	81.2%
	637	7.3%
	722.9	1.8%
Γ =	220	
mR/hr per Ci at 1 meter		

Ingestion Model
f1 is 1.0 for all forms
h eff = $1.44\text{E}-8$ Sv/Bq 53.28 mrem/ μCi
162% of the D Class inhalation dose

I-133 Retention Fraction



I-133 Excretion Fraction



Notes

I-133

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
D	1.0	1.95E-11	2.94E-11	8.20E-10	2.72E-11	2.52E-11	4.86E-08	5.00E-11
CDE per μCi Inhaled =		0.1	0.1	3.0	0.1	0.1	179.8	0.2
CEDE per μCi Inhaled =		0.0	0.0	0.4	0.0	0.0	5.4	0.1

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule		
	1.58E-09	853	278	h eff	(S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =	5.9	853	278 (Thy)	5.4	927	900	300

Whole Body Retention		Urinary Excretion
D		D
Days	Fract	Fract
0.1	0.544	
0.2	0.452	
0.3	0.378	
0.4	0.319	
0.5	0.272	
0.6	0.233	
0.7	0.201	
0.8	0.175	
0.9	0.153	
1	0.134	1.49E-1
2	4.49E-2	1.50E-2
3	1.82E-2	1.90E-3
4	7.93E-3	2.58E-4
5	3.52E-3	3.71E-5
6	1.58E-3	4.55E-6
7	7.08E-4	1.76E-6
8	3.17E-4	6.69E-7
9	1.42E-4	3.10E-7
10	6.39E-5	1.50E-7
20	2.08E-8	

DAC (D) = $1\text{E-}7$
 DAC-hr = 120 nCi
 DAC-hr = 0.67 mrem (ALI)
 DAC-hr = 0.71 mrem (h)

"Recommended ALI/DAC"

(N)ALI = 280 μCi

(S)ALI = 850 μCi

DAC (D) = $3.5\text{E-}07$ *

DAC-hr = 420 nCi

DAC-hr = 2.47 mrem (ALI)

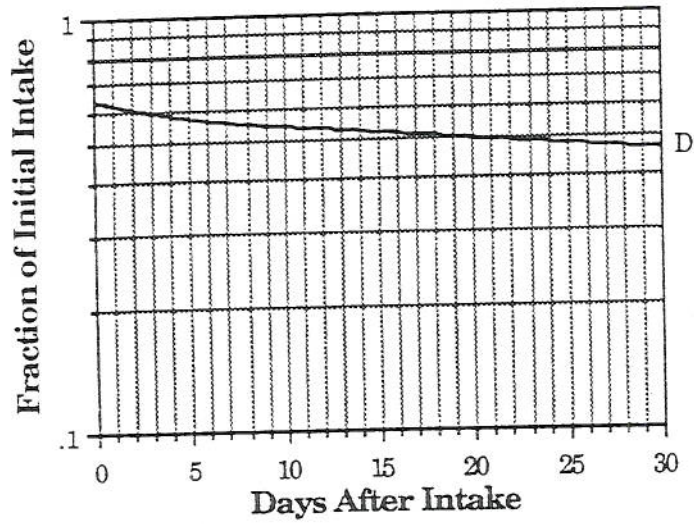
DAC-hr = 2.48 mrem (h)

* I-133 limited to 600 DAC-hrs/yr
 or 500 DAC-hrs/yr to be conservative

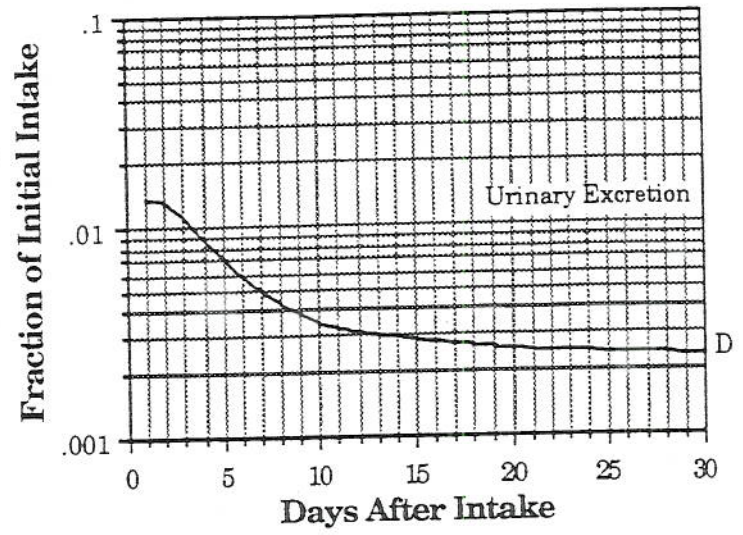
Misc Data		
T 1/2 =	20.3 h	
β^-	1270	
γ	529.5	87.5%
	875.3	4.6%
Γ =	260	
mR/hr per Ci at 1 meter		

Ingestion Model
f1 is 1.0 for all forms
h eff = $2.80\text{E-}9$ Sv/Bq 10.36 mrem/ μCi
176% of the D Class inhalation dose

Cs-134 Retention Fraction



Cs-134 Excretion Fraction



Notes

Cs-134

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
D	1.0	1.30E-08	1.08E-08	1.18E-08	1.18E-08	1.10E-08	1.11E-08	1.39E-08
CDE per μCi Inhaled =		48.1	40.0	43.7	43.7	40.7	41.1	51.4
CEDE per μCi Inhaled =		12.0	6.0	5.2	5.2	1.2	1.2	15.4

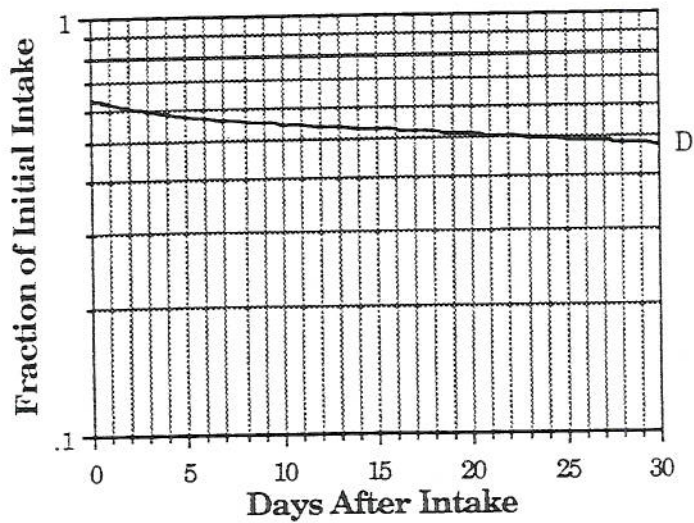
* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule			
	1.25E-08	108	972	h eff	(S)ALI	(S)ALI	(N)ALI	
CEDE per μCi Inhaled =	46.4	108	972 (SI Wall)	46.4	108	100	1000	

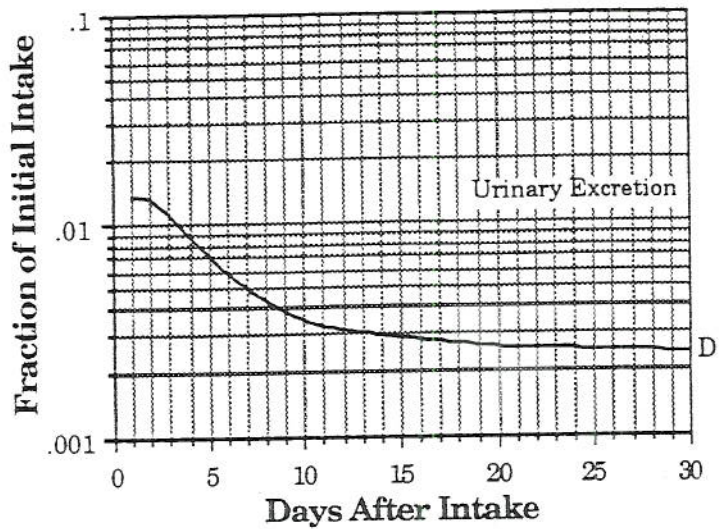
Whole Body Retention		Urinary Excretion		DAC (D) = 4E-8	
Days	D	D		DAC-hr = 48 nCi	
	Fract	Fract		DAC-hr = 2.4 mrem (ALI)	
				DAC-hr = 2.23 mrem (h)	
0.1	0.638			"Properly Based ALI/DAC"	
0.2	0.636				
0.3	0.635				
0.4	0.633				
0.5	0.631				
0.6	0.629				
0.7	0.628				
0.8	0.626				
0.9	0.623				
1	0.621				
2	0.605			Misc Data	
3	0.590				
4	0.579				
5	0.569				
6	0.561				
7	0.554				
8	0.549				
9	0.543				
10	0.539				
20	0.499				
30	0.464				
40	0.432				
50	0.402				
60	0.374				
70	0.348				
80	0.323				
90	0.301				
100	0.280				
200	1.36E-1				
300	6.60E-2				
400	3.20E-2				
				T 1/2 = 2.06 y β^- 662 γ 563.3 8.4% 569.3 15.4% 604.7 97.6% 795.8 85.4% 801.8 8.7% 1167.9 1.8% 1365.1 3.0% Γ = 870 mR/hr per Ci at 1 meter	

Ingestion Model
f1 is 1.0 for all forms
h eff = 1.98E-8 Sv/Bq 73.26 mrem/ μCi
158% of the D Class inhalation dose

Cs-137 Retention Fraction



Cs-137 Excretion Fraction



Notes

Cs-137

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
D	1.0	8.76E-09	7.84E-09	8.82E-09	8.30E-09	7.94E-09	7.93E-09	9.12E-09
CDE per μCi Inhaled =		32.4	29.0	32.6	30.7	29.4	29.3	33.7
CEDE per μCi Inhaled =		8.1	4.4	3.9	3.7	0.9	0.9	10.1

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule		
	8.63E-09	157	1482	h eff	(S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =	31.9	157	1482 (SI Wall)	31.9	157	200	1000

Whole Body Retention		Urinary Excretion
D	Fract	D
Days	Fract	Fract
0.1	0.638	
0.2	0.636	
0.3	0.635	
0.4	0.633	
0.5	0.631	
0.6	0.629	
0.7	0.628	
0.8	0.626	
0.9	0.624	
1	0.622	1.35E-2
2	0.606	1.33E-2
3	0.592	1.10E-2
4	0.581	8.87E-3
5	0.572	7.16E-3
6	0.564	5.89E-3
7	0.558	4.97E-3
8	0.553	4.32E-3
9	0.548	3.85E-3
10	0.543	3.51E-3
20	0.508	2.59E-3
30	0.476	2.41E-3
40	0.447	2.26E-3
50	0.419	2.12E-3
60	0.394	1.99E-3
70	0.369	1.87E-3
80	0.347	1.75E-3
90	0.325	1.64E-3
100	0.305	1.54E-3
200	0.161	8.16E-4
300	8.55E-2	4.32E-4
400	4.52E-2	2.29E-4

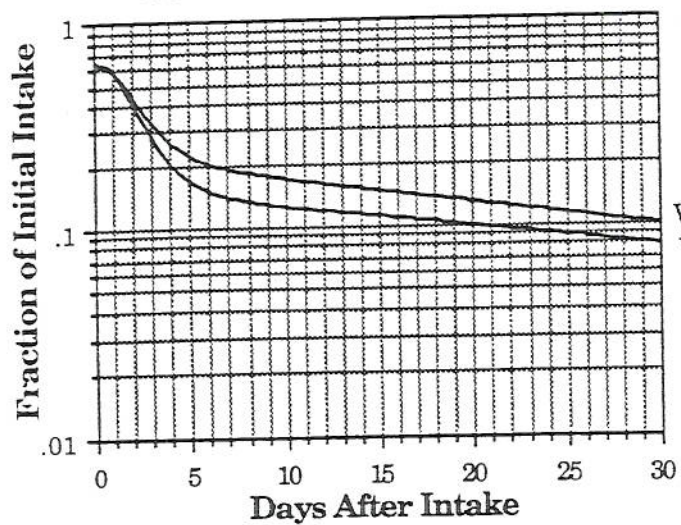
DAC (D) = $6\text{E}-8$
 DAC-hr = 72 nCi
 DAC-hr = 1.8 mrem (ALI)
 DAC-hr = 2.3 mrem (h)

"Properly Based ALI/DAC"
 ALI = $160\mu\text{Ci}$
 DAC (D) = $6.7\text{E}-08$
 DAC-hr = 80 nCi
 DAC-hr = 2.51 mrem (ALI)
 DAC-hr = 2.57 mrem (h)

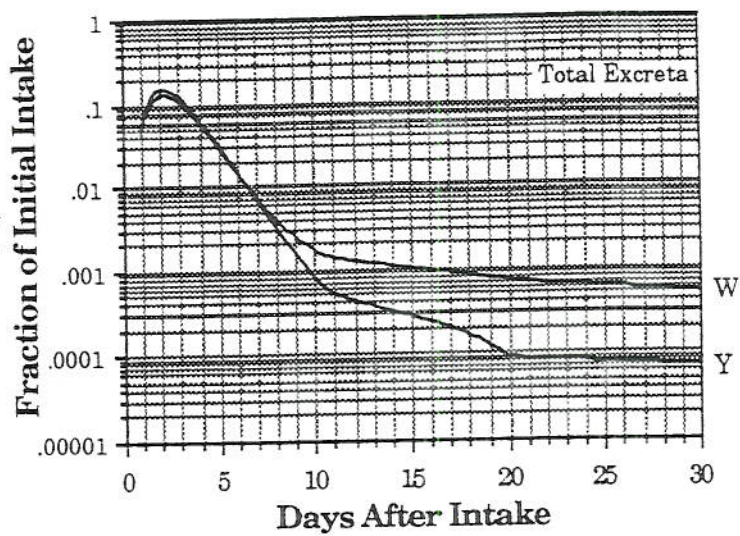
Misc
 Data
 T 1/2 = 30.1 y
 β^- 514
 γ 661.6 84.6%
 Γ = 330
 mR/hr per Ci at 1 meter

Ingestion Model
f1 is 1.0 for all forms
h eff = $1.35\text{E}-8\text{ Sv/Bq}$ $50\text{ mrem}/\mu\text{Ci}$
157% of the D Class inhalation dose

Ce-141 Retention Fractions



Ce-141 Excretion Fractions



Notes

Ce-141

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
Y	3E-4	5.54E-11	4.46E-11	1.67E-08	8.96E-11	2.54E-10	2.55E-11	1.26E-09
CDE per μCi Inhaled =		0.2	0.2	61.8	0.3	0.9	0.1	4.7
CEDE per μCi Inhaled =		0.05	0.02	7.41	0.04	0.03	0.00	1.40

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule		
	2.42E-09	558	809	h eff	(S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =	9.0	558	809 (Lung)	8.3	601	600	800

Whole Body Retention			Total Excreta	
	W	Y	W	Y
Days	Fract	Fract	Fract	Fract
0.1	0.638	0.638		
0.2	0.636	0.636		
0.3	0.634	0.634		
0.4	0.631	0.631		
0.5	0.627	0.626		
0.6	0.621	0.619		
0.7	0.614	0.611		
0.8	0.606	0.600		
0.9	0.596	0.588		
1	0.584	0.575	f 4.13E-2	5.10E-2 f
2	0.442	0.409	f 1.30E-1	1.54E-1 f
3	0.326	0.277	f 1.07E-1	1.23E-1 f
4	0.258	0.204	f 6.10E-2	6.76E-2 f
5	0.222	0.167	f 3.07E-2	3.27E-2 f
6	0.202	0.148	f 1.50E-2	1.52E-2 f
7	0.190	0.138	f 7.57E-3	7.00E-3 f
8	0.182	0.132	f 4.09E-3	3.27E-3 f
9	0.176	0.127	f 2.46E-3	1.58E-3 f
10	0.170	0.124	f 1.68E-3	7.96E-4 f
20	0.129	0.099	f 7.18E-4	8.91E-5 f
30	0.099	0.079	f 5.07E-4	7.06E-5 f
40	0.076	0.063	f 3.57E-4	5.63E-5 f
50	0.059	0.051	f 2.52E-4	4.48E-5 f
60	0.046	0.041	f 1.78E-4	3.58E-5 f
70	0.036	0.033	f 1.26E-4	2.85E-5 f
80	0.028	0.026	f 8.92E-5	2.27E-5 f
90	0.022	0.021	f 6.32E-5	1.81E-5 f
100	0.017	0.017	f 4.48E-5	1.44E-5 f
200	1.73E-3	1.82E-3	1.57E-6	1.50E-6 f
300	1.94E-4	1.99E-4	7.45E-8	
400	2.23E-5	2.18E-5		

DAC (Y) = $2\text{E-}7$
 DAC-hr = 240 nCi
 DAC-hr = 2.0 mrem (ALI)
 DAC-hr = 2.16 mrem (h)

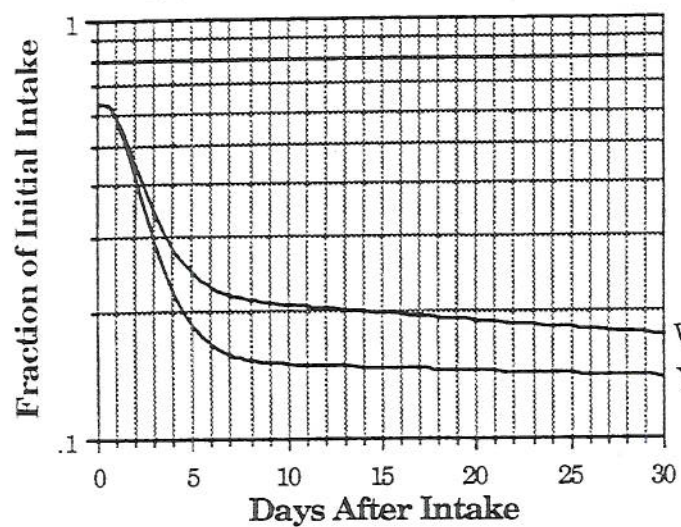
"Properly Based ALI/DAC"
 ALI = $560 \mu\text{Ci}$
 DAC (Y) = $2.3\text{E-}07$
 DAC-hr = 276 nCi
 DAC-hr = 2.46 mrem (ALI)
 DAC-hr = 2.48 mrem (h)

Misc
 Data
 T 1/2 = 32.4 d
 β^- 581
 γ 145.5 48%
 Γ = 35
 mR/hr per Ci at 1 meter

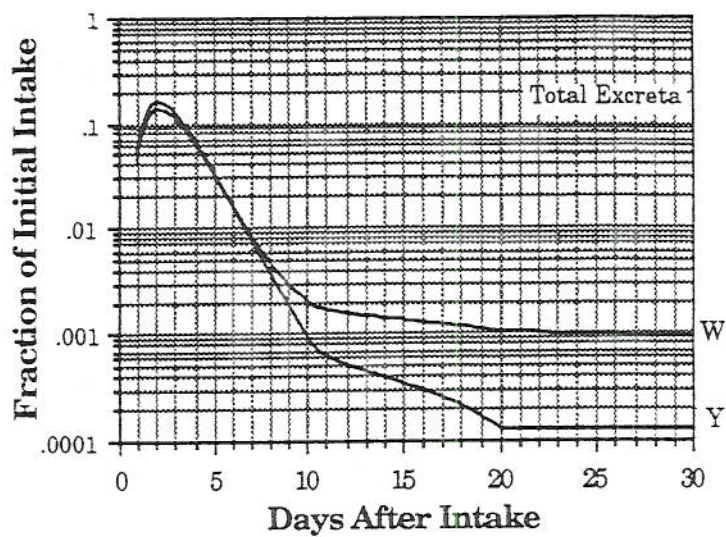
Ingestion Model
f1 is $3\text{E-}04$ for all forms
h eff = $7.83\text{E-}10 \text{ Sv/Bq}$ $2.90 \text{ mrem}/\mu\text{Ci}$
32% of the Y Class inhalation dose

Note: f - fecal excretion >90%

Ce-144 Retention Fractions



Ce-144 Excretion Fractions



Notes

Ce-144

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
Y	3E-4	2.39E-10	3.48E-10	7.91E-07	2.88E-09	4.72E-09	2.92E-10	1.91E-08
CDE per μCi Inhaled =		0.9	1.3	2926.7	10.7	17.5	1.1	70.7
CEDE per μCi Inhaled =		0.2	0.2	351.2	1.3	0.5	0.0	21.2

* Most Restrictive Inhalation Classification

	h Based	h Based	10%	10%
	h eff	(S)ALI	(N)ALI	Rule
CEDE per μCi Inhaled =	1.01E-07	13	17	h eff
	374.7	13	17	351.2
			(Lung)	

Whole Body Retention			Total Excreta		
Days	W	Y	W	Y	
0.1	0.639	0.639	Fract	Fract	
0.2	0.639	0.639			
0.3	0.638	0.638			
0.4	0.636	0.635			
0.5	0.633	0.632			
0.6	0.629	0.626			
0.7	0.623	0.619			
0.8	0.615	0.609			
0.9	0.606	0.598			
1	0.596	0.586	f	4.20E-2	5.20E-2 f
2	0.459	0.424	f	1.35E-1	1.60E-1 f
3	0.345	0.293	f	1.13E-1	1.30E-1 f
4	0.278	0.220	f	6.58E-2	7.29E-2 f
5	0.244	0.183	f	3.37E-2	3.60E-2 f
6	0.226	0.166	f	1.68E-2	1.70E-2 f
7	0.217	0.157	f	8.64E-3	7.99E-3 f
8	0.212	0.153	f	4.75E-3	3.81E-3 f
9	0.208	0.151	f	2.91E-3	1.87E-3 f
10	0.206	0.150	f	2.03E-3	9.62E-4 f
20	0.189	0.144	f	1.05E-3	1.29E-4 f
30	0.175	0.139	f	8.93E-4	1.24E-4 f
40	0.163	0.135	f	7.61E-4	1.19E-4 f
50	0.152	0.130	f	6.49E-4	1.14E-4 f
60	0.142	0.126	f	5.55E-4	1.10E-4 f
70	0.134	0.122	f	4.73E-4	1.06E-4 f
80	0.126	0.118	f	4.04E-4	1.02E-4 f
90	0.120	0.114	f	3.46E-4	9.91E-5 f
100	0.113	0.110	f	2.96E-4	9.55E-5 f
200	7.58E-2	7.95E-2		6.85E-5	6.54E-5 f
300	5.60E-2	5.75E-2		2.16E-5	4.49E-5 f
400	4.26E-2	4.17E-2		1.05E-5	3.08E-5 f

DAC (Y) = 6E-9
 DAC-hr = 7.2 nCi
 DAC-hr = 3.6 mrem (ALI)
 DAC-hr = 2.7 mrem (h)

"Properly Based ALI/DAC"

ALI = 13 μCi
 DAC (Y) = 5.4E-09
 DAC-hr = 6 nCi
 DAC-hr = 2.49 mrem (ALI)
 DAC-hr = 2.43 mrem (h)

Misc
 Data
 T 1/2 = 284.2 d
 β^- 310
 γ 80.1 1.6%
 133.5 10.8%
 Γ = 40
 mR/hr per Ci at 1 meter

Ingestion Model
f1 is 3E-04 for all forms
h eff = 5.68E-9 Sv/Bq 21.0 mrem/ μCi
6% of the Y Class inhalation dose

Note: f - fecal excretion >90%

Rb-88

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
D	1.0	1.31E-12	1.43E-12	1.47E-10	1.45E-12	1.47E-12	1.37E-12	1.38E-11
CDE per μCi Inhaled =		0.00	0.01	0.54	0.01	0.01	0.01	0.05
CEDE per μCi Inhaled =		0.001	0.001	0.065	0.001	0.000	0.000	0.015

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule		
	2.26E-11	59844	91929	h eff	(S)ALI	(S)ALI	(N)ALI
CEDE per μCi Inhaled =	0.084	59844	91929 (Lung)	0.079	63317	60000	90000

Whole Body Retention		Urinary Excretion	
D		D	
Days	Fract		Fract

0.1 2.35E-3
0.2 8.59E-6
0.3 3.15E-8

0.4
0.5
0.6
0.7
0.8
0.9

1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
200
300
400

DAC (D) = $3\text{E}-5$
DAC-hr = 36000 nCi
DAC-hr = 3.00 mrem (ALI)
DAC-hr = 2.88 mrem (h)

"Properly Based ALI/DAC"
ALI = 60000 μCi
DAC (D) = $2.5\text{E}-05$
DAC-hr = 30000 nCi
DAC-hr = 2.50 mrem (ALI)
DAC-hr = 2.52 mrem (h)

Misc Data
T 1/2 = 17.8 m
 β^- 5300
 γ 898 14.5%
1836 22.1%
2678 2.0%

Γ = 320
mR/hr per Ci at 1 meter

Cs-138

(All CDE and CEDE in mrem; ALI's in μCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
D	1.0	3.28E-12	4.02E-12	1.59E-10	3.95E-12	3.55E-12	3.57E-12	2.06E-11
CDE per μCi Inhaled =		0.012	0.015	0.588	0.015	0.013	0.013	0.076
CEDE per μCi Inhaled =		0.0030	0.0022	0.0706	0.0018	0.0004	0.0004	0.0229

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule			
	2.74E-11	49372	84991	h eff	(S)ALI	(S)ALI	(N)ALI	
CEDE per μCi Inhaled =	0.101	49372	84991 (Lung)	0.088	57080	60000	80000	

Whole Body Retention		Urinary Excretion		DAC (D) = 2E-5	
Days	D	D	Fract	DAC-hr = 24000 nCi	DAC-hr = 2.0 mrem (ALI)
0.1	0.028			DAC-hr = 2.42 mrem (h)	
0.2	0.001				

"Properly Based ALI/DAC"

ALI = 50000 μCi

DAC (D) = 2.1E-05

DAC-hr = 25200 nCi

DAC-hr = 2.52 mrem (ALI)

DAC-hr = 2.55 mrem (h)

1		0.00E+0
2		
3		
4		
5		
6		
7		
8		
9		
10		
20		
30		
40		
50		
60		
70		
80		
90		
100		
200		
300		
400		

Misc Data		
T 1/2 =	32.2 m	
β -	3400	
γ	462.8	30.8%
	546.9	10.8%
	1010	29.8%
	1435.9	76.3%
	2218	15.2%
	2639.6	7.6%
Γ =	1100	
mR/hr per Ci at 1 meter		

Committed Dose Equivalent per Unit Intake (mrem/ μ Ci)

All Classifications

Nuclide	Class	f									Recommended		Lung to
			Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem	Eff	Calculated		
											ALI	DAC	Eff
H-3	D	1.00	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	78000	1.6E-05	1.0
C-14	Org	1.00	2.09	2.09	2.09	2.09	2.09	2.09	2.09	2.09	2400	1.0E-06	1.0
C-14	CO	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1700000	7.1E-04	1.0
C-14	CO2	1.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	210000	8.8E-05	1.0
F-18	D	1.00	0.01	0.01	0.40	0.10	0.10	0.01	0.05	0.08	60000	2.5E-05	4.8
F-18	W	1.00	0.00	0.01	0.48	0.04	0.04	0.01	0.03	0.07	67000	2.8E-05	6.4
F-18	Y	1.00	0.00	0.01	0.52	0.02	0.02	0.01	0.03	0.08	64000	2.7E-05	6.6
Cr-51	D	0.10	0.10	0.07	0.14	0.10	0.10	0.07	0.13	0.11	46000	1.9E-05	1.3
Cr-51	W	0.10	0.08	0.06	1.39	0.07	0.06	0.04	0.18	0.26	19000	7.9E-06	5.3
Cr-51	Y	0.10	0.08	0.06	1.98	0.07	0.05	0.04	0.19	0.33	15000	6.3E-06	5.9
Mn-54	D	0.10	3.27	3.38	4.37	6.14	9.47	2.41	7.73	5.25	950	4.0E-07	0.8
Mn-54	W	0.10	2.60	3.20	24.60	4.10	4.60	2.70	6.40	6.70	750	3.1E-07	3.7
Fe-55	D	0.10	1.94	1.88	1.92	1.91	1.90	2.01	4.48	2.69	1900	7.9E-07	0.7
Fe-55	W	0.10	0.66	0.64	3.92	0.65	0.65	0.68	1.62	1.34	3700	1.5E-06	2.9
Fe-59	D	0.10	12.28	11.14	12.95	11.77	10.77	10.92	21.50	14.81	340	1.4E-07	0.9
Fe-59	W	0.10	5.14	4.66	51.06	4.85	4.11	4.33	10.95	12.23	410	1.7E-07	4.2
Co-57	W	0.05	0.60	0.58	14.99	0.94	0.73	0.42	1.50	2.63	1900	7.9E-07	5.7
Co-57	Y	0.05	0.46	1.39	62.53	2.18	1.67	1.00	3.04	9.08	550	2.3E-07	6.9
Co-58	W	0.05	2.41	2.26	29.38	2.34	1.77	2.04	5.00	6.36	790	3.3E-07	4.6
Co-58	Y	0.05	2.28	3.47	59.20	3.42	2.56	3.23	6.99	10.88	460	1.9E-07	5.4
Co-60	W	0.05	15.0	15.4	132.1	15.7	13.1	13.8	28.3	33.1	150	6.3E-08	4.0
Co-60	Y	0.05	17.6	68.1	1276.5	63.6	50.0	59.9	133.2	218.7	23	9.6E-09	5.8
Cu-64	D	0.50	0.06	0.05	0.75	0.05	0.04	0.04	0.25	0.20	26000	1.1E-05	3.8
Cu-64	W	0.50	0.04	0.03	1.24	0.03	0.02	0.02	0.29	0.26	19000	7.9E-06	4.8
Cu-64	Y	0.50	0.05	0.02	1.30	0.03	0.02	0.02	0.34	0.28	18000	7.5E-06	4.7
Zn-65	Y	0.50	7.5	11.4	77.7	13.4	12.4	11.2	17.2	20.4	250	1.0E-07	3.8
Rb-87	D	1.00	2.65	2.65	3.89	4.70	8.88	2.65	2.66	3.23	1500	6.3E-07	1.2
Rb-88	D	1.00	0.00	0.01	0.54	0.01	0.01	0.01	0.05	0.08	60000	2.5E-05	6.5
Rb-89	D	1.00	0.00	0.01	0.25	0.01	0.01	0.01	0.03	0.04	120000	5.0E-05	5.9
Zr-95	D	0.002	7.0	7.1	8.0	48.1	381.1	5.3	8.4	23.7	130/210	8.8E-08	0.3
Zr-95	W	0.002	3.1	3.4	68.8	12.0	80.3	2.9	7.9	15.9	320	1.3E-07	4.3
Zr-95	Y	0.002	2.1	4.6	150.6	5.0	8.6	4.3	10.2	23.3	210	8.8E-08	6.5
Nb-95	W	0.01	1.79	1.39	20.31	2.49	8.95	1.16	3.65	4.79	1000	4.2E-07	4.2
Nb-95	Y	0.01	1.60	1.51	30.78	1.64	1.90	1.32	3.96	5.80	860	3.6E-07	5.3
Ru-103	D	0.05	2.70	2.25	3.77	2.46	2.29	2.21	3.85	3.05	1600	6.7E-07	1.2
Ru-103	W	0.05	1.46	1.18	36.48	1.25	1.00	1.02	4.44	6.48	770	3.2E-07	5.6
Ru-103	Y	0.05	1.14	1.15	57.72	1.18	0.88	0.95	4.63	8.95	560	2.3E-07	6.4
Ru-106	D	0.05	51.06	50.69	66.60	50.69	50.69	50.69	62.53	56.24	89	3.7E-08	1.2
Ru-106	W	0.05	14.91	14.91	780.70	15.02	14.80	14.84	51.43	117.66	42	1.8E-08	6.6
Ru-106	Y	0.05	4.81	6.59	3848	6.51	5.96	6.36	44.40	477.30	10	4.2E-09	8.1
Sb-122	D	0.10	0.60	0.44	5.81	1.43	1.31	0.41	3.96	2.32	2200	9.2E-07	2.5
Sb-122	W	0.01	0.53	0.19	20.91	0.39	0.30	0.13	8.07	5.15	970	4.0E-07	4.1
Sb-124	D	0.10	3.39	2.41	7.51	5.66	12.62	2.10	7.77	5.56	900	3.8E-07	1.4
Sb-124	W	0.01	3.85	3.31	153.18	4.03	4.59	2.49	15.47	25.18	200	8.3E-08	6.1
I-131	D	1.00	0.09	0.29	2.43	0.23	0.21	1080	0.30	32.89	46/150	6.3E-08	0.1
I-133	D	1.00	0.07	0.11	3.03	0.10	0.09	180	0.19	5.86	280/850	3.5E-07	0.5
Cs-134	D	1.00	48.1	40.0	43.7	43.7	40.7	41.1	51.4	46.4	110	4.6E-08	0.9
Cs-137	D	1.00	32.4	29.0	32.6	30.7	29.4	29.3	33.7	31.9	160	6.7E-08	1.0
Cs-138	D	1.00	0.01	0.01	0.59	0.01	0.01	0.01	0.08	0.10	49000	2.0E-05	5.8
Ba-140	D	0.10	1.59	1.06	6.14	4.77	8.92	0.95	5.22	3.73	1300	5.4E-07	1.6
La-140	D	0.001	1.34	0.76	6.14	1.69	1.49	0.45	6.70	3.46	1400	5.8E-07	1.8
La-140	W	0.001	1.68	0.54	15.58	0.79	0.52	0.25	7.84	4.84	1000	4.2E-07	3.2
Ce-141	W	3E-4	0.31	0.26	41.44	1.55	14.02	0.17	8.73	8.32	600	2.5E-07	5.0
Ce-141	Y	3E-4	0.20	0.17	61.79	0.33	0.94	0.09	4.66	8.96	560	2.3E-07	6.9
Ce-144	W	3E-4	7.1	7.3	677.1	98.8	168.0	7.0	381.1	215.6	23	9.6E-09	3.1
Ce-144	Y	3E-4	0.9	1.3	2926.7	10.7	17.5	1.1	70.7	374.7	13	5.4E-09	7.8

Offsite Dose Calculations Using RG 1.109 and Corrected by EPA 11

This section shows the significant calculation problems associated with the RG 1.109 and the new Effluent Concentrations.

10CFR20 Effluent Conc	RG 1.109		Adult	
	Total Body Dose Factor (mrem/μCi)	Max Organ Dose Factor (mrem/μCi)	Total Body Yearly Dose (mrem)	Max Organ Yearly Dose (mrem)
H-3	0.16	0.2	126.4	126.4
Cr-51	0.01	1.8	3.0	432.0
Mn-54	0.79	175.0	6.3	1400.0
Fe-59	1.32	127.0	5.3	508.0
Co-57	0.26	116.0	2.1	928.0
Co-58	1.85	746.0	0.7	298.4
Zn-65	5.82	108.0	18.6	345.6
Zr-95	2.91	221.0	9.3	707.2
Nb-95	0.53	63.1	8.4	1009.6
Ru-103	0.08	63.1	0.6	454.3
Ru-106	1.09	1170.0	0.2	187.2
Sb-124	2.56	149.0	4.1	238.4
I-131	5.65	269.0	45.2	2152.0
Cs-134	91.00	106.0	145.6	169.6
Cs-137	53.50	77.6	85.6	124.2
Ce-141	0.19	45.2	1.2	289.3
Ce-144	23.00	972.0	3.7	155.5

This section shows the yearly CEDE calculation using EPA 11 and the new Eff Conc.

10CFR20 Effluent Conc	EPA 11		Adult	
	Dose factor (mrem/μCi)	Yearly Dose (mrem)		
H-3	0.1	48		
Cr-51	0.3	79		
Mn-54	6.7	54		
Fe-59	14.8	59		
Co-57	9.1	66		
Co-58	10.9	87		
Co-60	218.7	87		
Zn-65	20.4	65		
Zr-95	23.7	76		
Nb-95	5.8	93		
Ru-103	9.0	65		
Ru-106	478.4	77		
Sb-124	25.2	60		
I-131	32.9	53		
I-133	5.9	47		
Cs-134	46.4	74		
Cs-137	31.9	51		
Ce-141	9.0	58		
Ce-144	374.7	60		

This section shows the yearly CEDE calculation using EPA 11 and my recommended mods to the Eff Conc.

Recommended 10CFR20			EPA 11	Adult
ALI	Effluent Conc	Dose factor (mrem/μCi)	Yearly Dose (mrem)	
H-3	78000	9.7E-08	0.1	47
Cr-51	15000	1.9E-08	0.3	49
Mn-54	750	9.4E-10	6.7	50
Fe-59	340	4.2E-10	14.8	50
Co-57	550	6.9E-10	9.1	50
Co-58	460	5.7E-10	10.9	50
Co-60	23	2.9E-11	218.7	50
Zn-65	250	3.1E-10	20.4	51
Zr-95	210	2.6E-10	23.7	50
Nb-95	860	1.1E-09	5.8	50
Ru-103	560	7.0E-10	9.0	50
Ru-106	10	1.2E-11	478.4	48
Sb-124	200	2.5E-10	25.2	50
I-131	150	1.9E-10	32.9	49
I-133	850	1.1E-09	5.9	50
Cs-134	110	1.4E-10	46.4	51
Cs-137	160	2.0E-10	31.9	51
Ce-141	560	7.0E-10	9.0	50
Ce-144	13	1.6E-11	374.7	49

To Determine the current 10CFR20 Effluent Concentrations, use:

- The Stochastic ALI
- Divide by 2.4E9 cc/yr occupational breathing rate
- Divide by 300 for following three factors:
 - A factor of 50 for dose limit difference
 - A factor of 2 for age groups
 - A rounded factor of 3 for difference in hours, breathing rate

$$\text{Nb-95: } 2\text{E-9 } \mu\text{Ci/cc} \times 8\text{E9 cc/yr} \times 0.63 \text{ mrem}/\mu\text{Ci} = 8.48 \text{ mrem/yr}$$

$$\text{Nb-95: } 2\text{E-9 } \mu\text{Ci/cc} \times 8\text{E9 cc/yr} \times 5.8 \text{ mrem}/\mu\text{Ci} = 92.8 \text{ mrem/yr}$$

$$\text{Nb-95: } 1.1\text{E-9 } \mu\text{Ci/cc} \times 8\text{E9 cc/yr} \times 5.8 \text{ mrem}/\mu\text{Ci} = 49.8 \text{ mrem/yr}$$

To Determine the Recommended Effluent Concentrations, use:
 The recommended Stochastic ALI rounded to two significant figures
 Divide by 8E9 cc/yr Non-occupational breathing rate
 Divide by a factor of 50 for dose limit difference
 Divide by a factor of 2 for age groups
 Round to two significant figures

COMMITTED DOSE EQUIVALENT WORKSHEET

INTAKES

Nuclide	H-3	Cr-51 Y	Mn-54 W	Fe-59 D	Co-57 Y	Co-58 Y	Co-60 Y	Co-60 W	Zn-65 Y	Zr-95 D	Nb-95 Y	Ru-103 Y	Ru-106 Y	Sb-124 W	I-131 D	I-133 D	Cs-134 D	Cs-137 D	Ce-141 Y	Rb-88 D	Cs-138 D
Intakes	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1/1/92	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Total = 1

INTAKE TOTALS

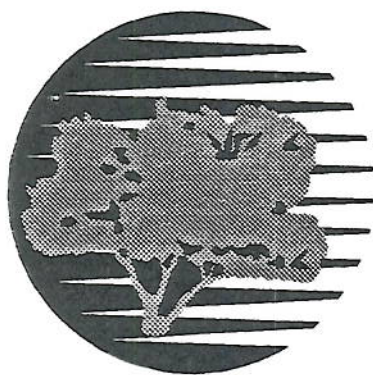
INTERNAL DOSES

Committed Dose Equivalents

(mrem)

Nuclide	Class	Intake (μCi)	Gonad mrem	Breast mrem	Lung mrem	R Mar mrem	B Surf mrem	Thy mrem	Rem mrem
H-3	V	1	0	0	0	0	0	0	0
Cr-51	Y	1	0	0	2	0	0	0	0
Mn-54	W	1	3	3	25	4	5	3	6
Fe-59	D	1	12	11	13	12	11	11	22
Co-57	Y	1	0	1	63	2	2	1	3
Co-58	Y	1	2	4	59	3	3	3	7
Co-60	Y	1	18	68	1277	64	50	60	133
Co-60	W	1	15	15	132	16	13	14	28
Zn-65	Y	1	8	11	78	13	12	11	17
Zr-95	D	1	7	7	8	48	381	5	8
Nb-95	Y	1	2	2	31	2	2	1	4
Ru-103	Y	1	1	1	58	1	1	1	5
Ru-106	Y	1	5	7	3848	7	6	6	44
Sb-124	W	1	4	3	153	4	5	3	16
I-131	D	1	0	0	2	0	0	1080	0
I-133	D	1	0	0	3	0	0	180	0
Cs-134	D	1	48	40	44	44	41	41	51
Cs-137	D	1	32	29	33	31	29	29	34
Ce-141	Y	1	0	0	62	0	1	0	5
Ce-144	Y	1	1	1	2927	11	18	1	71
Rb-88	D	1	0	0	1	0	0	0	0
Cs-138	D	1	0	0	1	0	0	0	0

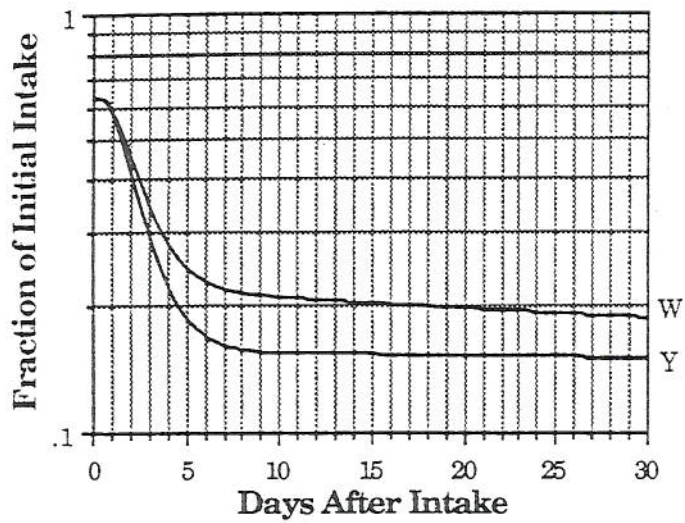
Totals = 158 205 8817 261 579 1451 455



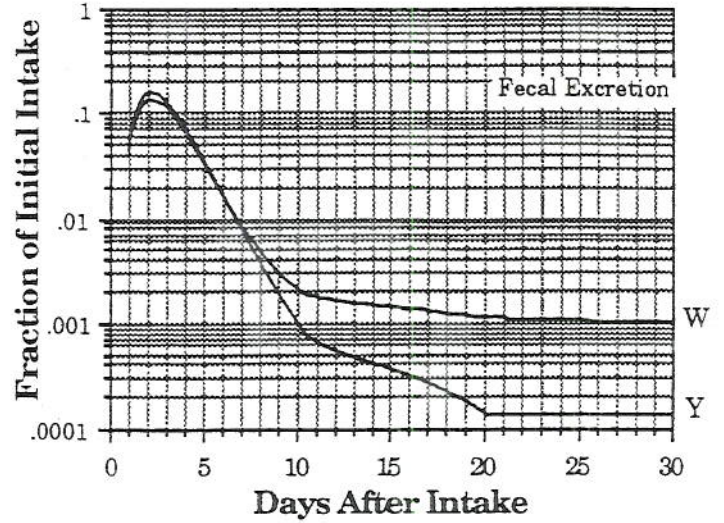
Alpha Emitter Internal Dose Information

Note in Bold: CDE and CEDE based on nCi intakes instead of μCi

Pu-238 Retention Fractions



Pu-238 Excretion Fractions



Notes

Pu-238

(All CDE and CEDE in mrem; ALI's in nCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
W	1.0E-3	2.80E-05	1.00E-09	1.84E-05	1.52E-04	1.90E-03	9.62E-10	7.02E-05
CDE per nCi Inhaled =		104	0	68	562	7030	0	260
CEDE per nCi Inhaled =		26	0	8	67	211	0	78

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule h eff	10% Rule (S)ALI	(S)ALI	(N)ALI
CEDE per nCi Inhaled =	1.06E-04	0.01	0.01	382	13	10	7

(B Surf)

Days	Whole Body Retention		Fecal Excretion	
	W	Y	W	Y
	Fract	Fract	Fract	Fract
0.1	0.639	0.639		
0.2	0.639	0.639		
0.3	0.638	0.638		
0.4	0.636	0.636		
0.5	0.634	0.632		
0.6	0.629	0.627		
0.7	0.623	0.620		
0.8	0.616	0.610		
0.9	0.607	0.599		
1	0.596	0.587	4.24E-2	5.21E-2
2	0.461	0.426	1.36E-1	1.61E-1
3	0.346	0.295	1.14E-1	1.31E-1
4	0.280	0.222	6.65E-2	7.36E-2
5	0.245	0.185	3.42E-2	3.64E-2
6	0.228	0.168	1.71E-2	1.73E-2
7	0.219	0.160	8.81E-3	8.13E-3
8	0.214	0.156	4.86E-3	3.89E-3
9	0.211	0.154	2.99E-3	1.91E-3
10	0.209	0.153	2.09E-3	9.87E-4
20	0.196	0.151	1.10E-3	1.36E-4
30	0.186	0.149	9.59E-4	1.34E-4
40	0.177	0.148	8.35E-4	1.32E-4
50	0.169	0.147	7.27E-4	1.30E-4
60	0.162	0.145	6.34E-4	1.28E-4
70	0.156	0.144	5.52E-4	1.26E-4
80	0.151	0.143	4.82E-4	1.24E-4
90	0.146	0.141	4.20E-4	1.23E-4
100	0.142	0.140	3.66E-4	1.21E-4
200	0.121	0.129	9.57E-5	1.05E-4
300	0.115	0.118	2.72E-5	9.15E-5
400	0.112	0.110	9.34E-6	7.96E-5

DAC (Y) = 3E-12
 DAC-hr = 3.6 pCi
 DAC-hr = 1.8 mrem (ALI)
 DAC-hr = 1.4 mrem (h)

"Recommended ALI/DAC"

(N)ALI = 7.1 nCi

(S)ALI = 13 nCi

DAC (Y) = 5.4E-12 *

DAC-hr = 6.5 pCi

DAC-hr = 2.50 mrem (ALI)

DAC-hr = 2.54 mrem (h)

* Pu-238 limited to 1094 DAC-hrs/yr

or 1000 DAC-hrs/yr to be conservative

Misc.

Data

T 1/2 = 87.75 yrs

α 5.50 MeV 72%

5.46 MeV 28%

γ 0

Γ = 0

mR/hr per Ci at 1 meter

Ingestion Model

f1 is 1E-05 for oxides

f1 is 1E-04 for nitrates

f1 is 1E-03 for others

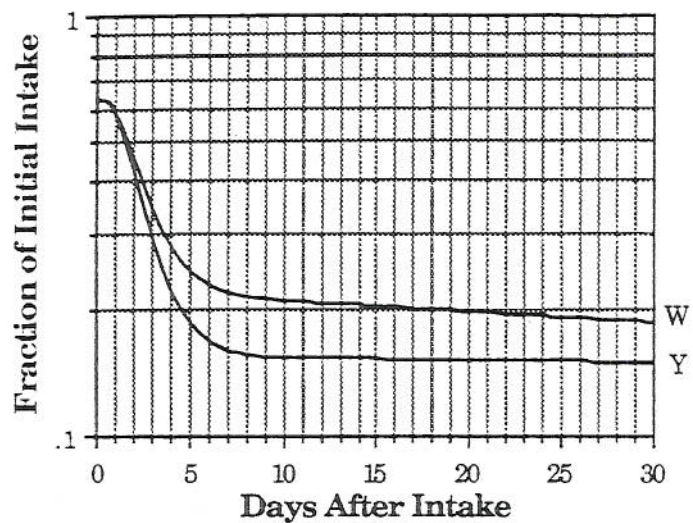
h (1E-5) = 0.05 mrem/nCi

h (1E-4) = 0.34 mrem/nCi

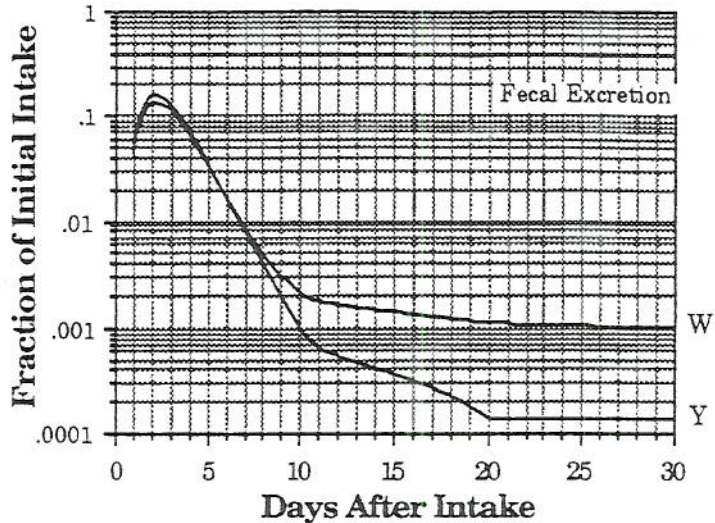
h (1E-3) = 3.2 mrem/nCi

.01%, .1%, 1% of the W Class inhalation dose

Pu-239 Retention Fractions



Pu-239 Excretion Fractions



Notes

Pu-239

(All CDE and CEDE in mrem; ALI's in nCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
W	1.0E-3	3.18E-05	9.22E-10	1.73E-05	1.69E-04	2.11E-03	9.03E-10	7.56E-05
CDE per nCi Inhaled =		118	0	64	625	7807	0	280
CEDE per nCi Inhaled =		29	0	8	75	234	0	84

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule h eff	10% Rule (S)ALI	(S)ALI	(N)ALI
CEDE per nCi Inhaled =	1.16E-04	0.01	0.01	423	12	10	6

(B Surf)

Days	Whole Body Retention		Fecal Excretion	
	W	Y	W	Y
	Fract	Fract	Fract	Fract
0.1	0.639	0.639		
0.2	0.639	0.639		
0.3	0.638	0.638		
0.4	0.636	0.636		
0.5	0.634	0.632		
0.6	0.629	0.627		
0.7	0.623	0.620		
0.8	0.616	0.610		
0.9	0.607	0.600		
1	0.596	0.587	4.24E-2	5.21E-2
2	0.461	0.426	1.36E-1	1.61E-1
3	0.346	0.295	1.14E-1	1.31E-1
4	0.280	0.222	6.65E-2	7.36E-2
5	0.245	0.185	3.42E-2	3.64E-2
6	0.228	0.168	1.71E-2	1.73E-2
7	0.219	0.160	8.81E-3	8.13E-3
8	0.214	0.156	4.86E-3	3.89E-3
9	0.211	0.154	2.99E-3	1.91E-3
10	0.209	0.153	2.09E-3	9.87E-4
20	0.197	0.151	1.10E-3	1.36E-4
30	0.186	0.149	9.59E-4	1.34E-4
40	0.177	0.148	8.35E-4	1.32E-4
50	0.169	0.147	7.28E-4	1.30E-4
60	0.162	0.146	6.34E-4	1.28E-4
70	0.156	0.144	5.53E-4	1.26E-4
80	0.151	0.143	4.82E-4	1.25E-4
90	0.146	0.142	4.21E-4	1.23E-4
100	0.142	0.141	3.67E-4	1.21E-4
200	0.121	0.129	9.62E-5	1.06E-4
300	0.115	0.119	2.73E-5	9.21E-5
400	0.113	0.110	9.42E-6	8.03E-5

DAC (Y) = 3E-12
 DAC-hr = 3.6 pCi
 DAC-hr = 1.8 mrem (ALI)
 DAC-hr = 1.55 mrem (h)

"Recommended ALI/DAC"

(N)ALI = 6.4 nCi

(S)ALI = 12 nCi

DAC (Y) = 5.0E-12 *

DAC-hr = 6.0 pCi

DAC-hr = 2.50 mrem (ALI)

DAC-hr = 2.58 mrem (h)

* Pu-239 limited to 1067 DAC-hrs/yr

or 1000 DAC-hrs/yr to be conservative

Misc.

Data

T 1/2 = 24400 yrs

α 5.16 MeV 88%

5.11 MeV 11%

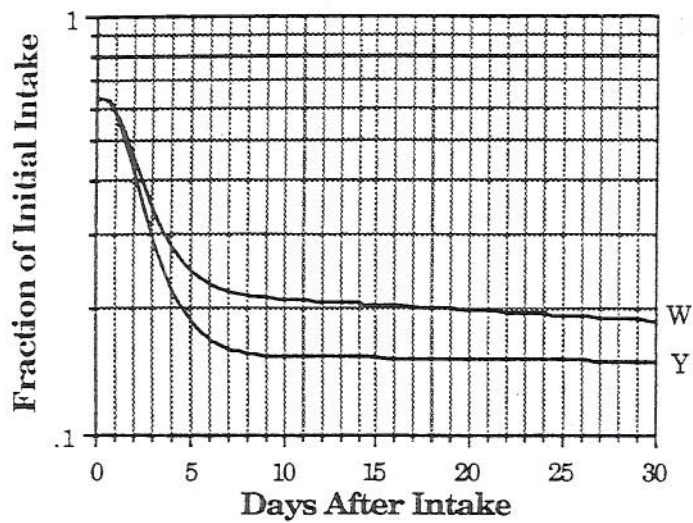
γ 0

Γ = 0

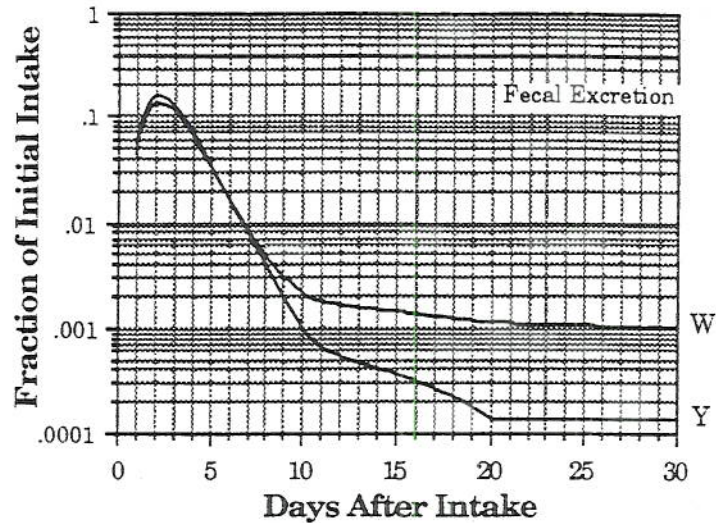
mR/hr per Ci at 1 meter

Ingestion Model
f1 is 1E-05 for oxides
f1 is 1E-04 for nitrates
f1 is 1E-03 for others
h (1E-5)= 0.05 mrem/nCi
h (1E-4)= 0.37 mrem/nCi
h (1E-3)= 3.54 mrem/nCi
.01%, .1%, 1% of the W Class inhalation dose

Pu-240 Retention Fractions



Pu-240 Excretion Fractions



Notes

Pu-240

(All CDE and CEDE in mrem; ALI's in nCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
W	1.0E-3	3.18E-05	9.51E-10	1.73E-05	1.69E-04	2.11E-03	9.03E-10	7.56E-05
CDE per nCi Inhaled =		118	0	64	625	7807	0	280
CEDE per nCi Inhaled =		29	0	8	75	234	0	84

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule h eff	10% Rule (S)ALI	(S)ALI	(N)ALI
CEDE per nCi Inhaled =	1.16E-04	0.01	0.01	423	12	10	6

(B Surf)

Days	Whole Body Retention		Fecal Excretion	
	W	Y	W	Y
	Fract	Fract	Fract	Fract
0.1	0.639	0.639		
0.2	0.639	0.639		
0.3	0.638	0.638		
0.4	0.636	0.636		
0.5	0.634	0.632		
0.6	0.629	0.627		
0.7	0.623	0.620		
0.8	0.616	0.610		
0.9	0.607	0.600		
1	0.596	0.587	4.24E-2	5.21E-2
2	0.461	0.426	1.36E-1	1.61E-1
3	0.346	0.295	1.14E-1	1.31E-1
4	0.280	0.222	6.65E-2	7.36E-2
5	0.245	0.185	3.42E-2	3.64E-2
6	0.228	0.168	1.71E-2	1.73E-2
7	0.219	0.160	8.81E-3	8.13E-3
8	0.214	0.156	4.86E-3	3.89E-3
9	0.211	0.154	2.99E-3	1.91E-3
10	0.209	0.153	2.09E-3	9.87E-4
20	0.197	0.151	1.10E-3	1.36E-4
30	0.186	0.149	9.59E-4	1.34E-4
40	0.177	0.148	8.35E-4	1.32E-4
50	0.169	0.147	7.28E-4	1.30E-4
60	0.162	0.146	6.34E-4	1.28E-4
70	0.156	0.144	5.53E-4	1.26E-4
80	0.151	0.143	4.82E-4	1.25E-4
90	0.146	0.142	4.21E-4	1.23E-4
100	0.142	0.141	3.67E-4	1.21E-4
200	0.121	0.129	9.62E-5	1.06E-4
300	0.115	0.119	2.73E-5	9.21E-5
400	0.113	0.110	9.42E-6	8.03E-5

DAC (Y) = 3E-12
 DAC-hr = 3.6 pCi
 DAC-hr = 1.8 mrem (ALI)
 DAC-hr = 1.55 mrem (h)

"Recommended ALI/DAC"

(N)ALI = 6.4 nCi

(S)ALI = 12 nCi

DAC (Y) = 5.0E-12 *

DAC-hr = 6.0 pCi

DAC-hr = 2.50 mrem (ALI)

DAC-hr = 2.58 mrem (h)

* Pu-240 limited to 1067 DAC-hrs/yr
 or 1000 DAC-hrs/yr to be conservative

Misc.

Data

T 1/2 = 6580 yrs

α 5.17 MeV 76%

5.12 MeV 24%

γ 0

Γ = 0

mR/hr per Ci at 1 meter

Ingestion Model
f1 is 1E-05 for oxides
f1 is 1E-04 for nitrates
f1 is 1E-03 for others
h (1E-5)= 0.05 mrem/nCi
h (1E-4)= 0.37 mrem/nCi
h (1E-3)= 3.54 mrem/nCi
.01%, .1%, 1% of the W Class inhalation dose

Am-241

(All CDE and CEDE in mrem; ALI's in nCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
W	1.0E-3	3.25E-05	2.67E-09	1.84E-05	1.74E-04	2.17E-03	1.60E-09	7.82E-05
CDE per nCi Inhaled =		120	0	68	644	8029	0	289
CEDE per nCi Inhaled =		30	0	8	77	241	0	87

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule			
	1.20E-04	0.01	0.01	h eff	(S)ALI	(S)ALI	(N)ALI	
CEDE per nCi Inhaled =	443	11	6.2 (B Surf)	435	11	10	6	

Whole Body Retention		Total Excreta	DAC (Y) = 3E-12
Days	W Fract	W Fract	DAC-hr = 3.6 pCi
0.1	0.638		DAC-hr = 1.8 mrem (ALI)
0.2	0.636		DAC-hr = 1.60 mrem (h)
0.3	0.634		
0.4	0.632		
0.5	0.629		
0.6	0.624		
0.7	0.618		
0.8	0.610		
0.9	0.601		

1	0.590
2	0.455
3	0.340
4	0.274
5	0.239
6	0.222
7	0.214
8	0.209
9	0.206
10	0.203
20	0.191
30	0.180
40	0.171
50	0.163
60	0.156
70	0.150
80	0.145
90	0.140
100	0.136
200	0.115
300	0.110
400	0.108

4.88E-2
1.35E-1 f
1.14E-1 f
6.64E-2 f
3.41E-2 f
1.71E-2 f
8.83E-3 f
4.89E-3 f
3.02E-3 f
2.12E-3 f
1.13E-3 f
9.86E-4 f
8.60E-4 f
7.50E-4 f
6.55E-4 f
5.71E-4 f
4.99E-4 f
4.35E-4 f
3.80E-4 f
9.90E-5
2.79E-5
9.71E-6

"Recommended ALI/DAC"
 (N)ALI = 6.2 nCi
 (S)ALI = 11 nCi
 DAC (Y) = 4.6E-12 *
 DAC-hr = 5.5 pCi
 DAC-hr = 2.51 mrem (ALI)
 DAC-hr = 2.46 mrem (h)

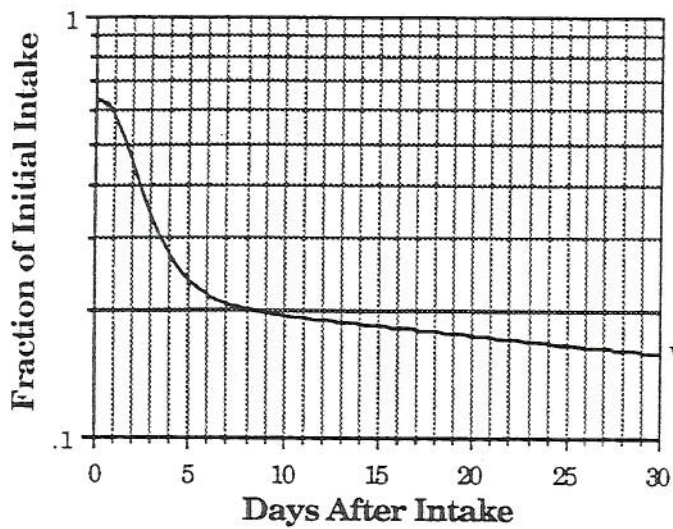
* Am-241 limited to 1128 DAC-hrs/yr
 or 1000 DAC-hrs/yr to be conservative

Misc.
 Data
 T 1/2 = 458 yrs
 α 5.49 MeV 85%
 5.44 MeV 15%
 γ 60
 Γ = 32
 mR/hr per Ci at 1 meter

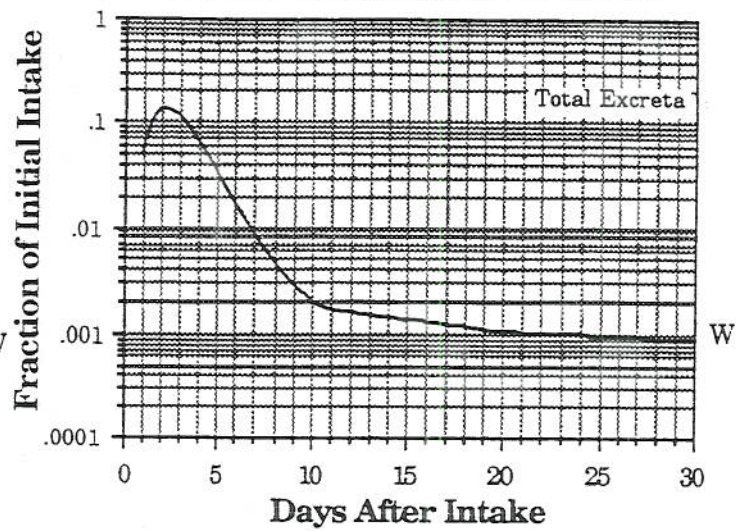
Ingestion Model
f1 is 0.001 for all forms
h eff = 9.84E-7 Sv/Bq 3.64 mrem/nCi
1% of the W Class inhalation dose

Note: f - fecal excretion >90%

Cm-242 Retention Fraction



Cm-242 Excretion Fraction



Notes

Cm-242

(All CDE and CEDE in mrem; ALI's in nCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
W	1.0E-3	5.70E-07	9.44E-10	1.55E-05	3.90E-06	4.87E-05	9.41E-10	2.45E-06
CDE per nCi Inhaled =		2	0	57	14	180	0	9
CEDE per nCi Inhaled =		0.5	0.0	6.9	1.7	5.4	0.0	2.7

* Most Restrictive Inhalation Classification

	h Based	h Based	10%	10%
	h eff	(S)ALI	(N)ALI	Rule
	4.67E-06	0.29	0.28	h eff
CEDE per nCi Inhaled =	17.3	290	277	16.7
			(B Surf)	300

Whole Body	Total	DAC (Y) =
Retention	Excreta	DAC-hr =
W	W	DAC-hr = 2.00 mrem (ALI)
Fract	Fract	DAC-hr = 2.08 mrem (h)

Days

0.1 0.637

0.2 0.636

0.3 0.634

0.4 0.631

0.5 0.627

0.6 0.622

0.7 0.616

0.8 0.608

0.9 0.598

1 0.588

2 0.451

3 0.336

4 0.269

5 0.234

6 0.217

7 0.207

8 0.202

9 0.198

10 0.195

20 0.175

30 0.159

40 0.144

50 0.132

60 0.121

70 0.111

80 0.103

90 0.096

100 0.089

200 0.049

300 0.031

400 0.020

4.86E-2

1.34E-1 f

1.13E-1 f

6.54E-2 f

3.35E-2 f

1.67E-2 f

8.57E-3 f

4.72E-3 f

2.90E-3 f

2.03E-3 f

1.04E-3 f

8.68E-4 f

7.25E-4 f

6.06E-4 f

5.07E-4 f

4.24E-4 f

3.55E-4 f

2.97E-4 f

2.49E-4 f

4.24E-5

7.76E-6

1.77E-6

DAC (Y) = 1E-10

DAC-hr = 120 pCi

DAC-hr = 2.00 mrem (ALI)

DAC-hr = 2.08 mrem (h)

"Recommended ALI/DAC"

(N)ALI = 280 nCi

(S)ALI = 1290 nCi

DAC (Y) = 1.2E-10 *

DAC-hr = 145 pCi

DAC-hr = 2.50 mrem (ALI)

DAC-hr = 2.51 mrem (h)

* Cm-242 limited to 1916 DAC-hrs/yr

2000 DAC-hrs/yr may be acceptable

Misc.

Data

T 1/2 = 163 days

α 6.12 MeV 74%

6.07 MeV 26%

γ 44 0.04%

Γ = 0

mR/hr per Ci at 1 meter

Ingestion Model

f1 is 0.001 for all forms

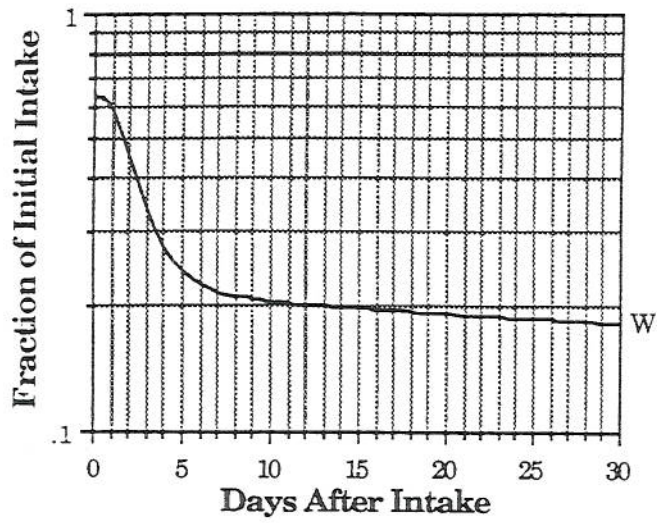
h eff = 3.10E-8 Sv/Bq

0.115 mrem/nCi

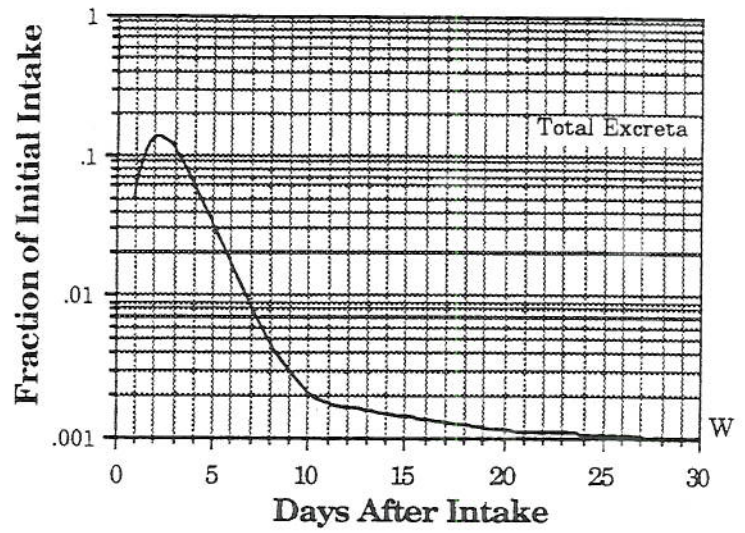
0.6% of the W Class inhalation dose

Note: f - fecal excretion >90%

Cm-243 Retention Fraction



Cm-243 Excretion Fraction



Notes

Cm-243

(All CDE and CEDE in mrem; ALI's in nCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
W	1.0E-3	2.07E-05	6.29E-09	1.94E-05	1.18E-04	1.47E-03	3.83E-09	5.76E-05
CDE per nCi Inhaled =		77	0	72	437	5439	0	213
CEDE per nCi Inhaled =		19.1	0.0	8.6	52.4	163.2	0.0	63.9

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule	10% Rule			
	8.30E-05	0.02	0.01	h eff	(S)ALI	(S)ALI	(N)ALI	
CEDE per nCi Inhaled =	307	16	9	298.6	17	20	9	

(B Surf)

Whole Body Retention		Total Excreta	DAC (Y) = 4E-12		
Days	W	W	DAC-hr = 4.8 pCi		
	Fract	Fract	DAC-hr = 1.20 mrem (ALI)		
0.1	0.637		DAC-hr = 1.47 mrem (h)		
0.2	0.637				
0.3	0.635				
0.4	0.632		"Recommended ALI/DAC		
0.5	0.628		(N)ALI = 9.2 nCi		
0.6	0.624		(S)ALI = 16 nCi		
0.7	0.618		DAC (Y) = 6.7E-12 *		
0.8	0.610		DAC-hr = 8.0 pCi		
0.9	0.600		DAC-hr = 2.51 mrem (ALI)		
1	0.590	4.88E-2	DAC-hr = 2.47 mrem (h)		
2	0.455	1.35E-1 f	* Cm-243 limited to 1143 DAC-hr		
3	0.340	1.14E-1 f	or 1000 DAC-hrs/yr to be conserv		
4	0.274	6.65E-2 f			
5	0.239	3.42E-2 f	Misc.		
6	0.223	1.71E-2 f	Data		
7	0.213	8.83E-3 f	T 1/2 =	32 yrs	
8	0.209	4.88E-3 f	α	6.06 MeV	6%
9	0.206	3.01E-3 f		5.99 MeV	6%
10	0.203	2.12E-3 f		5.79 MeV	73%
20	0.190	1.13E-3 f		5.74 MeV	12%
30	0.180	9.84E-4 f	γ	209	4%
40	0.170	8.57E-4 f		228	12%
50	0.163	7.47E-4 f		278	14%
60	0.156	6.52E-4 f	Γ =	40	
70	0.149	5.69E-4 f	mR/hr per Ci at 1 meter		
80	0.144	4.96E-4 f			
90	0.139	4.33E-4 f			
100	0.135	3.79E-4 f			
200	0.114	9.80E-5			
300	0.108	2.73E-5			
400	0.105	9.46E-6			

Ingestion Model		
f1 is 0.001 for all forms		
h eff = 6.79E-7 Sv/Bq		
2.51 mrem/nCi		

"Recommended ALI/DAC"

(N)ALI = 9.2 nCi

(S)ALI = 16 nCi

DAC (Y) = 6.7E-12 *

DAC-hr = 8.0 pCi

DAC-hr = 2.51 mrem (ALI)

DAC-hr = 2.47 mrem (h)

* Cm-243 limited to 1143 DAC-hrs/yr
or 1000 DAC-hrs/yr to be conservative

Misc.

Data

T 1/2 =

32 yrs

α

6.06 MeV

6%

5.99 MeV

6%

5.79 MeV

73%

5.74 MeV

12%

γ

209

4%

228

12%

278

14%

Γ =

40

mR/hr per Ci at 1 meter

Ingestion Model

f1 is 0.001 for all forms

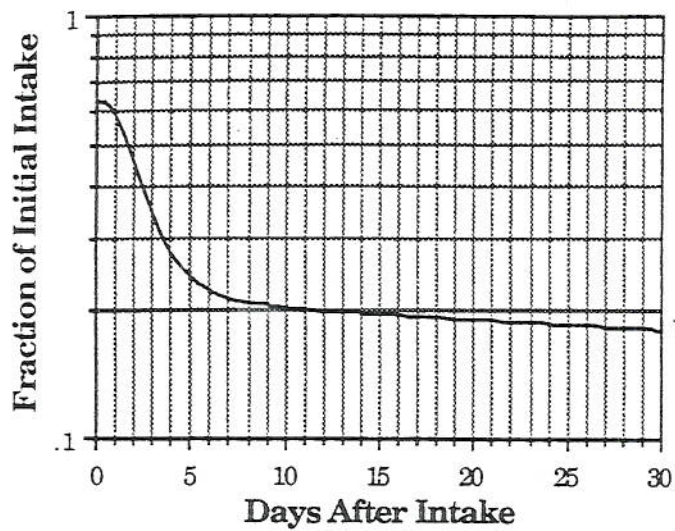
h eff = 6.79E-7 Sv/Bq

2.51 mrem/nCi

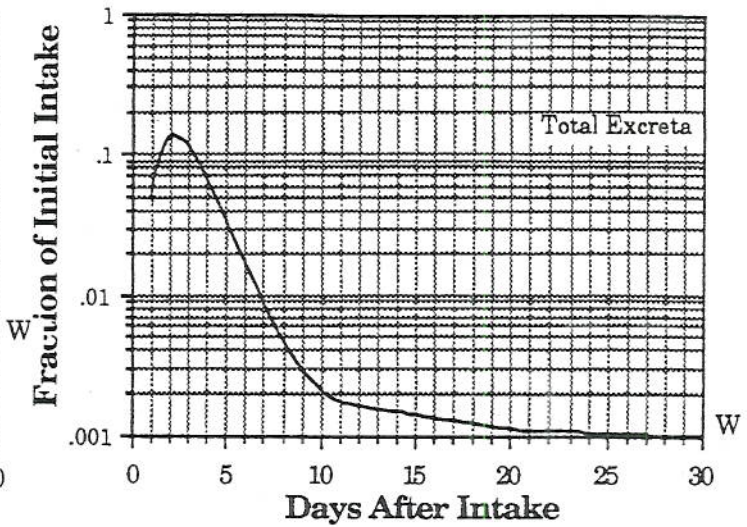
Note: f - fecal excretion >90%

1% of the W Class inhalation dose

Cm-244 Retention Fraction



Cm-244 Excretion Fraction



Notes

Cm-244

(All CDE and CEDE in mrem; ALI's in nCi)

Class*	f	Gonad	Breast	Lung	R Mar	B Surf	Thy	Rem
W	1.0E-3	1.59E-05	1.04E-09	1.93E-05	9.38E-05	1.17E-03	1.01E-09	4.78E-05
CDE per nCi Inhaled =		59	0	71	347	4329	0	177
CEDE per nCi Inhaled =		14.7	0.0	8.6	41.6	129.9	0.0	53.1

* Most Restrictive Inhalation Classification

	h eff	h Based (S)ALI	h Based (N)ALI	10% Rule h eff	10% Rule (S)ALI	(S)ALI	(N)ALI
CEDE per nCi Inhaled =	6.70E-05	0.02	0.01	239.3	21	20	10
	248	20	12				

(B Surf)

Whole Body Retention		Total Excreta
Days	W Fract	W Fract
0.1	0.637	
0.2	0.637	
0.3	0.635	
0.4	0.632	
0.5	0.628	
0.6	0.624	
0.7	0.618	
0.8	0.610	
0.9	0.600	
1	0.590	4.88E-2
2	0.455	1.35E-1 f
3	0.340	1.14E-1 f
4	0.273	6.65E-2 f
5	0.239	3.42E-2 f
6	0.222	1.71E-2 f
7	0.213	8.82E-3 f
8	0.209	4.88E-3 f
9	0.206	3.01E-3 f
10	0.203	2.12E-3 f
20	0.190	1.13E-3 f
30	0.180	9.83E-4 f
40	0.170	8.56E-4 f
50	0.162	7.45E-4 f
60	0.155	6.50E-4 f
70	0.148	5.67E-4 f
80	0.143	4.94E-4 f
90	0.139	4.31E-4 f
100	0.135	3.77E-4 f
200	0.113	9.71E-5
300	0.106	2.69E-5
400	0.103	9.28E-6

DAC (Y) = 5E-12
 DAC-hr = 6.0 pCi
 DAC-hr = 1.50 mrem (ALI)
 DAC-hr = 1.49 mrem (h)

"Recommended ALI/DAC"

(N)ALI = 12 nCi

(S)ALI = 20 nCi

DAC (Y) = 8.3E-12 *

DAC-hr = 10 pCi

DAC-hr = 2.49 mrem (ALI)

DAC-hr = 2.47 mrem (h)

* Cm-244 limited to 1160 DAC-hrs/yr

or 1000 DAC-hrs/yr to be conservative

Misc.

Data

T 1/2 = 17.6 yrs

α 5.81 MeV 77%

5.77 MeV 23%

γ 0

Γ = 0

mR/hr per Ci at 1 meter

Ingestion Model

f1 is 0.001 for all forms

h eff = 5.45E-7 Sv/Bq

2.02 mrem/nCi

1% of the W Class inhalation dose

Note: f - fecal excretion >90%