

The Health Physics and Radiological Health Handbook

Revised Edition

Edited
by
Bernard Shleien, Pharm. D.
Certified Health Physicist, ABHP FAPHA

Scinta, inc.

Silver Spring, MD

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Table 6.1 Specific Gamma Ray Dose Constants for Selected Nuclides Important to Radiological Assessment and Protection

(After Unger and Trubey ORNL/RSIC-45 1981)

The unshielded gamma ray dose-equivalent rate at 1 meter from a point source, i.e., the specific gamma ray dose constant, is a useful quantity in radiation protection applications. An extensive compilation of the nuclear data required to compute this constant is available (Kocher 1981) for approximately 500 nuclides important to dosimetry and radiological assessment applications, and it has been used to compute a table of the specific gamma ray dose constant. In addition, the half-life, mean attenuation coefficient, and thickness for 95% attenuation with a lead shield have been computed.

The data were computed on a different basis from earlier tabulations (Nachtigall 1969). The dose equivalent rate is given in SI units as mSv/h for a unit source of 1 MBq. To convert to the previous common normalization, one may note that 1 mCi is equal to 37 MBq and 1 Sv is equal to 100 rem. That is, to convert data in units of (mSv/h)/MBq to (mrem/h)/μCi, multiply by 3.7.

A second difference is that the conversion of gamma ray flux density was taken to be:

$$\ln D(E) = A + B(\ln E) + C(\ln E)^2 + F(\ln E)^3 \quad (\text{rem/h})(\text{cm}^2\text{-s}) \quad (1)$$

where the energy is in units of MeV, and the constants are given in Table 6.1.1 taken from ANSI 1977.

The specific gamma ray dose constant, Γ , was summed over n according to:

$$\Gamma = (1/4\pi R^2) \sum S_i D(E_i) \quad (\text{rem/h per Bq}) \quad (2)$$

where $R = 100$ cm,

n = number of gamma rays emitted by the nuclide,

S_i = emission probability of each gamma ray,

E_i = energy of the gamma ray (MeV),

$D(E_i)$ = dose rate per unit flux density from Eq. 1.

Only gamma rays of energy greater than 0.01 MeV were included.

The mean attenuation coefficient^a was determined by first computing the thickness of lead required for 95% attenuation, i.e.,

$$0.05 \Gamma = \sum \Gamma_i \exp(-\mu(E_i) t) \quad (3)$$

where $\Gamma_i = S_i D(E_i)/(4\pi R^2)$

μE_i = linear attenuation coefficient (Hubbell 1969) for lead,

t = thickness required (cm).

The value of t was determined by an iterative procedure, i.e., Newton's method. The value of the mean attenuation coefficient was determined by solving the following equation for μ :

$$0.05 = \exp(-\mu t).$$

^a An alternative description of μ as employed in Table 6.1.2 might be the effective attenuation coefficient for lead at 95% attenuation.

The results, presented in Table 6.1.2 were computed using computer-readable data (Kocher 1981) available as DLC-80/DRALIST from the Radiation Shielding Information Center. The computations were performed using a computer program, SPEC-GAM, programmed by the first author for the ORNL Engineering Physics Information Centers (EPIC) Data General Eclipse S/130 computer in FORTRAN.

Table 6.1.1 Gamma Ray Flux-to-Dose Rate Conversion Factors
Polynomial Coefficients in Analytic Form

$$\ln D(E) = A + Bx + Cx^2 + Fx^3$$

$D(E) = (\text{rem/h})(\text{cm}^2\text{-s})$, $E = \text{Photon Energy in MeV}$ and $x = \ln E$

(After Unger and Trubey ORNL/RSIC-45 1981)

Photon Energy (Mev)		A	B	C	F
0.01 to	0.03	-20.477	-1.7454		
0.03 to	0.5	-13.626	-0.57117	-1.0954	-0.24897
0.5 to	5.0	-13.133	0.72008	-0.033603	
5.0 to	15.0	-12.791	0.28309	0.10873	

Table 6.1.2 Specific Gamma Ray Dose Constants at 1 Meter

Units: Γ in (mSv/h)/MBq, μ in cm^{-1}

(After Unger and Trubey ORNL/RSIC-45 1981)

Nuclide	Half-Life	Γ	μ	Nuclide	Half-Life	Γ	μ
7Be	53.4d	9.292-6	1.879	59Fe	44.6d	1.789-4	0.705
11C	20.5m	1.937-4	1.695	56Co	78.8d	5.205-4	0.643
13N	10.0m	1.938-4	1.695	57Co	270.9d	4.087-5	39.800
16N	7.1s	3.984-4	0.495	58Co	70.8d	1.659-4	1.008
15O	2.0m	1.940-4	1.695	58mCo	9.1h	2.637-8	528.9
18F	1.8h	1.879-4	1.695	60Co	5.3y	3.703-4	0.679
22Na	2.6y	3.620-4	0.854	60mCo	10.5m	9.057-7	0.837
24Na	15.0h	5.237-4	0.525	61Co	1.6h	2.286-5	1.706
27Mg	9.5m	1.449-4	0.869	56Ni	6.1d	2.941-4	1.002
28Mg	20.9h	2.375-4	0.763	57Ni	1.5d	2.911-4	0.681
26Al	7.2+5y	4.047-4	0.652	65Ni	2.5h	8.038-5	0.655
28Al	2.2m	2.384-4	0.548	61Cu	3.4h	1.536-4	1.499
31Si	2.6h	1.306-7	0.676	62Cu	9.7m	1.910-4	1.680
38Cl	37.2m	1.942-4	0.527	64Cu	12.7h	3.566-5	1.615
41Ar	1.8h	1.881-4	0.667	67Cu	61.9d	2.363-5	13.011
40K	1.28+9y	2.208-5	0.619	62Zn	9.3h	8.990-5	1.592
42K	12.4h	3.869-5	0.604	65Zn	244.4d	8.924-5	0.738
43K	22.6h	1.811-4	1.545	69Zn	55.6m	1.168-9	2.362
45Ca	162.7d	8.072-12	823.3	69mZn	13.8h	7.983-5	2.153
47Ca	4.5d	1.581-4	0.686	66Ga	9.4h	3.504-4	0.615
49Ca	8.7m	3.615-4	0.472	67Ga	3.3d	3.004-5	4.768
44Sc	3.9h	3.602-4	0.918	68Ga	1.1h	1.789-4	1.609
46Sc	83.8d	3.155-4	0.787	72Ga	14.1h	3.936-4	0.643
46mSc	18.7s	1.809-5	24.378	68Ge	288.d	1.634-5	1345.
47Sc	3.4d	2.170-5	18.513	71Ge	11.8d	1.653-5	1345.
48Sc	1.8d	5.117-4	0.728	77Ge	11.3h	1.934-4	1.089
49Sc	57.4m	1.407-7	0.556	72As	1.1d	3.148-4	1.107
44Ti	47.3y	3.909-5	28.726	73As	80.3d	3.784-5	662.1
45Ti	3.1h	1.653-4	1.688	74As	17.8d	1.472-4	1.475
51Ti	5.8m	7.130-5	2.109	76As	1.1d	7.408-5	1.036
48V	16.0d	4.598-4	0.770	77As	1.6d	1.699-6	2.522
52V	3.7m	2.057-4	0.626	73Se	7.1h	2.969-4	2.212
49Cr	42.1m	2.029-4	1.765	75Se	119.8d	2.323-4	9.079
51Cr	27.7d	6.320-6	3.833	77Br	2.4d	1.923-4	3.068
52Mn	5.6d	5.430-4	0.773	80Br	17.4m	2.166-5	1.625
52mMn	21.4m	3.903-4	0.797	80mBr	4.4h	1.900-4	698.2
54Mn	312.7d	1.382-4	0.932	82Br	1.5d	4.377-4	0.906
56Mn	2.6h	2.496-4	0.661	83Br	2.4h	1.401-6	1.612
57Mn	1.5m	3.031-5	1.692	84Br	31.8m	2.392-4	0.573
52Fe	8.3h	1.413-4	1.857	85Br	172. s	1.059-5	0.834

Table 6.1.2 Specific Gamma Ray Dose Constants (Continued)

Units: Γ in (mSv/h)/MBq, μ in cm^{-1}
 (After Unger and Trubey ORNL/RSIC-45 1981)

Nuclide	Half-Life	Γ	μ	Nuclide	Half-Life	Γ	μ
79Kr	1.5d	1.631-4	3.139	91Nb	1.0+4y	8.832-5	1330.
81Kr	2.1+5y	1.172-4	795.2	91mNb	61. d	7.160-5	3.692
83mKr	1.8h	3.209-5	801.4	92Nb	3.6+7y	3.414-4	1.097
85Kr	10.7y	4.232-7	1.681	92mNb	10.1d	2.413-4	0.977
85mKr	4.5h	4.328-5	9.045	93mNb	14.6y	1.421-5	1292.
87Kr	1.3h	1.169-4	0.627	94Nb	2.0+4y	2.648-4	0.983
88Kr	2.8h	2.769-4	0.556	94mNb	6.3m	5.481-5	1180.
89Kr	3.2m	2.626-4	0.622	95Nb	35.1d	1.298-4	1.023
90Kr	32.3s	2.073-4	0.733	95mNb	3.6d	6.390-5	16.959
81Rb	4.6h	2.264-4	2.452	96Nb	23.3h	4.120-4	0.926
82Rb	1.2m	2.104-4	1.572	97Nb	1.2h	1.175-4	1.203
83Rb	86.2d	2.085-4	2.186	97mNb	60. s	1.262-4	1.063
84Rb	32.9d	2.326-4	1.176	91Mo	15.5m	1.898-4	1.660
86Rb	18.7d	1.458-5	0.747	93Mo	3500. y	7.963-5	1292.
88Rb	17.8m	8.701-5	0.571	99Mo	2.8d	3.052-5	1.165
89Rb	15.4m	2.960-4	0.630	101Mo	14.6m	2.391-4	0.736
90Rb	157. s	2.548-4	0.518	95Tc	20.0h	2.092-4	1.179
90mRb	258.0s	4.429-4	0.585	95mTc	61. d	1.939-4	1.407
82Sr	25.0d	1.065-4	842.8	96Tc	4.3d	4.899-4	0.994
85Sr	64.8d	2.052-4	2.244	96mTc	51.5m	4.430-5	2.427
85mSr	1.1h	6.004-5	8.972	97Tc	2.6+6y	7.596-5	1176.
87mSr	2.8h	8.010-5	2.872	97mTc	89. d	5.233-5	1060.
89Sr	50.6d	2.205-8	0.858	98Tc	4.2+6y	2.430-4	1.130
91Sr	9.5h	1.118-4	0.865	99Tc	2.1+5y	1.242-10	21.144
92Sr	2.7h	1.946-4	0.651	99mTc	6.0h	3.317-5	27.731
93Sr	7.3m	3.665-4	0.780	101Tc	14.2m	6.916-5	2.913
86Y	14.7h	6.292-4	0.782	97Ru	2.9d	1.194-4	10.310
87Y	3.3d	1.861-4	2.486	103Ru	39.4d	8.970-5	1.724
88Y	106.6d	4.819-4	0.661	105Ru	4.4h	1.397-4	1.202
90mY	3.2h	1.316-4	2.213	103mRh	56.1m	6.912-6	864.0
91Y	58.5d	5.403-7	0.697	105Rh	1.5d	1.588-5	3.949
91mY	49.7m	1.028-4	1.527	105mRh	45. s	4.251-5	98.565
92Y	3.5h	3.971-5	0.784	106Rh	29.9s	3.734-5	1.260
93Y	10.1h	1.396-5	0.696	103Pd	17.0d	6.219-5	871.6
86Zr	16.5h	2.383-4	11.219	109Pd	13.5h	1.310-7	1.706
88Zr	83.4d	1.710-4	3.559	106mAg	8.5d	5.237-4	0.948
89Zr	3.3d	2.662-4	1.046	108Ag	2.4m	4.399-6	1.545
95Zr	64.0d	1.258-4	1.059	108mAg	127. y	3.436-4	1.392
97Zr	16.9h	2.922-5	0.803	109mAg	39.6s	2.722-5	548.6
90Nb	14.6h	6.597-4	0.627	110Ag	24.6s	5.558-6	1.210

Table 6.1.2 Specific Gamma Ray Dose Constants (Continued)

Units: Γ in (mSv/h)/MBq, μ in cm^{-1}
 (After Unger and Trubey ORNL/RSIC-45 1981)

Nuclide	Half-Life	Γ	μ	Nuclide	Half-Life	Γ	μ
110mAg	249.9d	4.466-4	0.876	131mTe	30. h	2.452-4	0.895
111Ag	7.5d	5.329-6	3.440	132Te	3.3d	7.549-5	10.115
109Cd	464. d	4.983-5	683.6	133Te	12.4m	1.584-4	0.898
111mCd	48.7m	8.463-5	8.502	133mTe	55.4m	3.689-4	0.851
115Cd	2.2d	4.068-5	1.711	134Te	41.8m	1.731-4	1.365
115mCd	44.6d	3.433-6	0.778	122I	3.6m	1.901-4	1.555
117Cd	2.5h	1.740-4	0.733	123I	13.1h	7.478-5	19.341
117mCd	3.4h	2.935-4	0.619	124I	4.2d	2.050-4	0.968
111In	2.8d	1.356-4	10.321	125I	60.1d	7.432-5	373.1
113mIn	1.7h	6.567-5	2.858	126I	12.9d	1.055-4	1.452
114In	1.2m	6.223-6	1.358	128I	25.0m	1.616-5	1.988
114mIn	49.5d	4.074-5	2.318	129I	1.6+7y	3.401-5	287.0
115mIn	4.4h	5.329-5	4.220	130I	12.4h	3.791-4	1.187
116mIn	54.1m	3.660-4	0.674	131I	8.0d	7.647-5	2.409
117In	43.8m	1.359-4	1.682	132I	2.3h	3.858-4	0.972
117mIn	1.9h	3.060-5	5.608	133I	20.8h	1.105-4	1.321
113Sn	115.1d	4.844-5	462.8	134I	52.6m	4.251-4	0.845
117mSn	13.6d	6.796-5	26.595	135I	6.6h	2.327-4	0.664
119mSn	293.0d	2.789-5	517.0	136I	83. s	3.417-4	0.579
123Sn	129.2d	1.062-6	0.744	122Xe	20.1h	4.867-5	7.257
125Sn	9.6d	4.674-5	0.735	123Xe	2.1h	1.416-4	1.147
126Sn	1.0+5y	3.408-5	31.647	125Xe	16.8h	9.622-5	4.757
117Sb	2.8h	8.219-5	14.115	127Xe	36.4d	9.331-5	7.526
122Sb	2.7d	8.223-5	1.400	129mXe	8.9d	6.165-5	235.8
124Sb	60.2d	2.883-4	0.714	131mXe	11.8d	2.533-5	263.7
125Sb	2.8y	1.028-4	1.764	133Xe	5.2d	2.783-5	39.877
126Sb	12.4d	4.860-4	1.172	133mXe	2.2d	3.034-5	19.750
126mSb	19.0m	2.824-4	1.266	135Xe	9.1h	5.121-5	5.015
127Sb	3.9d	1.200-4	1.255	135mXe	15.4m	8.651-5	1.668
129Sb	4.4h	2.315-4	0.840	137Xe	3.8m	3.346-5	1.247
121Te	16.8d	1.455-4	1.683	138Xe	14.1m	1.679-4	0.611
121mTe	154. d	6.703-5	5.779	126Cs	1.6m	2.166-4	1.581
123Te	1.0+13y	2.687-5	429.8	129Cs	1.3d	9.725-5	3.213
123mTe	119.7d	5.261-5	24.041	131Cs	9.7d	3.363-5	310.3
125mTe	58. d	6.168-5	368.9	132Cs	6.5d	1.556-4	1.295
127Te	9.4h	9.428-7	2.419	134Cs	2.1y	2.701-4	1.095
127mTe	109. d	1.977-5	373.5	134mCs	2.9h	1.904-5	75.989
129Te	1.2h	1.833-5	2.063	136Cs	13.2d	3.632-4	0.872
129mTe	33.6d	1.997-5	2.000	137Cs	30.17y	1.032 x 10 ⁴	
131Te	25.0m	8.073-5	1.203	138Cs	32.2m	3.422-4	0.634

Table 6.1.2 Specific Gamma Ray Dose Constants (Continued)

Units: Γ in (mSv/h)/MBq, μ in cm^{-1}
 (After Unger and Trubey ORNL/RSIC-45 1981)

Nuclide	Half-Life	Γ	μ	Nuclide	Half-Life	Γ	μ
139Cs	9.4m	4.260-5	0.596	162Gd	9.7m	8.341-5	2.282
131Ba	11.8d	1.244-4	2.239	157Tb	150. y	2.426-6	114.4
133Ba	10.5y	1.231-4	4.188	160Tb	72.3d	1.788-4	0.834
133mBa	1.6d	3.372-5	8.792	162Tb	7.8m	1.924-4	1.018
135mBa	1.2d	2.974-5	9.494	157Dy	8.1h	8.357-5	4.052
137mBa	2.6m	1.081-4	1.224	165Dy	2.3h	6.193-6	1.817
139Ba	1.4h	7.717-6	2.807	166Dy	3.4d	1.550-5	23.196
140Ba	12.8d	4.446-5	1.889	166Ho	1.1d	6.270-6	0.879
141Ba	18.3m	1.562-4	0.981	166mHo	1200.0y	2.870-4	1.140
142Ba	10.7m	1.537-4	0.841	169Er	9.4d	3.406-10	46.160
141La	3.9h	6.112-6	0.633	171Er	7.5h	8.010-5	3.957
142La	1.6h	3.656-4	0.558	170Tm	128.6d	1.673-6	29.074
139Ce	137.7d	5.554-5	22.320	171Tm	1.9y	2.597-7	60.086
141Ce	32.5d	1.979-5	26.056	169Yb	32.0d	8.837-5	13.301
143Ce	1.4d	6.893-5	2.109	175Yb	4.2d	8.233-6	2.998
144Ce	284.3d	6.302-6	35.806	177Lu	6.7d	7.636-6	10.935
142Pr	19.1h	8.106-6	0.591	177mLu	160.1d	2.112-4	3.983
143Pr	13.6d	1.524-12	1.061	181Hf	42.4d	1.061-4	2.078
144Pr	17.3m	4.600-6	0.619	182Ta	114.7d	2.086-4	0.751
144mPr	7.2m	9.933-6	184.2	181W	120.9d	1.389-5	52.038
147Nd	11.0d	3.769-5	2.234	185W	75.1d	5.465-9	33.602
149Nd	1.7h	8.112-5	2.200	187W	23.8h	8.886-5	1.353
143Pm	265. d	7.216-5	1.222	188W	69.4d	3.615-7	5.327
144Pm	363. d	2.958-4	1.299	182Re	2.7d	3.078-4	0.853
145Pm	17.7y	2.418-5	152.1	182mRe	12.7h	1.994-4	0.761
146Pm	2020. d	1.462-4	1.316	183Re	70. d	4.257-5	17.021
147Pm	2.6d	7.232-10	36.526	184Re	38.0d	1.573-4	0.963
148Pm	5.4d	8.937-5	0.741	184mRe	169. d	7.678-5	1.211
148mPm	41.3d	3.567-4	1.210	186Re	3.8d	4.909-6	28.571
149Pm	2.2d	2.317-6	2.479	188Re	17.0h	1.094-5	1.324
151Pm	1.2d	7.086-5	1.966	185Os	93.6d	1.310-4	1.219
151Sm	90. y	2.442-8	776.6	190mOs	9.9m	3.018-4	1.684
153Sm	1.9d	2.440-5	69.799	191Os	15.4d	1.837-5	34.767
152Eu	13.6y	2.012-4	0.831	191mOs	13.0h	1.449-6	40.828
152mEu	9.3h	5.746-5	0.911	193Os	1.2d	1.414-5	2.450
154Eu	8.8y	2.042-4	0.802	190Ir	11.8d	2.681-4	1.580
155Eu	5.0y	1.804-5	28.563	190mIr	1.2h	6.120-11	456.9
156Eu	15.2d	1.992-4	0.647	190mIr	3.2h	1.499-5	40.962
153Gd	241.6d	4.659-5	79.273	192Ir	74.0d	1.599-4	2.331
159Gd	18.6h	1.059-5	3.622	193mIr	11.9d	1.017-7	37.618

Table 6.1.2 Specific Gamma Ray Dose Constants (Continued)

Units: Γ in (mSv/h)/MBq, μ in cm^{-1}

(After Unger and Trubey ORNL/RSIC-45 1981)

Nuclide	Half-Life	Γ	μ	Nuclide	Half-Life	Γ	μ
194Ir	19.1h	1.673-5	1.248	211Po	0.5s	1.328-6	1.016
194mIr	171. d	4.372-4	1.587	213Po	4.2-6s	5.146-9	1.002
191Pt	2.7d	6.588-5	2.483	214Po	1.6-4s	1.398-8	0.975
193mPt	4.3d	4.649-6	40.629	215Po	1.8-3s	2.861-8	2.152
195mPt	4.0d	2.029-5	36.632	216Po	0.1s	2.424-9	0.965
197Pt	18.3h	5.647-6	17.673	211At	7.2h	6.120-5	61.088
197mPt	1.6h	1.931-5	4.581	217At	0.032s	4.331-8	1.378
194Au	1.6d	1.784-4	0.753	218Rn	0.035s	1.367-7	1.337
195Au	183. d	2.362-5	36.236	219Rn	4.0s	1.419-5	3.555
195mAu	30.6s	4.132-5	6.174	220Rn	55.6s	9.723-8	1.534
196Au	6.2d	9.922-5	3.261	222Rn	3.8d	7.390-8	1.690
198Au	2.7d	7.882-5	2.317	221Fr	4.8m	1.193-5	11.522
199Au	3.1d	1.866-5	16.121	223Fr	21.8m	8.930-5	67.566
197Hg	2.7d	1.874-5	29.898	222Ra	38.0s	2.115-6	3.912
197mHg	23.8h	2.059-5	14.537	223Ra	11.4d	8.789-5	10.794
203Hg	46.6d	6.841-5	6.007	224Ra	3.6d	2.967-6	8.124
200Tl	1.1d	2.253-4	0.886	225Ra	14.8d	4.164-5	304.4
201Tl	3.0d	2.372-5	26.211	226Ra	1600.0y	3.274-6	18.693
202Tl	12.2d	9.438-5	2.272	225Ac	10.0d	5.172-5	472.6
204Tl	3.8y	3.014-7	30.056	227Ac	21.8y	2.364-6	690.1
207Tl	4.8m	3.524-7	0.870	228Ac	6.1h	2.281-4	0.985
208Tl	3.1m	4.605-4	0.554	226Th	30.9m	1.818-5	138.9
209Tl	2.2m	3.496-4	0.705	227Th	18.7d	1.145-4	14.730
210Tl	1.3m	4.601-4	0.736	228Th	1.9y	2.142-5	731.9
203Pb	2.2d	1.828-4	8.722	229Th	7340.0y	1.989-4	103.7
204mPb	1.1h	3.650-4	0.946	230Th	7.7+4d	1.861-5	815.2
205Pb	1.5+7y	6.789-5	1345.	231Th	1.1d	1.473-4	679.1
210Pb	22.3y	6.801-5	1098.	232Th	1.4+10y	1.848-5	828.7
211Pb	36.1m	9.836-6	1.211	233Th	22.3m	2.587-5	3.684
212Pb	10.6h	7.389-5	11.112	234Th	24.1d	2.038-5	148.5
214Pb	26.8m	8.742-5	4.027	230Pa	17.4d	2.387-4	1.322
206Bi	6.2d	6.820-4	0.945	231Pa	3.3+4d	1.011-4	131.7
207Bi	33.4y	3.603-4	1.015	233Pa	27.0d	1.335-4	7.024
208Bi	3.7+5y	4.110-4	0.532	234Pa	6.7h	5.356-4	1.107
211Bi	2.1m	1.274-5	3.617	234mPa	1.2m	2.776-6	0.978
212Bi	1.0h	5.264-5	1.042	230U	20.8d	2.463-5	683.5
213Bi	45.6m	3.140-5	2.094	231U	4.2d	2.120-4	293.4
214Bi	19.9m	2.268-4	0.672	232U	72.0y	2.403-5	716.7
209Po	102.0y	9.811-7	1.288	233U	1.59+5y	7.866-6	705.0
210Po	138. d	1.424-9	0.967	234U	2.44+5y	2.097-5	720.7

Table 6.1.2 Specific Gamma Ray Dose Constants (Continued)

Units: Γ in (mSv/h)/MBq, μ in cm^{-1}
 (After Unger and Trubey ORNL/RSIC-45 1981)

Nuclide	Half-Life	Γ	μ	Nuclide	Half-Life	Γ	μ
235U	7.04+8y	9.159-5	22.675	246Am	25.0m	2.149-5	0.899
236U	2.34+7y	1.992-5	722.4	242Cm	163.2d	1.949-5	1054.
237U	6.7d	1.589-4	54.239	243Cm	28.5y	1.286-4	23.268
238U	4.47+9y	1.763-5	722.5	244Cm	18.1y	1.741-5	1054.
239U	23.4m	3.630-5	23.988	245Cm	8500.0y	1.220-4	140.0
240U	14.1h	7.686-5	921.3	246Cm	4750.0y	1.551-5	1054.
235Np	1.1y	6.979-5	840.5	247Cm	1.6+7y	7.217-5	2.675
236Np	1.15+5y	2.833-4	161.6	248Cm	3.4+5y	1.227-5	1054.
236mNp	22.5h	6.390-5	69.674	249Cm	1.1h	4.007-6	1.478
237Np	2.1+6y	1.251-4	512.0	250Bk	3.2h	1.834-4	0.862
238Np	2.1d	1.497-4	0.965	248Cf	333.5d	1.229-5	1271.
239Np	2.4d	1.386-4	19.449	249Cf	350.6y	1.119-4	3.459
240Np	65. m	3.826-4	1.342	250Cf	13.1y	1.212-5	1269.
240mNp	7.4m	1.144-4	1.489	251Cf	900.0y	1.162-4	43.960
236Pu	2.9y	2.405-5	863.6	252Cf	2.6y	1.131-5	1269.
237Pu	45.3d	1.039-4	212.7	253Cf	17.8d	2.080-7	1272.
238Pu	87.8y	2.135-5	864.8	254Cf	60.5d	1.311-11	122.5
239Pu	2.41+4y	8.145-6	860.3	253Es	20.5d	6.921-6	1196.
240Pu	6569. y	2.030-5	864.4	254Es	275.7d	1.490-4	1229.
242Pu	3.76+5y	1.684-5	864.4	254mEs	1.6d	1.519-4	1.404
243Pu	5.0h	2.509-5	35.548	255Es	39.8d	8.529-7	1263.
244Pu	8.3+7y	1.462-5	865.1	254Fm	3.2h	1.121-5	1375.
245Pu	10.6h	1.046-4	1.432	255Fm	20.1h	8.721-5	1334.
246Pu	10.9d	2.727-5	10.771				
241Am	432.2y	8.479-5	260.7				
242Am	16.0h	5.476-5	720.7				
242mAm	152.0y	4.950-5	1132.				
243Am	7380.0y	8.456-5	71.213				
244Am	10.1h	3.168-4	1.420				
245Am	2.0h	2.341-5	17.710				

Analysis Flow Diagram

