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**GAMMA-EMISSION DATA FOR THE CALCULATION
OF EXPOSURE RATES FROM NUCLEAR DEBRIS.**
Vol. II. Induced Activities

by
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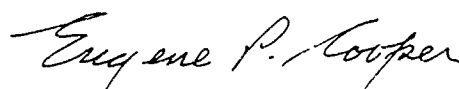
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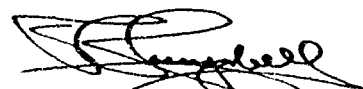
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ABSTRACT

Photon energies and photon abundances have been compiled and summarized for some induced activities which may result from nuclear events. The data are presented in tabular form, including photon energies and abundances for the gamma rays, X rays, and beta particles emitted per disintegration. A list of multipliers is also presented for converting activities of the radionuclides to infinite-plane exposure rates.

SUMMARY

The radiation exposure rate from fallout depends upon the energies and abundances of the photons emitted by the fission products and the induced activities. The latter may result from activation of device materials or of materials on the site of the detonation, including the ground, and may sometimes make a major contribution to the total exposure rate. This report presents a compilation of the photon energies and abundances for some induced activities which may be present in debris from nuclear weapons. A list of factors for converting radionuclide activities to infinite-plane exposure-rate contributions is also presented.

INTRODUCTION

In order to predict exposure rates for fallout, it is necessary to know the energies and abundances per disintegration of the gamma photons emitted by the fission products and the induced activities. In addition, the exposure per unit of photon flux, as a function of energy, must be calculated for the situation of interest. This latter result can be expressed as the average exposure at a well-defined point (in a standard situation) that results from one disintegration of a specified radionuclide. This value can be regarded as a multiplier for converting the activity of that nuclide to its contribution to the exposure rate.

Volume I of this series¹ presented gamma-photon energies and abundances for the fission products of uranium and plutonium. Appendix I of this volume presents similar data on some radionuclides which may reasonably be expected to be induced by neutron activation of materials in the vicinity of a nuclear explosion or of a reactor or of the materials of the device itself. Many of the radionuclides included in this volume have been reported to be present in fallout; the presence of others has been a matter only of speculation. Appendix II presents a list of multipliers for converting nuclide activities to exposure-rate contributions.

SOURCES AND INTERPRETATION OF PUBLISHED DECAY DATA

The Nuclear Data Sheets (NDS) published by the National Academy of Sciences-National Research Council, including additions and revisions to date, formed the basic source for this compilation. In addition, many recently published papers which have not yet been incorporated into NDS were taken into consideration.

Data on the gamma and X radiation accompanying beta decay are usually presented in the literature with a view toward establishing the energy-level structure of the nuclides involved, rather than toward displaying photon energies and abundances as such. Consequently, it is usually necessary to deduce the photon abundances by interpretation of the decay

data in conjunction with a logical decay scheme. The methods followed in assembling the data reported here are presented in detail, with illustrative examples, in Reference 1.

Many of the induced activities, in contrast with the fission products, decay by electron capture. This process is usually accompanied by the emission of a K- or L-series X ray. Since the K-L branching ratios are not usually well known, it was assumed for the purposes of this report that each electron capture results in the emission of a K-series X ray. This is in accord with the practice followed in Reference 1 of preferring overestimation of gamma-decay energy to underestimation, since the data are intended for use in predicting radiation hazards.

The X-ray photon abundances have not been corrected for fluorescent yield, since the contribution of the X rays to the exposure is small and the extra calculation did not seem warranted. The K-series X-ray energies have been taken from Nuclear Spectroscopy Tables.² For the L-series X rays, the binding energies taken from Siegbahn,³ have been used.

BRANCHING RATIOS

In the case of branching decays, all possible decay paths were considered in calculating the photon abundances. The decay paths were considered to extend only to the next stable or metastable state. For the convenience of the user, the branching ratios used are summarized here:

Mass 64 Ni (stable) $\xleftarrow{62\%}$ Cu (13 h) $\xrightarrow{38\%}$ Zn (stable)

Mass 74 Ge (stable) $\xleftarrow{68\%}$ As (18 d) $\xrightarrow{32\%}$ Se (stable)

Mass 102 Ru (stable) $\xleftarrow{77\%}$ Rh (206 d) $\xrightarrow{19\%}$ Pd (stable)
(4% of the decay not accounted for)

Mass 106 Pd (stable) $\xleftarrow{99\%}$ Ag (24 m) $\xrightarrow{1\%}$ Cd (stable)

Mass 108 Pd (stable) $\xleftarrow{91.5\%}$ Ag (≥ 5 yr) $\xrightarrow{8.5\%}$ Cd (stable)
 $\xleftarrow{4.1\%}$ Ag (2.4 m) $\xrightarrow{91.9\%}$ Cd (stable)

Mass 110 Ag (253 d) $\xrightarrow{98\%}$ Cd (stable)
 $\xrightarrow{2.0\%}$ Ag (24 s) $\xrightarrow{100\%}$ Cd (stable)

Mass 113 Cd (3×10^{15} y) $\xleftarrow{0.1\%}$ Ca (14 y) $\xrightarrow{99.9\%}$ In (stable)

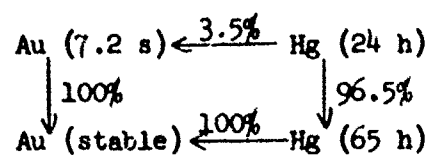
Mass 114 In (2.5 s) $\xrightarrow{100\%}$ In (50 d) $\xrightarrow{96.5\%}$ Sn (stable)
Cd (stable) $\xleftarrow{3.5\%}$ In (50 d) $\xleftarrow{0.95\%}$ In (72 s) $\xrightarrow{99.05\%}$ Sn (stable)

Mass 120 Sb (5.8 d) $\xrightarrow{100\%}$ Sn (stable)
 $\xrightarrow{100\%}$ Sb (16 m)

Mass 126 Te (stable) $\xleftarrow{56\%}$ I (13 d) $\xrightarrow{44\%}$ Xe (stable)

Mass 152	Sm (stable) $\xleftarrow{100\%}$ Eu (9.3 h)
Mass 158	Gd (stable) $\xleftarrow{86\%}$ Tb (150 y) $\xrightarrow{14\%}$ Dy (stable)
Mass 166	Ho (1200 y) $\xrightarrow{100\%}$ Er (stable) Ho (27 h) $\xrightarrow{100\%}$ Er (stable)
Mass 170	Er (stable) $\xleftarrow{0.15\%}$ Tm (127 d) $\xrightarrow{99.85\%}$ Yb (stable)
Mass 176	Lu (3.7 h) $\xrightarrow{100\%}$ Hf (stable) Lu (2.2×10^{10} y) $\xrightarrow{100\%}$ Hf (stable)
Mass 180	Hf (stable) $\xleftarrow{83\%}$ Ta (8.15 h) $\xrightarrow{17\%}$ W (stable) Hf (stable) $\xleftarrow{100\%}$ Ta ($> 10^{13}$ y)
Mass 186	W (stable) $\xleftarrow{4\%}$ Re (90 h) $\xrightarrow{96\%}$ Os (stable)
Mass 190	Os (10 m) $\xleftarrow{100\%}$ Ir (3.2 h) $\downarrow 100\%$ Os (stable) $\xleftarrow{100\%}$ Ir (12 d)
Mass 191	Os (15 d) $\xrightarrow{99.9\%}$ Ir (4.9 s) $\downarrow 100\%$ Ir (stable) Os (15 d) $\xrightarrow{0.1\%}$ Ir (stable)
Mass 192	Os (stable) $\xleftarrow{4\%}$ Ir (74 d) $\xrightarrow{96\%}$ Pt (stable)
Mass 196	Pt (stable) $\xleftarrow{94\%}$ Au (6.18 d) $\xrightarrow{6\%}$ Hg (stable)

Mass 197



CALCULATION OF EXPOSURE-RATE MULTIPLIERS

The gamma-photon abundances have been used to calculate exposure-rate multipliers for converting radionuclide activities to exposure rates three feet above a uniformly contaminated, infinite plane. The multipliers are based on the build-up factors of Gates and Eisenhauer.⁴ The energy conversion was made according to the following expression:

$$D = (5.97E - 1.21E^2 + 0.201E^3 - 0.013E^4) \times 10^{-6} \quad (1)$$

where D is the exposure rate, in roentgens per hour, at a point 3 feet above an infinite plane uniformly contaminated with one emitter per square centimeter emitting one photon of energy E , in Mev, per second. If nuclide n emits N_1 photons of energy E_1 per disintegration, N_2 photons of energy E_2 , etc., then a total exposure-rate multiplier, D_n , for the nuclide can be defined:

$$D_n = D_1 N_1 + D_2 N_2 + \dots$$

If the activity per square centimeter, A_n , of the nuclide is known, the contribution of the nuclide to the exposure rate is $D_n A_n$ roentgens per hour.

The exposure-rate multipliers for the induced activities are listed in Appendix II. Since the multipliers were hand-calculated, the energy-to-exposure-rate conversion factors were read from a graph of equation 1. Those multipliers marked with an asterisk pertain to nuclides which do not emit photons with energies greater than 0.075 Mev. Calculations for such low energies are very uncertain.

REFERENCES

1. G. R. Crocker, M. A. Connors, "Gamma-Emission Data for the Calculation of Exposure Rates From Nuclear Debris, Vol. I. Fission Products," U. S. Naval Radiological Defense Laboratory, USNRDL-TR-876, 28 July 1965.
2. A. H. Wapstra, G. J. Nijgh, R. van Lieshout. Nuclear Spectroscopy Tables. New York, Interscience Publishers, Inc., 1959.
3. K. Siegbahn. Beta- and Gamma-Ray Spectroscopy. New York, Interscience Publishers, Inc., 1955.
4. L. D. Gates, Jr., C. Eisenhauer, "Spectral Distribution of Gamma Rays Propagated in Air," Armed Forces Special Weapons Project, Technical Analysis Report AFSWP No. 502A, 1954.

APPENDIX I

SUMMARY OF PHOTON ENERGIES AND ABUNDANCES

Nuclides are arranged by ascending atomic numbers, ordered by mass number. Metastable-state decays are summarized separately. The half-life of each nuclide is stated below its identification. The source or sources of the data are quoted at the beginning of each summary. The abbreviation NDS is used for the Nuclear Data Sheets compiled and published by the National Academy of Sciences-National Research Council. Other literature abbreviations follow standard practice.

The data contained in the columns is indicated by the headings, as follows:

- E_γ - Gamma energy in Mev.
- N_T - Number of transitions per disintegration. This column is totalled. This column was for the compiler's convenience and was frequently omitted.
- N_γ - Number of gamma photons emitted per disintegration. This column is totalled.
- N_K - Number of gammas converted to X-ray photons per disintegration. This column is totalled.
- $N_\gamma E_\gamma$ - Product of abundance and energy. This column is totalled.
- E_β - End-point beta-ray energy in Mev.
- N_β - Corresponding number of beta particles per disintegration.

Following the columns the X-ray energy, E_K , is given. The product of this energy times the total of the N_K column is given. The following totals are then listed:

- PH - Total photons emitted per disintegration.
- HPH - Total photons emitted per disintegration with energies greater than 0.020 Mev.
- ED - Total photon energy per disintegration (Mev/D).
- HED - Total photon energy per disintegration (Mev/D) counting only photons greater than 0.020 Mev.

Source: J. G. V. Taylor and J. S. Merritt,
Can. J. Phys. 40, 926 (1962).

⁴Be 7
53.4 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.477	0.115	- - -	0.055
capture e^-	- - -	1.0	- - -
$E_K = 5 \times 10^{-5}$ Mev		$E_K N_K \sim 0$	
PH = 0.115		ED = 0.055 Mev/D	
HPH = 0.115		HED = 0.055 Mev/D	

E_β Mev	N_β
Decays by E. C.	

Source: NDS 59-4-16 and 59-4-19

¹¹Na 22
2.6 years

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
1.274	1.0	- - -	1.274
capture e^-	- - -	0.102	- - -
$E_K = 0.00087$ Mev		$E_K N_K \sim 0$	
PH = 1.102		ED = 1.274 Mev/D	
HPH = 1.0		HED = 1.274 Mev/D	

E_β Mev	N_β
0.544	0.898

Source: NDS 59-6-10a and 59-6-13

¹¹Na 24
15.0 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
1.368	1.0	- - -	1.368
2.750	1.0	- - -	2.750
Total	2.0		4.118
$E_K = 0.0013$ Mev		$N_K E_K = 0$	
PH = 2.0		ED = 4.118 Mev/D	
HPH = 2.0		HED = 4.118 Mev/D	

E_β Mev	N_β
0.391	1.0

Source: NDS 59-6-27 and 59-6-34

$^{13}\text{Al }^{26}$
 7.4×10^5 years

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
2.97	0.003	0.003	- - -	0.009	1.16	0.96
1.14	0.037	0.037	- - -	0.042		
1.83	0.997	0.997	- - -	1.825		
capture e^-	- - -	- - -	0.052	- - -		
Total	1.037	1.037	0.052	1.876		
$E_K = 0.0013$ Mev				$N_K E_K = 0.0001$		
PH = 1.089				ED = 1.876 Mev/D		
HPH = 1.037				HED = 1.876 Mev/D		

Source: NDS 60-3-25 and 60-3-27

$^{14}\text{Si }^{31}$
2.6 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.27	0.0007	- - -	0.001	0.210	0.0007
				1.477	0.9993
PH = 0.0007		ED = 0.001 Mev/D			
HPH = 0.0007		HED = 0.001 Mev/D			

Source: NDS 60-1-53 and 60-1-57

$^{17}\text{Cl }^{34m}$
32.4 min.

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.16	0.166	- - -	0.193	0.43	0.005
2.13	0.353	- - -	0.752	1.24	0.322
3.30	0.166	- - -	0.548	2.41	0.351
4.10	0.006	- - -	0.025		
capture e^-	- - -	0.015	- - -		
Total	0.691	0.015	1.518		
$E_K = 0.0025$ Mev		$N_K E_K = 0$			
PH = 0.706		ED = 1.518 Mev/D			
HPH = 0.691		HED = 1.518 Mev/D			

Source: NDS 60-1-60 and 60-1-63

17 Cl 38
38 min.

E_{γ} Mev	N_{γ}	N_K	$N_{\gamma}E_{\gamma}$ Mev/D
1.60	0.31	- - -	0.496
2.16	0.47	- - -	1.015
Total	0.78		1.511
PH = 0.78		ED = 1.511 Mev/D	
HPH = 0.78		HED = 1.511 Mev/D	

E_{β} Mev	N_{β}
1.11	0.31
2.77	0.16
4.81	0.53

Source: D. W. Engelkemeir, K. F. Flynn and L. E. Glendenin, Phy. Rev. 126, 1818 (1962).

19 K 40
 1.27×10^9 year

E_{γ} Mev	N_{γ}	N_K	$N_{\gamma}E_{\gamma}$ Mev/D
1.46	0.11	- - -	0.161
capture e^{-}	- - -	0.11	- - -
$E_K = 0.0032$ Mev		$N_K E_K = 0.0004$	
PH = 0.11		ED = 0.161 Mev/D	
HPH = 0.11		HED = 0.161 Mev/D	

E_{β} Mev	N_{β}
1.321	0.89

Source: NDS 60-6-3

19 K 42
12.5 hours

E_{γ} Mev	N_{γ}	N_K	$N_{\gamma}E_{\gamma}$ Mev/D
1.92	0.0006	- - -	0.0010
1.02	0.0002	- - -	0.0002
0.49	0.0002	- - -	- - -
2.44	0.0004	- - -	0.0010
0.90	0.0002	- - -	0.0002
0.60	0.0002	- - -	0.0001
0.32	0.0020	- - -	0.0006
1.52	0.1800	- - -	0.2736
Total	0.1838		0.2767
PH = 0.1838		ED = 0.2767 Mev/D	
HPH = 0.1838		HED = 0.2767 Mev/D	

E_{β} Mev	N_{β}
0.09	0.0008
0.28	0.0002
1.11	0.0006
1.71	0.0018
2.03	0.1770
3.55	0.8200

Source: NDS 60-2-16 and 60-2-20

21 Sc 44m
2.4 days

E_{γ} Mev	N_T	N_{γ}	N_K	$N_{\gamma} E_{\gamma}$ Mev/D	E_{β} Mev	N_{β}
0.27	1.0	0.877	0.123	0.2368	Isomeric Transition*	

$$E_K = 0.0041 \text{ Mev}$$

$$PH = 1.0$$

$$HPH = 0.877$$

$$N_K E_K = 0.0005$$

$$ED = 0.2373 \text{ Mev/D}$$

$$HED = 0.2368 \text{ Mev/D}$$

*There is actually some small unknown amount of E. C. directly to ^{44}Ca (L. T. Dillman and J. J. Kraushaar, Nucl. Phys., 42, 383, 1963), but this has been ignored. This schema is for: $^{44}\text{m}_{21}\text{Sc} \xrightarrow{100\%} ^{44}\text{Sc} \xrightarrow{100\%} ^{44}\text{Ca}$

Source: NDS 60-2-16 and 60-2-20

21 Sc 44
3.9 hours

E_{γ} Mev	N_T	N_{γ}^{**}	N_K	$N_{\gamma} E_{\gamma}$ Mev/D	E_{β} Mev	N_{β}
2.69	0.002	0.002	- - -	0.005	1.467	0.91 ⁵
1.50	0.010	0.010	- - -	0.015		
2.28	0.002	0.002	- - -	0.005		
1.14	0.030	0.030	- - -	0.034		
1.16	1.000	1.000	- - -	1.160		
capture e^{-}	- - -	- - -	0.085	- - -		
Total	1.044	1.044	0.085	1.219		

$$E_K = 0.0037 \text{ Mev}$$

$$PH = 1.129$$

$$HPH = 1.044$$

$$N_K E_K = 0.0003$$

$$ED = 1.219 \text{ Mev/D}$$

$$HED = 1.219 \text{ Mev/D}$$

**Gamma intensities agree reasonably well with L. T. Dillman and J. J. Kraushaar, Nucl. Phys., 42, 383, 1963.

Source: NDS 60-2-30 and 60-2-34

21 Sc 46m
20 sec.

E_{γ} Mev	N_T	N_{γ}	N_K	$N_{\gamma} E_{\gamma}$ Mev/D	E_{β} Mev	N_{β}
0.15	1.0	0.5	0.5	0.075	Isomeric Transition	

$$E_K = 0.0041 \text{ Mev}$$

$$PH = 1.0$$

$$HPH = 0.5$$

$$N_K E_K = 0.0021$$

$$ED = 0.077 \text{ Mev/D}$$

$$HED = 0.075 \text{ Mev/D}$$

Source: NDS 60-2-30 and 60-2-33

21 Sc 46
84 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.119	1.0	- - -	1.119	0.357	1.0
0.887	1.0	- - -	0.887		
Total	2.0		2.006		

(There is probably a crossover transition of ~ 2 Mev of very low intensity. See Ark. Fys. 21, 383, 1962)

PH = 2.0

ED = 2.006 Mev/D

HPH = 2.0

HED = 2.006 Mev/D

Source: NDS 60-2-23 and 60-2-28

22 Ti 45
3.1 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.376	0.003	- - -	0.001	0.62	0.003
				1.02	0.850
capture e^-	- - -	0.15	- - -		
$E_K = 0.0041$ Mev		$N_K E_K = 0.0006$			
PH = 0.153		ED = 0.0016 Mev/D			
HPH = 0.003		HED = 0.001 Mev/D			

Source NDS 61-3-3

23 V 49
330 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
capture e^-	- - -	1.0	- - -		
$E_K = 0.0046$ Mev		$N_K E_K = 0.0046$			
PH = 1.0		ED = 0.0046 Mev/D			
HPH = 0		HED = 0 Mev/D			

Decays by E. C.

Source: NDS 61-3-3 and 61-3-11

24 Cr 49
42 min.

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.063	0.130	0.018	0.0082
0.089	0.277	0.018	0.0247
0.150	0.139	0.003	0.0209
capture e^-	- - -	0.068	- - -
Total	0.546	0.107	0.0538

$E_K = 0.0046$ Mev $N_K E_K = 0.0005$
 $PH = 0.653$ $ED = 0.0543$ Mev/D
 $HPH = 0.546$ $HED = 0.0538$ Mev/D

E_β Mev	N_β
1.39	0.266
1.46	0.139
1.54	0.527

Source: NDS 61-3-14 and 61-3-20

24 Cr 51
28 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.645	0.0005	- - -	0.0003
0.320	0.0010	- - -	0.0003
0.322	0.0910	- - -	0.0293
capture e^-	- - -	1.0	- - -
Total	0.0925	1.0	0.0299

$E_K = 0.0046$ Mev $N_K E_K = 0.0046$
 $PH = 1.0925$ $ED = 0.0345$ Mev/D
 $HPH = 0.0925$ $HED = 0.0299$ Mev/D

E_β Mev	N_β
Decays by E. C.	

Source: P. Kramer, Miss E. C. Bos, A. deBeer and J. Blok,
 Physica 28, 569 (1962). C. Manduche and G. Zannoni,
 Nuovo Cimento 27, 251 (1963).

25 Mn 54
291 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.842	1.0	- - -	0.842
capture e^-	- - -	0.902	- - -
$E_K = 0.0055$ Mev		$N_K E_K = 0.0050$	
$PH = 1.902$		$ED = 0.847$ Mev/D	
$HPH = 1.0$		$HED = 0.842$ Mev/D	

E_β Mev	N_β
Decays by E. C.	

Source: NDS 59-4-50. D. A. Howe, L. M. Langer, E. H. Spejwesi and D. E. Wortman, Phys. Rev. 128, 2748 (1962).

²⁵Mn 56
2.58 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.845	1.000	- - -	0.845	0.300	0.01
1.810	0.333	- - -	0.603	0.718	0.18
2.120	0.175	- - -	0.371	1.028	0.34
2.520	0.009	- - -	0.023	2.838	0.47
2.660	0.007	- - -	0.019		
2.960	0.005	- - -	0.015		
3.390	0.002	- - -	0.007		
Total	1.531		1.883		

$$E_K = 0.0065 \text{ Mev}$$

$$N_K E_K \approx 0$$

$$PH = 1.531$$

$$ED = 1.883 \text{ Mev/D}$$

$$HPH = 1.531$$

$$HED = 1.883 \text{ Mev/D}$$

Source: NDS 59-2-3 and 59-2-9

²⁶Fe 55
2.7 years

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
capture e^-	- - -	1.0	- - -	Decays by E. C.	

$$E_K = 0.0065 \text{ Mev}$$

$$PH = 1.0$$

$$HPH = 0$$

$$ED = 0.0065 \text{ Mev/D}$$

$$HED = 0 \text{ Mev/D}$$

Source: NDS 60-6020

²⁶Fe 59
45 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.337	0.003	- - -	0.0010	0.130	0.010
0.145	0.008	- - -	0.0012	0.271	0.460
1.290	0.440	- - -	0.5676	0.462	0.540
0.191	0.030	- - -	0.0057	1.560	0.003
1.100	0.570	- - -	0.6270		
Total	1.051		1.2025		

$$PH = 1.051$$

$$HPH = 1.051$$

$$ED = 1.203 \text{ Mev/D}$$

$$HED = 1.203 \text{ Mev/D}$$

Source: NDS 61-2-13 and 61-2-21. P. Kramer, et al,
Physica 28, 569 (1962).

27 Co 57
270 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.014	0.120	0.780	0.0017
0.122	0.890	0.010	0.1086
0.136	0.088	0.012	0.0120
0.710	0.002	- - -	0.0014
capture e^-	- - -	0.870	- - -
Total	1.100	1.672	0.1237

$E_K = 0.0065$ Mev

$N_K E_K = 0.0109$

PH = 2.772

ED = 0.1346 Mev/D

HPH = 1.100

HED = 0.1237 Mev/D

E_β Mev	N_β
------------------	-----------

Decays by E. C.

Source: NDS 60-5-12 and 60-5-18

27 Co 58m
9.0 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.025	1.0	- - -	0.025

PH = 1.0

ED = 0.025 Mev/D

HPH = 1.0

HED = 0.025 Mev/D

E_β Mev	N_β
------------------	-----------

Isomeric Transition

Source: NDS 60-5-12 and 60-2-17

27 Co 58
71 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
1.650	0.005	- - -	0.0083
0.810	0.016	- - -	0.0130
0.805	0.995	- - -	0.8010
capture e^-	- - -	0.852	- - -
Total	1.016	0.852	0.8223

$E_K = 0.0065$ Mev

$N_K E_K = 0.0055$

PH = 1.868

ED = 0.8278 Mev/D

HPH = 1.016

HED = 0.8223 Mev/D

E_β Mev	N_β
------------------	-----------

0.485 0.148

Source: NDS 60-5-24 and 60-5-27

27 Co 60
5.27 years

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.173	1.0	- - -	1.173	0.318	1.0
1.332	1.0	- - -	1.332		
Total	2.0		2.505		
PH = 1.0		ED = 2.505 Mev/D			
HPH = 1.0		HED = 2.505 Mev/D			

Source: G. Chilosi, S. Monaro and R. A. Ricci,

28 Ni 57
36.5 hours

E_γ	N_T	N_γ	N_K	$N_\gamma E_\gamma$	E_β	N_β
Mev				Mev/D	Mev	
1.360	0.750	0.750	- - -	1.020	0.32	0.006
0.130	0.130	0.130	- - -	0.017	0.47	0.011
1.590	0.012	0.012	- - -	0.019	0.63	0.003
1.750	0.075	0.075	- - -	0.131	0.73	0.043
1.910	0.160	0.160	- - -	0.306	0.86	0.310
capture e^-	- - -	- - -	0.624	- - -		
Total	1.127	1.127	0.624	1.493		
$E_K = 0.0070$ Mev			$N_K E_K = 0.0044$			
PH = 1.751			ED = 1.497 Mev/D			
HPH = 1.127			HED = 1.493 Mev/D			

Source: R. A. Ricci et al., Nuovo Cimento 17, 523 (1960).
R. Jambunathan et al., Phys. Rev. 120, 1839 (1960).

28 Ni 65
2.5 hours

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.730	0.006	0.006	- - -	0.0104	0.375	0.004
1.630	0.011	0.011	- - -	0.0179	0.477	0.004
1.490	0.280	0.280	- - -	0.4172	0.618	0.220
0.360	0.060	0.060	- - -	0.0216	0.986	0.079
1.120	0.130	0.130	- - -	0.1456	2.100	0.690
Total	0.487	0.487		0.6127		
PH = 0.487			ED = 0.6127 Mev/D			
HPH = 0.487			HED = 0.6127 Mev/D			

Source: NDS 59-2-13 and 59-2-16

29 Cu 64
13 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.34	0.006	- - -	0.008	0.573	0.38
- - -	- - -	- - -	- - -	0.656	0.19
capture e^-	- - -	0.43	- - -		
$E_K = 0.0076$ Mev		$N_K E_K = 0.0033$			
PH = 0.436		ED = 0.011 Mev/D			
HPH = 0.006		HED = 0.008 Mev/D			

Source: J. B. Cumming and N. T. Porile, Phys. Rev. 122, 1267 (1961). 30 Zn 63
38.4 min.

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.67	0.074	0.074	- - -	0.050	2.33	0.800
0.96	0.051	0.051	- - -	0.045	1.66	0.074
- - -	- - -	- - -	- - -	- - -	1.37	0.051
Few other weak γ 's		(<0.010)	- - -	- - -	3 others <0.01	
capture e^-	- - -	- - -	0.059	- - -		
Total	1.125	0.125	0.059	0.099		
$E_K = 0.0082$ Mev			$N_K E_K = 0.0005$			
PH = 0.184			ED = 0.0995 Mev/D			
HPH = 0.125			HED = 0.099 Mev/D			

Source: NDS 59-2-23 and 59-2-26

30 Zn 65
245 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
1.114	0.49	- - -	0.546
capture e^-	- - -	0.983	- - -
$E_K = 0.0082$ Mev		$N_K E_K = 0.008$	
PH = 1.473		KD = 0.554 Mev/D	
HPH = 0.49		HED = 0.546 Mev/D	

E_β Mev	N_β
0.326	0.017

Source: NDS 59-3-30 and 59-3-32

³⁰Zn 69m
14 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.435	0.943	0.057	0.410	Isomeric Transition	
$E_K = 0.0087$		$N_K E_K = 0.0005$			
PH = 1.000		ED = 0.4105 Mev/D			
HPH = 0.943		HED = 0.4100 Mev/D			

Source: NDS 59-2-39 and 59-2-41

T. T. Thwaites and W. W. Pratt, Phys. Rev. 124, 1526 (1961). ³⁰Zn 71m
4 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.38	1.0	- - -	0.38	1.5	1.0
0.49	1.0	- - -	0.49		
0.61	1.0	- - -	0.61		
Total	3.0		1.48		
PH = 3.0		ED = 1.48 Mev/D			
HPH = 3.0		HED = 1.48 Mev/D			

Source: T. T. Thwaites and W. W. Pratt
Phys. Rev. 124, 1526 (1961).

³⁰Zn 71
2.45 min

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$	E_β (Mev)	N_β
1.63	0.001	- -	0.0016	0.99	0.017
1.12	0.013	- -	0.0146	1.69	0.030
0.68	0.003	- -	0.0020	2.10	0.140
0.92	0.031	- -	0.0285	2.61	0.820
0.12	0.009	- -	0.0011		
0.39	0.013	- -	0.0051		
0.51	0.140	-	0.0714		
Total	0.210		0.1243		
PH = 0.210		ED = 0.1243 Mev/D			
HPH = 0.210		HED = 0.1243 Mev/D			

Source: A. W. Schardt and A. Goodman, Phys. Rev. 123, 893 (1961)

$^{33}\text{As}^{74\text{m}}$
8 sec.

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.283	1.0	- - -	0.283	Isomeric Transition	
PH = 1.0		ED = 0.283 Mev/D			
HPH = 1.0		HED = 0.283 Mev/D			

Source: NDS 59-4-67 and 59-4-71

33 As 74
18 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.5963	0.608	- - -	0.363
0.6350	0.145	- - -	0.921
- - -	- - -	- - -	- - -
- - -	- - -	- - -	- - -
capture e^-	- - -	0.381	- - -
Total	0.753	0.381	0.4559

E_β Mev	N_β
0.72	0.145
1.36	0.177
0.91	0.261
1.51	0.036

Several very weak γ 's ignored.

$E_K \approx 0.010$ Mev

$N_K E_K = 0.0038$

PH ≈ 1.134

ED = 0.4597 Mev/D

HPH = 7.53

HED = 0.4559 Mev/D

Source: NDS 60-3-67 and 60-3-73

39 Y 88
105 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
2.760	0.005	- - -	0.0138
0.899	0.920	- - -	0.8271
1.835	1.000	- - -	1.8350
capture e^-	- - -	0.993	- - -
Total	1.925	0.993	2.6759

E_β Mev	N_β
0.57	0.007

$E_K = 0.0144$ Mev

$N_K E_K = 0.0143$

PH = 2.918

ED = 2.6902 Mev/D

HPH = 1.925

HED = 2.6759 Mev/D

Source: NDS 61-2-37. P. Born, C. Bobeldijk, H. M. W. Booy
and J. Blok, Physica 27, 1229 (1961)

⁴⁵Rh 102
206 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.417	0.020	- - -	0.0083	1.15	0.186
0.475	0.545	- - -	0.2589	0.81	0.039
0.630	0.110	- - -	0.0693	1.28	0.102
0.695	0.064	- - -	0.0445		
0.745	0.005	- - -	0.0037		
0.765	0.047	- - -	0.0360		
1.050	0.063	- - -	0.0662		
1.110	0.027	- - -	0.0300		
1.105	0.028	- - -	0.0309		
1.365	0.004	- - -	0.0055		
1.565	0.002	- - -	0.0031		
capture e^-	- - -	0.585	- - -		
Total	0.915	0.585	0.5564		
$E_K = 0.0196$		$N_K E_K = 0.0115$			
PH = 1.500		ED = 0.5679 Mev/D			
HPH = 0.915		HED = 0.5564 Mev/D			

Source: NDS 60-4-44 and 60-4-52

47 Ag 106m
8.3 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
1.20	0.09	- - -	0.108
0.81	0.11	- - -	0.089
0.72	0.23	- - -	0.166
0.46	0.22	- - -	0.101
0.41	0.30	- - -	0.123
1.83	0.03	- - -	0.055
1.23	0.09	- - -	0.111
0.78	0.12	- - -	0.094
0.41	0.05	- - -	0.021
0.74	0.13	- - -	0.096
0.21	0.09	- - -	0.019
1.58	0.09	- - -	0.142
1.54	0.15	- - -	0.231
0.70	0.08	- - -	0.056
0.31	0.01	- - -	0.003
0.82	0.17	- - -	0.139
0.75	0.05	- - -	0.038
1.73	0.016	- - -	0.028
1.56	0.01	- - -	0.016
1.05	0.31	- - -	0.326
0.85	0.08	- - -	0.068
1.12	0.11	- - -	0.123
0.612	0.23	- - -	0.141
0.513	0.86	- - -	0.441
capture e^-	- - -	1.0	- - -
Total	3.63	1.0	2.735

$$E_K = 0.0216 \text{ Mev}$$

$$PH = 4.63$$

$$HPH = 4.63$$

$$E_{KK} = 0.0216$$

$$ED = 2.757 \text{ Mev/D}$$

$$HED = 2.757 \text{ Mev/D}$$

E_β
Mev

N_β

Decays by E. C.

Source: NDS 60-4-44 and 60-4-52

47 Ag 106
24 min.

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.513	1.0	1.0	- - -	0.513	1.45	0.07
- - -	- - -	- - -	- - -	- - -	1.96	0.5 ^b
capture e^-	- - -	- - -	0.39	- - -		
$E_K = 0.0216$ Mev			$N_K E_K = 0.008$ Mev/D			
PH = 1.39			ED = 0.521 Mev/D			
HPH = 1.39			HED = 0.521 Mev/D			

Source: NDS 60-5-135 and 60-5-141

47 Ag 107m
44 sec.

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.094	0.095	0.905	0.0089	Isomeric Transition	

$E_K = 0.0226$ Mev $N_K E_K = 0.0205$
 PH = 1.00 ED = 0.0294 Mev/D
 HPH = 1.00 HED = 0.0294 Mev/D

Source: NDS 5-1-5 and 5-1-10

⁴⁷Ag 108m
>5 years

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.724	1.000	- - -	0.724
0.618	1.000	- - -	0.618
0.433	1.000	- - -	0.433
0.031	0.085	- - -	0.003
0.081	0.067	0.018(Ag)	0.005
capture e^-	- - -	0.915(Pd)	- - -
Total	3.152	0.933	1.783
$E_K(\text{Ag}) = 0.0226 \text{ Mev}$			
$E_K(\text{Pd}) = 0.0216 \text{ Mev}$			
$PH = 4.085$			
$HPH = 4.085$			

E_β Mev	N_β
Isomeric Transition and E. C.	

$N_K E_K = 0.0004 \text{ Mev/D}$
$N_K E_K = 0.0198 \text{ Mev/D}$
$ED = 1.803 \text{ Mev/D}$
$HED = 1.803 \text{ Mev/D}$

Source: NDS 5-1-5 and 5-1-9

47 Ag 108
2.4 min.

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.633	0.019	- - -	0.012
0.617	0.004	- - -	0.002
0.433	0.006	- - -	0.003
capture e^-	- - -	0.033	- - -
Total	0.029	0.033	0.017
$E_K = 0.0216$		$N_K E_K = 0.0007$	
$PH = 0.062$		$ED = 0.0177 \text{ Mev/D}$	
$HPH = 0.062$		$HED = 0.0177 \text{ Mev/D}$	

E_β Mev	N_β
1.02	0.019
1.65	0.940
0.69	0.002

Source: NDS 60-2-47

47 Ag 109m
39.00 sec.

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.088	0.046	0.436	0.004	Isomeric Transition	

$E_K = 0.023$ Mev

$N_K E_K = 0.010$

PH = 0.482

ED = 0.014 Mev/D

HPH = 0.482

HED = 0.014 Mev/D

Source: NDS 60-2-62 and -66 and -67

⁴⁷Ag 110m
253d

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.116	0.02	- -	0.02	- -
0.030	0.02	- -	0.02	- -
1.384	0.24	0.24	- -	.3322
0.764	0.23	0.23	- -	.1757
0.706	0.19	0.19	- -	.1341
0.446	0.06	0.06	- -	.0268
0.937	0.34	0.34	- -	.3186
1.56	0.01	0.01	- -	.0156
0.745	0.02	0.02	- -	.0149
0.677	0.09	0.09	- -	.0609
1.504	0.12	0.12	- -	.1805
0.687	0.07	0.07	- -	.0481
0.619	0.04	0.04	- -	.0248
0.885	0.72	0.72	- -	.6372
1.474	0.05	0.05	- -	.0737
0.815	0.07	0.07	- -	.0571
0.656	0.93	0.93	- -	.6101
Total	3.22	3.18	0.04	2.7103

E_β Mev	N_β
0.085	0.65
0.530	0.33

$E_K = 0.0226$ Mev
PH = 3.22
HPH = 3.22

$E_{K N} = 0.0009$ Mev/D
 $E_{K K} = 2.7112$ Mev/D
HED = 2.7112 Mev/D

Source: NDS 60-2-62 and 60-2-63

47 Ag 110
24 sec.

E_{γ} (Mev)	N_{γ}	N_K	$N_{\gamma}E_{\gamma}$ (Mev/D)	E_{β} (Mev)	N_{β}
0.656	0.05	- -	0.0328	2.21	0.05
				2.87	0.95

PH = 0.05

HPH = 0.05

ED = 0.0328 Mev/D

IED = 0.0328 Mev/D

Source: NDS 60-5-135 and 60-5-143. N. L. Lark et al.,
Nucl. Phys. 35, 582, (1962).

^{107}Cd
6.5 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.846	0.002	- - -	0.002	0.32	0.003
0.094	0.513	0.224	0.048		
capture e^-	- - -	0.997	- - -		
Total	0.515	1.221	0.050		
$E_K = 0.0226$ Mev		$N_K E_K = 0.028$			
PH = 1.736		ED = 0.078 Mev/D			
HPH = 1.736		HED = 0.078 Mev/D			

Source: NDS 60-2-48 and 60-2-56

48 Cd 109
470 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
capture e^-	- - -	1.0	- - -
$E_K = 0.0226$ Mev		$N_K E_K = 0.0226$	
PH = 1.0		ED = 0.0226 Mev/D	
HPH = 1.0		HED = 0.0226 Mev/D	

E_β Mev	N_β
Decays by π^+ C.	

Source: NDS 60-2-99 and 60-2-103

48 Cd 113m
14 years

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)
0.265	0.001	- -	0.0003

E_β (Mev)	N_β
0.575	0.999

PH = 0.001
HPH = 0.001

ED = 0.0003 Mev/D
HED = 0.0003 Mev/D

Source: NDS 60-2-99 and 60-2-105

49 In 113m
1.7 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.393	0.667	0.333	0.2621
$E_K = 0.0247$ Mev		$N_K E_K = 0.0082$	
PH = 1.0		ED = 0.270 Mev/D	
HPH = 1.0		HED = 0.270 Mev/D	

E_β Mev	N_β
Isomeric Transition	

Source: NDS 60-3-88 and 60-3-98

49 In 114m₂
2.5 sec

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.150	1.0	- - -	0.150
PH = 1.0		ED = 0.150 Mev/D	
HPH = 1.0		HED = 0.150 Mev/D	

E_β Mev	N_β
Isomeric Transition	

Source: NDS 60-3-88 and 60-3-97

49 In 114m₁
50 days

E_{γ} Mev	N_{γ}	N_K	$N_{\gamma}E_{\gamma}$ Mev/D
0.192	0.182	0.783(In)	0.0349
0.722	0.035	- - -	0.0253
0.556	0.035	- - -	0.0195
capture e ⁻	- - -	0.035(Cd)	- - -
Total	0.252	0.818	0.0797
E_K (Cd) = 0.0236 Mev		$N_K E_K$ = 0.0008	
E_K (In) = 0.0247 Mev		$N_K E_K$ = 0.0193	
PH = 1.070		ED = 0.0998 Mev/D	
HPH = 1.070		HED = 0.0998 Mev/D	

E_{β} Mev	N_{β}
Isomeric Transition and E. C.	

Source: NDS 60-3-88 and 60-3-96

49 In 114
72 sec.

E_{γ} Mev	N_{γ}	N_K	$N_{\gamma}E_{\gamma}$ Mev/D
1.30	0.0015	- - -	0.0020
1.21	0.0025	- - -	0.0030
- - -	- - -	- - -	- - -
capture e ⁻	- - -	0.01	- - -
Total	0.0040	0.01	0.0050
E_K = 0.0236 Mev		$N_K E_K$ = 0.0002	
PH = 0.0140		ED = 0.0052 Mev/D	
NPH = 0.0140		HED = 0.0052 Mev/D	

E_{β} Mev	N_{β}
0.670	0.002
1.984	0.989
0.397	0.003

Source: NDS 60-2-99 and 60-2-106

50 Sn 113m
27 min.

E_{γ} Mev	N_{γ}	N_K	$N_{\gamma}E_{\gamma}$ Mev/D
0.079	1.0	- - -	0.079
PH = 1.0		ED = 0.079 Mev/D	
HPH = 1.0		HED = 0.079 Mev/D	

E_{β} Mev	N_{β}
Isomeric Transition	

Source: NDS 60-2-99 and 60-2-106. W. E. Phillips and
J. I. Hopkins, Phys. Rev. 119, 1315 (1960).

50 Sn 113
118 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.255	0.02	- - -	0.0051	Decays by E. C.	
0.393	0.68	0.32	0.2672		
capture e^-	- - -	1.00	- - -		
Total	0.70	1.32	0.3723		
$E_K = 0.0247$ Mev		$N_K E_K = 0.0326$			
PH = 2.02		ED = 0.4049 Mev/D			
HPH = 2.02		HED = 0.4049 Mev/D			

Source: NDS 60-4-66 and 60-4-70

51 Sb 120m
5.8 days

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.039	0.90	0.70	0.20	0.062	Decays by E. C.	
0.199	1.00	0.88	0.12	0.175		
1.040	1.00	1.00	- - -	1.040		
1.180	1.00	1.00	- - -	1.180		
capture e^-	- - -	- - -	1.00	- - -		
Total	3.90	3.58	1.32	2.457		
$E_K = 0.0258$ Mev			$N_K E_K = 0.034$			
PH = 4.90			ED = 2.491 Mev/D			
HPH = 4.90			HED = 2.491 Mev/D			

Source: NDS 60-4-66 and 60-4-70

51 Sb 120
16 min.

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
1.18	0.013	- - -	0.015	1.70	0.436
capture e^-	- - -	0.551	- - -		
$E_K = 0.0258$ Mev		$N_K E_K = 0.014$			
PH = 0.561		ED = 0.029 Mev/D			
HPH = 0.54		HED = 0.029 Mev/D			

Source: NDS 60-6-104 and -109 and -110

53 I 126
13 day

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
1.41	0.004	0.004	- -	.0056	0.385	0.06
0.747	0.040	0.040	- -	.0299	0.865	0.29
0.665	0.330	0.330	- -	.2195	1.25	0.09
0.860	0.010	0.010	- -	.0086	0.46	0.003
0.48	0.050	0.050	- -	.0240	1.129	0.010
0.386	0.340	0.330	0.01 (Xe)	.1274		
capture e^-	- - -	- - -	0.55 (Te)	- -		
Total	0.774	0.764	0.56	0.4150		

$$E_K(Xe) = 0.0304 \text{ Mev}$$

$$E_K N_K = .0003 \text{ Mev/D}$$

$$E_K(Te) = 0.0280 \text{ Mev}$$

$$E_K N_K = .0154 \text{ Mev/D}$$

$$PH = 1.324$$

$$ED = .4307 \text{ Mev/D}$$

$$HPH = 1.324$$

$$HED = .4307 \text{ Mev/D}$$

Source: NDS 61-2-69 and -79

55 Cs 132
6.5 day

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.673	0.99	- -	.6663	0.6	0.012
capture e^-		0.97 (Xe)			
Total	0.99	0.97	.6663		

(Several weak gammas and possible weak negatron decay not accounted for.)

$$E_K = 0.0304 \text{ Mev}$$

$$E_K N_K = 0.0295 \text{ Mev/D}$$

$$PH = 1.96$$

$$ED = 0.6958 \text{ Mev/D}$$

$$HPH = 1.96$$

$$HED = 0.6958 \text{ Mev/D}$$

Source: NDS 59-1-96 and -101

59 Pr 142
19.3 hours

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
1.57	0.04	- -	.0628	0.58	0.04
				2.15	0.96

$$E_K = 0.0382 \text{ Mev}$$

$$E_K N_K = 0.0 \text{ Mev/D}$$

$$PH = 0.04$$

$$ED = 0.0628 \text{ Mev/D}$$

$$HPH = 0.04$$

$$HED = 0.0628 \text{ Mev/D}$$

Source: NDS 59-4-79

⁶³Eu 152m
9.30 hrs.

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
1.390	0.010	0.	0.014	0.210	0.000
0.963	0.090	0.	0.087	0.560	0.016
0.841	0.110	0.	0.093	1.260	0.000
0.563	0.240	0.	0.135	1.550	0.020
0.122	0.132	0.	0.016	1.870	0.740
1.320	0.010	0.	0.013		
0.975	0.005	0.	0.005		
0.344	0.026	0.	0.009		
Total	0.623	0.	0.372		

$$E_K = 0.044 \text{ Mev}$$

$$PH = 0.623$$

$$HPH = 0.623$$

$$N_K E_K = 0.$$

$$ED = 0.372 \text{ Mev/D}$$

$$HED = 0.372 \text{ Mev/D}$$

Source: NDS 59-4-77

⁶³Eu 152
13.00 y

E_γ (Mev)	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.344	0.252	0.008	0.087	0.220	0.020
0.411	0.020	0.000	0.008	0.360	0.027
0.778	0.120	0.000	0.093	0.710	0.120
0.692	0.002	0.	0.001	1.040	0.018
1.100	0.025	0.	0.027	1.470	0.075
1.240	0.020	0.	0.025		
0.122	0.387	0.232	0.047		
0.245	0.075	0.005	0.018		
1.085	0.120	0.000	0.130		
0.964	0.150	0.000	0.144		
0.866	0.040	0.000	0.034		
1.112	0.130	0.000	0.144		
0.443	0.050	0.000	0.022		
1.411	0.250	0.000	0.352		
1.210	0.020	0.	0.024		
Total	1.661	0.245	1.156		

$$E_K = 0.044 \text{ Mev}$$

$$PH = 1.906$$

$$HPH = 1.906$$

$$N_K E_K = 0.011$$

$$ED = 1.167 \text{ Mev/D}$$

$$HED = 1.167 \text{ Mev/D}$$

Source: NDS 5-5-27 and -39

64 Gd 153
242 days

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)
0.0697	0.160	0.037	0.123	0.0026
0.1032	0.560	0.224	0.336	0.0231
0.0895	0.004	0.002	0.002	0.0002
0.0198	0.004	0.001	- - -	- - -
0.0974	0.380	0.280	0.090	0.0273
0.0141	0.003	- - -	- - -	- - -
0.0834	0.011	0.007	0.004	0.0006
capture e^-	- - -	- - -	1.000	- - -
Total	1.122	0.551	1.555	0.0538

E_β
(Mev)
Decays by E.C.

$$E_K = .0425 \text{ Mev}$$

$$N_K E_K = 0.0661 \text{ Mev/D}$$

$$PH = 2.106$$

$$ED = .1199 \text{ Mev/D}$$

$$HPH = 2.106$$

$$HED = .1199 \text{ Mev/D}$$

Source: NDS 5-6-108 and -116

65 Tb 158
150 years

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)
0.2181	0.01	0.01	- -	0.0022
0.0990	0.14	0.04	0.10 (Dy)	0.0040
0.9630	0.24	0.24	- - -	0.2311
0.7770	0.14	0.14	- - -	0.1088
0.9450	0.41	0.41	- - -	0.3875
0.1820	0.17	0.13	0.04 (Gd)	0.0237
0.0795	0.86	0.12	0.74 (Gd)	0.0095
capture e^-	- - -	- - -	0.86 (Gd)	- - -
Total	1.97	1.09	1.74	0.7668

E_β
(Mev)
0.628
0.845
 N_β
0.01
0.13

$$E_K (\text{Dg}) = 0.0470 \text{ Mev} \quad N_K E_K = 0.0047 \text{ mev/D}$$

$$E_K (\text{Gd}) = 0.0440 \text{ Mev} \quad N_K E_K = 0.0722 \text{ mev/D}$$

$$PH = 2.83$$

$$ED = 0.8437 \text{ Mev/D}$$

$$HPH = 2.83$$

$$HED = 0.8437 \text{ Mev/D}$$

Source NDS 5-5-81 and -88

66 Dy 159
144 day

E_{γ} (Mev)	N_T	N_{γ}	N_K	$N_{\gamma}E_{\gamma}$ (Mev/D)	E_{β} (Mev)	N_{β}
0.0580	0.260	0.034	0.226	0.0020	Decays by E. C.	
capture e^-	- - -	- - -	1.00			
Total	0.260	0.034	1.226	0.0020		

$$E_K = 0.0455 \text{ Mev}$$

$$N_K E_K = 0.0558 \text{ Mev/D}$$

$$PH = 1.260$$

$$ED = 0.0578 \text{ Mev/D}$$

$$HPH = 1.260$$

$$HED = 0.0578 \text{ Mev/D}$$

Source: NDS 6-4-36

67 Ho 166m
1200 years

E_{γ} (Mev)	N_T	N_{γ}	N_K	$N_{\gamma} E_{\gamma}$ (Mev/D)	E_{β} (Mev)	N_{β}
0.751	0.144	0.144	- -	.1081	0.01	0.15
0.610	0.025	0.025	- -	.0153	0.06	0.85
0.451	0.027	0.027	- -	.0122		
1.242	0.010	0.010	- -	.0124		
0.711	0.580	0.580	- -	.4124		
0.569	0.071	0.071	- -	.0404		
0.410	0.130	0.130	- -	.0533		
0.830	0.106	0.106	- -	.0880		
0.465	0.017	0.017	- -	.0079		
0.300	0.037	0.037	- -	.0111		
0.950	0.033	0.033	- -	.0314		
0.670	0.057	0.057	- -	.0382		
0.258	0.010	0.010	- -	.0026		
0.810	0.600	0.600	- -	.4860		
0.529	0.100	0.100	- -	.0529		
0.2153	0.045	0.045	- -	.0097		
0.6917	0.014	0.014	- -	.0097		
0.365	0.017	0.017	- -	.0062		
0.7796	0.037	0.037	- -	.0288		
0.200	0.310	0.292	0.018	.0818		
0.1843	0.980	0.742	0.148	.1368		
0.0806	1.000	0.125	0.209	.0101		
Total	4.350	3.219	0.375	1.6553		

(Conversion data is missing on many of these gammas.
Some N_{γ} values may be overestimated.)

$$E_K = 0.0502 \text{ Mev}$$

$$ED = 1.6721 \text{ Mev/D}$$

$$N_K E_K = 0.0188 \text{ Mev/D}$$

$$HED = 1.6721 \text{ Mev/D}$$

$$PH = 3.594$$

$$HPH = 3.594$$

Source: NDS 6-4-36 and -44 and -45

67 Ho 166
27 hours

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
1.380	0.009	0.009	- -	0.0124	0.02	0.0004
0.0806	0.480	0.060	0.102	0.0048	0.23	0.0030
Total	0.489	0.069	0.102	0.072	0.40	0.0100
(Many very weak gamma transitions not accounted for.)					1.76	0.4760
					1.847	0.5160

$E_K = 0.0502$ Mev $N_K E_K = 0.0051$ Mev/D
 $PH = 0.171$ $ED = 0.0223$ Mev/D
 $HPH = 0.171$ $HED = 0.0223$ Mev/D

Source: NDS 6-1-56, 6-1-57 and 6-1-64

68 Er 169
9.3 days

E_γ Mev	N_γ	N_M	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.0084	- - -	0.42	- - -	0.332	0.42
- - -	- - -	- - -	- - -	0.340	0.58
$E_M = 0.00231$		$N_M E_M = 0.001$			
PH = 0.42		ED = 0.001 Mev/D			
HPH = 0		HED = 0 Mev/D			

Source: NDS 6-4-102 and 6-4-107

68 Er 171
7.5 hours

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.9060	0.0100	0.0100	- - -	0.009	0.493	0.005
0.7960	0.0090	0.0090	- - -	0.007	0.528	0.005
0.2770	0.0085	0.0085	- - -	0.002	0.575	0.038
0.2110	0.0090	0.0090	- - -	0.002	0.753	0.004
0.1664	0.0080	0.0080	- - -	0.001	0.816	0.004
0.3083	0.7200	0.7060	0.014	0.218	1.065	0.910
0.2958	0.2900	0.2840	0.006	0.084	1.370	0.015
0.1240	0.2060	0.0940	0.056	0.012	1.490	0.021
0.1167	0.0580	0.0310	0.027	0.004		
0.1116	0.6500	0.3000	0.350	0.033		
Total	1.969	1.460	0.453	0.372		

(many less than 0.01 ignored)

$E_K = 0.0519$ Mev

$N_K E_K = 0.0235$

PH = 1.969

ED = 0.396 Mev/D

HPH = 1.969

HED = 0.396 Mev/D

Source NDS 6-4-70 and -78, -79, -80

^{69}Tm 169
86 days

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
1.464	0.005	0.005	- -	.0073	Decays by E.C.	
1.280	0.040	0.040	- -	.0512		
0.721	0.180	0.180	- -	.1298		
0.646	0.020	0.020	- -	.0129		
0.547	0.030	0.030	- -	.0164		
0.448	0.290	0.279	0.011	.1250		
1.016	0.020	0.020	- -	.0203		
0.831	0.090	0.090	- -	.0748		
0.273	0.030	0.030	- -	.0082		
0.198	0.530	0.507	0.023	.1004		
0.0993	0.040	0.040	- -	.0040		
0.917	0.050	0.050	- -	.0459		
0.732	0.050	0.050	- -	.0366		
0.817	0.540	0.540	- -	.4412		
0.632	0.140	0.140	- -	.0885		
0.822	0.140	0.140	- -	.1151		
0.743	0.110	0.110	- -	.0817		
0.285	0.012	0.012	- -	.0034		
0.184	0.210	0.175	0.035	.0322		
0.0798	0.860	0.129	0.191	.0103		
capture e^-	- - -	- - -	1.000			
Total	.3387	2.587	1.260	1.4052		

$E_K = 0.0502$ Mev
 $M_{K E_K} = .0633$ Mev/D
 $PH = 3.847$
 $HPH = 3.847$

$ED = 1.4635$ Mev/D
 $HED = 1.4685$ Mev/D

Source: NDS 6-4-87 and 6-4-91

69 Tm 170
127 days

E_γ Mev	N_γ	N_K	N_L	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.0843	0.039	0.054	0.149	0.003	0.882	0.24
- - -	- - -	- - -	- - -	- - -	0.967	0.76
$E_K = 0.0536$ Mev				$N_K E_K = 0.003$		
$E_L = 0.010$ Mev				$N_L E_L = 0.001$		
PH = 0.242				ED = 0.007 Mev/D		
HPH = 0.093				HED = 0.006 Mev/D		

Source: NDS 6-4-103 and 6-4-111

69 Tm 171
1.9 years

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.06673	- - -	0.02	- - -	0.0300	0.02
- - -	- - -	- - -	- - -	0.0965	0.98
$E_K = 0.0536$		$N_K E_K = 0.001$			
PH = 0.02		ED = 0.001 Mev/D			
HPH = 0.02		HED = 0.001 Mev/D			

Source: NDS 59-2-95 and 59-2-98. P. E. Fossan and B. Herskind,
Nucl. Phys. 40, 24 (1963),

⁷¹Lu 176m
3.7 hours

E_γ Mev	N_T	N_γ	E_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.0883	1.00	0.088	0.91	0.0078	1.1	1.0
$E_K = 0.0571$ Mev				$N_{KK} = 0.0521$		
PH = 1.0				ED = 0.0599 Mev/D		
HPH = 1.0				HEED = 0.0599 Mev/D		

Source: NDS 59-3-99. H. I. West, Jr., L. G. Meade and
R. J. Nagle, Phys. Rev. 124, 527 (1961)

⁷¹Lu 177
6.75 days

E_γ Mev	N_T	N_γ	E_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.2084	0.121	0.121	- - -	0.0252	0.175	0.123
0.1130	0.239	0.075	0.059	0.0085	0.246	0.003
0.2497	0.002	0.002	- - -	0.0050	0.383	0.119
0.3213	0.002	0.002	- - -	0.0060	0.496	0.755
Total	0.364	0.200	0.059	0.0348		
$E_K = 0.0571$ Mev				$N_{KK} = .0034$		
PH = 0.259				ED = 0.0382 Mev/D		
HPH = 0.259				HEED = 0.0382 Mev/D		

Source: J. Valentin, D. J. Horen and J. M. Hollander,
Nucl. Phys. 31, 353 (1962).

72 Hf 173
24 hours

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.0778	0.001	0.001	- - -	0.0001
0.1236	0.985	0.835	0.150	0.1032
0.1349	0.112	0.064	0.048	0.0086
0.1396	0.297	0.114	0.183	0.0159
0.1618	0.059	0.054	0.005	0.0087
0.2967	0.372	0.366	0.006	0.1086
0.3064	0.058	0.058	- - -	0.0178
0.3111	0.096	0.096	- - -	0.0299
0.3568	0.005	0.005	- - -	0.0018
0.4223	0.005	0.005	- - -	0.0021
0.8977	0.019	0.019	- - -	0.0171
capture e^-	- - -	- - -	1.000	- - -
Total	2.009	1.617	1.392	0.3138

E_β N_β
Mev
Decays by E. C.

$E_K = 0.0553$ Mev

$N_K E_K = 0.0770$

PH = 2.009

ED = 0.3908 Mev/D

HPH = 2.009

HED = 0.3908 Mev/D

(Several very weak γ 's ignored.)

Source: NDS 59-2-89 and 59-2-92

72 Hf 173
70 days

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.08936	0.031	0.068	0.0028
0.11381	0.003	0.006	0.0003
0.22960	0.006	0.001	0.0014
0.34340	0.769	0.081	0.2641
0.43300	0.012	- - -	0.0052
capture e^-	- - -	1.000	- - -
Total	0.821	1.156	0.2738

E_β N_β
Mev
Decays by E. C.

$E_K = 0.0553$ Mev

$N_K E_K = 0.0639$

PH = 1.977

ED = 0.3377 Mev/D

HPH = 1.977

HED = 0.3377 Mev/D

Source: NDS 60-1-117 and 60-1-119

72 Hf 180m
5.5 hours

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
0.501	0.166	0.004	0.0832
0.058	0.624	- - -	0.0362
0.444	0.809	0.021	0.3592
0.332	0.948	0.052	0.3147
0.216	0.870	0.130	0.1879
0.093	0.200	0.260	0.0186
Total	3.617	0.467	0.9998

$E_K = 0.0571$ Mev
PH = 4.084
HPH = 4.084

$E_{K K} = 0.0267$
ED = 1.027 Mev/D
HED = 1.027 Mev/D

E_β
Mev

N_β

Isomeric Transition

Source: NDS 60-2-110

72 Hf 181
45 day

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.3476	0.001	- - -	0.0003	0.065	0.003
0.3423	0.001	- - -	0.0003	0.340	0.010
0.2590	0.002	- - -	0.0005	0.404	0.040
0.6990	0.010	- - -	0.0070	0.408	0.920
0.2170	0.005	- - -	0.0011	0.550	0.020
0.6190	0.0004	- - -	0.0002		
0.1369	0.041	- - -	0.0056		
0.6155	0.003	- - -	0.0018		
0.1330	0.650	0.210	0.0865		
0.4820	0.800	0.019	0.3856		
0.4760	0.020	- - -	0.0095		
0.3458	0.140	- - -	0.0484		
0.1361	0.050	0.100	0.0068		
0.0063	0.020	- - -	0.0001		
Total	1.743	0.329	0.5537		
$E_K = 0.0571$ Mev		$N_K E_K = 0.0188$			
PH = 2.072		ED = 0.5725 Mev/D			
HPH = 2.072		HED = 0.5725 Mev/D			

Source: NDS 60-1-117 and -121, and C. J. Gallagher, Jr.,
M. Jørgensen and O. Skilbreid, Nucl. Phys. 33, 285
(1962).

73 Ta 180m
8.15 hour

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.102	0.007	0.006 (W)	0.0007	0.600	0.032
0.093	0.068	0.068 (Hf)	0.0063	0.705	0.098
capture e^-	- - -	0.870 (Hf)	- - -		
Total	0.075	0.944	0.0070		
$E_K(W) = 0.0607$ Mev		$N_K E_K = 0.0004$			
$E_K(Hf) = 0.0571$ Mev		$N_K E_K = 0.0536$			
PH = 1.019		ED = 0.061 Mev/D			
HPH = 1.019		HED = 0.061 Mev/D			

Source: NDS 60-1-126 and -132

73 Ta 182m
16 min

E_γ	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β N_β Mev
0.356	0.042	0.008	0.034	0.0028	Isomeric transition
0.184	0.958	0.551	0.407	0.1014	
0.319	0.074	0.067	0.007	0.0214	
0.172	0.884	0.505	0.379	0.0869	
0.147	0.926	0.463	0.463	0.0681	
Total	2.884	1.594	1.290	0.2806	
$E_K = 0.0589$ Mev		$N_K E_K = 0.0760$			
PH = 2.884		ED = 0.3566 Mev/D			
HPH = 2.884		HED = 0.3566 Mev/D			

Source: NDS 60-1-126 and 60-1-137

73 Ta 182
115 days

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.264	0.0800	0.074	0.006	0.0195	0.180	0.38
0.220	0.1300	0.130	- - -	0.0286	0.250	0.05
0.179	0.0700	0.055	0.015	0.0098	0.330	0.02
0.066	0.1000	0.026	- - -	0.0017	0.363	0.20
0.198	0.0400	0.034	0.006	0.0067	0.443	0.23
0.156	0.0400	0.040	- - -	0.0062	0.480	0.04
0.114	0.0600	0.020	0.040	0.0023	0.514	0.08
0.116	0.0200	0.020	- - -	0.0023		
1.375	0.0040	0.004	- - -	0.0055		
1.273	0.0019	0.002	- - -	0.0025		
0.152	0.0090	0.006	0.003	0.0009		
0.085	0.1400	0.042	- - -	0.0036		
1.231	0.1100	0.110	- - -	0.1354		
1.003	0.0300	0.030	- - -	0.0301		
1.289	0.0160	0.016	- - -	0.0206		
1.189	0.1500	0.004	0.146	0.0048		
0.960	0.0080	0.008	- - -	0.0077		
0.0677	0.3400	0.266	- - -	0.0180		
1.254	0.0200	0.020	- - -	0.0251		
1.155	0.0100	- - -	0.010	- - -		
0.927	0.0090	0.009	- - -	0.0083		
1.222	0.2800	0.013	0.267	0.0159		
1.122	0.3300	0.010	0.320	0.0112		
0.229	0.0800	0.070	0.010	0.0160		
0.100	0.5600	0.280	0.280	0.0280		
Total	2.6380	1.289	1.103	0.4107		

$E_K = 0.0607$ Mev

PH = 2.392

HPH = 2.392

$N_K E_K = 0.0670$

ED = 0.4777 Mev/D

HED = 0.4777 Mev/D

Source: A. H. Muir, Jr., and F. Boehm, Phys. Rev. 122, 1564 (1961) 74 W 181
145 Day

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.1525	0.0011	0.0005	0.0006	0.0001	Decays by E.C.	
0.13625	0.0007	0.0003	0.0004	- - -		
0.00625	0.3500	- - - -	- - -	- - -		
capture e^-	- - -	- - -	1.0000	- - -		
Total	0.3518	0.0008	1.0010	0.0001		

$$E_K = 0.0589 \text{ Mev}$$

$$N_K E_K = 0.0590$$

$$PH = 1.0018$$

$$ED = 0.0591 \text{ Mev/D}$$

$$HPH = 1.0018$$

$$HED = 0.0591 \text{ Mev/D}$$

Source: K. Maak Bisgard, K. Olesen and P. Østergard,
Nucl. Phys. 33, 126 (1962).

74 W 187
24 hour

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.072	0.1470	0.1540	0.0106	0.325	0.08
0.107	0.0005	0.0014	0.0001	0.625	0.74
0.114	0.0011	0.0031	0.0001	1.329	0.18
0.134	0.1190	0.2120	0.0159		
0.206	0.0015	0.0046	0.0003		
0.239	0.0010	0.0004	0.0002		
0.246	0.0016	0.0005	0.0004		
0.479	0.3039	0.0061	0.1456		
0.511	0.0079	0.0002	0.0040		
0.552	0.0639	0.0004	0.0353		
0.618	0.0785	0.0025	0.0485		
0.625	0.0130	- - -	0.0081		
0.686	0.3526	0.0014	0.2419		
0.773	0.0492	0.0008	0.0380		
0.867	0.0047	0.0001	0.0041		
Total	1.1454	0.3874	0.5531		

$$E_K = 0.0626 \text{ Mev}$$

$$N_K E_K = 0.0243$$

$$PH = 1.533$$

$$ED = 0.5774 \text{ Mev/D}$$

$$HPH = 1.533$$

$$HED = 0.5774 \text{ Mev/D}$$

Source: K. M. Bisgard, C. S. Cook, P. Horskj  and A. B. Knutsen, 75 Re 184
Nucl. Phys. 41, 32 (1963), and NDS 60-1-142 and -148. 50 days

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.330	0.003	0.003	- - -	0.0010	Decays by E.C.	
0.230	0.004	0.004	- - -	0.0009		
0.250	0.008	0.008	- - -	0.0020		
0.895	0.190	0.190	- - -	0.1701		
0.642	0.005	0.005	- - -	0.0032		
0.904	0.400	0.400	- - -	0.3616		
0.793	0.400	0.396	0.004	0.3140		
0.540	0.006	0.006	- - -	0.0032		
0.253	0.042	0.037	0.005	0.0094		
0.111	0.600	0.151	0.151	0.0168		
capture e^-	- - -	- - -	1.000	- - -		
Total	1.658	1.200	1.160	0.8822		

$$E_K = 0.0607$$

$$PH = 2.360$$

$$HPH = 2.360$$

$$N_K E_K = 0.0704$$

$$ED = 0.9526 \text{ Mev/D}$$

$$HED = 0.9526 \text{ Mev/D}$$

Source: NDS 59-5-132 and -134

75 Re 186
90 hours

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.122	0.0383	0.0343	0.0040 (W)	0.0042	0.34	0.069
0.768	0.0003	0.0003	- - -	0.0002	0.934	0.231
0.631	0.0004	0.0004	- - -	0.0003	1.071	0.73
0.137	1.0000	0.4348	0.1739 (Os)	0.0596		
capture e^-	- - -	- - -	0.0383 (W)	- - -		
Total	1.0390	0.4698	0.2162	0.0643		

$$E_K(W) = 0.0607 \text{ Mev}$$

$$E_K(Os) = 0.0645 \text{ Mev}$$

$$PH = 0.686$$

$$HPH = 0.686$$

$$N_K E_K = 0.0026$$

$$N_K E_K = 0.0112$$

$$ED = 0.0781 \text{ Mev/D}$$

$$HED = 0.0781 \text{ Mev/D}$$

Source: R. Hardell and S. Nilsson
Nucl. Phys. 39, 286 (1962)

75 Re 188m
18.7 min

E_γ Mev	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.064	0.333	0.667	0.0213	Isomeric Transition	

$E_K = 0.0626$ Mev

$N_K E_K = 0.0418$

PH = 1.0

ED = 0.0631 Mev/D

HPH = 1.0

HED = 0.0631 Mev/D

Source: NDS 59-3-119 and 59-3-123

75 Re 188
17 hour

E_γ Mev	N_γ	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.155	0.200	0.116	0.084	0.0180	0.16	0.0004
0.478	0.010	0.010	- - -	0.0048	0.18	0.0004
0.633	0.015	0.015	- - -	0.0095	0.35	0.0010
0.828	0.005	0.005	- - -	0.0041	0.66	0.0040
0.931	0.006	0.006	- - -	0.0056	0.81	0.0010
Total	0.236	0.152	0.084	0.0420	1.03	0.0040

$E_K = 0.0645$ Mev

$N_K E_K = 0.0054$

PH = 0.236

ED = 0.0474 Mev/D

HPH = 0.236

HED = 0.0474 Mev/D

1.48 0.0100
1.96 0.2000
2.116 0.7800

Source: NDS 5-3-3 and 5-3-7

76 Os 190m
10 min.

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.0384	1.00	- - -	1.00	- - -	Isomeric Transition	
0.1870	0.88	0.74	0.14	0.1384		
0.3610	0.92	0.88	0.04	0.3177		
0.5000	1.00	0.98	0.02	0.4900		
0.6140	0.91	0.90	0.01	0.5526		
Total	4.71	3.50	1.21	1.4987		
$E_K = 0.0645$ Mev			$N E_K = 0.0780$			
PH = 4.71			ED = 1.577 Mev/D			
HPH = 4.71			HED = 1.577 Mev/D			

Source: NDS 5-3-17

76 Os 191
15 days

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.1867	0.001	0.001	- - -	.0002	0.123	0.001
0.042	0.999	- - -	- - -	- - -	0.139	0.999
0.1294	0.999	0.250	0.749	.0324		
0.047	- - -	- - -	- - -	- - -		
0.0823	- - -	- - -	- - -	- - -		
Total	1.999	0.251	0.749	.0326		
$E_K = 0.0645$ Mev			$N E_K = .0483$ Mev/D			
PH = 1.000			ED = .0809 Mev/D			
HPH = 1.000			HED = .0809 Mev/D			

Source: NDS 61-3-97

76 Os 193
32 hours

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.299	0.004	0.004	- -	.0012	0.52	0.008
0.251	0.004	0.003	0.001	.0008	0.57	0.032
0.559	0.022	0.021	0.001	.0117	0.67	0.074
0.468	0.003	0.003	- -	.0014	0.77	0.004
0.460	0.041	0.038	0.003	.0175	0.82	0.004
0.278	0.006	0.006	- -	.0017	0.85	0.010
0.196	0.001	0.001	- -	.0002	0.88	0.013
0.388	0.016	0.014	0.001	.0054	0.99	0.087
0.322	0.017	0.016	0.001	.0052	1.059	0.064
0.362	0.006	0.005	- -	.0018	1.132	0.700
0.289	0.003	0.003	- -	.0009		
0.314	0.003	0.003	- -	.0009		
0.243	0.002	0.002	- -	.0005		
0.117	0.003	0.002	0.001	.0004		
0.281	0.016	0.013	0.003	.0037		
0.248	0.003	0.003	- -	.0007		
0.107	0.010	0.003	- -	.0003		
0.139	0.012	0.005	0.006	.0007		
0.073	0.085	- -	- -	- -		
Total	0.257	0.145	0.017	.0550		

$$E_K = 0.0645 \text{ Mev}$$

$$PH = .162$$

$$HPH = .162$$

$$N_K E_K = 0.0011 \text{ Mev/D}$$

$$ED = 0.0561 \text{ Mev/D}$$

$$HED = 0.0561 \text{ Mev/D}$$

Source: NDS 5-3-3 and 5-3-11

77 Ir 190m
3.2 hours

E_{γ} Mev	N_{γ}	N_K	$N_{\gamma} E_{\gamma}$ Mev/D
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capture e^{-}	- - -	0 88	- - -
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$E_K = 0.0645$ Mev		$N_K E_K = 0.0568$	
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PH = 0.88		ED = 0.0568 Mev/D	
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IIPH = 0.88		HED = 0.0568 Mev/D	
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E_{β} Mev	N_{β}
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2.04	0.12
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Decay is to 10 min.

76 Os 190m, q.v.

Source: NDS 5-3-3 and 5-3-9

77 Ir 190
12 days

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D
1.330	0.005	0.005	- - -	0.0067
0.197	0.070	0.050	0.020	0.0099
0.725	0.039	0.039	- - -	0.0283
0.518	0.270	0.270	- - -	0.1399
0.295	0.082	0.082	- - -	0.0242
1.020	0.028	0.028	- - -	0.0286
0.827	0.040	0.040	- - -	0.0331
0.224	0.052	0.052	- - -	0.0116
0.604	0.320	0.317	0.003	0.1915
0.407	0.270	0.263	0.007	0.1070
0.206	0.040	0.040	- - -	0.0082
0.767	0.020	0.020	- - -	0.0153
0.397	0.056	0.056	- - -	0.0222
0.199	0.010	0.007	0.003	0.0014
0.569	0.250	0.247	0.003	0.1405
0.198	0.030	0.021	0.009	0.0042
0.557	0.280	0.276	0.004	0.1537
0.371	0.230	0.222	0.008	0.0824
0.361	0.150	0.144	0.006	0.0520
0.187	0.720	0.576	0.144	0.1077
capture e^-	- - -	- - -	1.000	- - -
Total	2.962	2.755	1.207	1.1684

E_β N_β
Mev
Decays by E. C.

$E_K = 0.0645$ Mev

PH = 3.962

HPH = 3.962

$N_K E_K = 0.0779$

ED = 1.246 Mev/D

HED = 1.246 Mev/D

Source: NDS 5-3-33 and 5-3-44

77 Ir 192m₂
650 year

E _γ Mev	N _T	N _γ	N _K	N _γ E _γ Mev/D
0.161	1.0	0.08	0.92	0.0129

E _β Mev	N _β
Isomeric Transition	

E_K = 0.0664 Mev N_KE_K = 0.0611
PH = 1.0 ED = 0.0740 Mev/D
HPH = 1.0 HED = 0.0740 Mev/D

SOURCE: NDS 5-3-33 and 5-3-37 to 41

77 Ir 192
74 day

E _γ Mev	N _T	N _γ	N _K	N _γ E _γ Mev/D
0.4847	0.030	0.029	0.001 ^{Os}	0.0141
0.2013	0.007	0.006	0.001 ^{Os}	0.0012
0.3744	0.006	0.006	- - -	0.0022
0.4891	0.004	0.004	- - -	0.0020
0.2834	0.004	0.004	- - -	0.0011
0.2057	0.038	0.038	- - -	0.0078
0.885	0.004	0.004	- - -	0.0035
0.5886	0.048	0.047	0.001 ^{Pt}	0.0277
0.417	0.014	0.014	- - -	0.0058
0.282	0.010	0.010	- - -	0.0028
0.6044	0.093	0.091	0.002 ^{Pt}	0.0550
0.3084	0.030	0.028	0.002 ^{Pt}	0.0086
0.1363	0.018	0.018	- - -	0.0025
0.4680	0.480	0.471	0.009 ^{Pt}	0.2204
0.173	0.012	0.012	- - -	0.0021
0.6124	0.063	0.062	0.001 ^{Pt}	0.0380
0.2959	0.290	0.282	0.008 ^{Pt}	0.0834
0.3165	0.800	0.759	0.041 ^{Pt}	0.2402
capture e ⁻	- - -	- - -	0.043 ^{Os}	- - -
Total	1.951	1.885	0.109	0.7184

E _β Mev	N _β
.072	.0008
.095	.0012
.24	.076
.535	.42
.669	.46

E_K(Os) = 0.0645 Mev N_KE_K = 0.0029
E_K(Pt) = 0.0684 Mev N_KE_K = 0.0044
PH = 1.994 ED = 0.7257 Mev/D
HPH = 1.994 HED = 0.7257 Mev/D

Source: NDS 61-3-97 and 61-3-103

77 Ir 193m
12 days

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.0802	1.0	1.0	- -	0.0802	Isomeric Transition	

PH = 1.0 ED = 0.0802 Mev/D
HPH = 1.0 HED = 0.0802 Mev/D

Source: NDS 61-4-65 and 61-4-70 and -71

77 Ir 194
19 hours

E_γ Mev	N_T	N_γ	N_K	$N_\gamma E_\gamma$ Mev/D	E_β Mev	N_β
0.293	0.069	0.065	0.004	0.0190	0.438	0.0115
0.3285	0.330	0.330	- - -	0.1084	0.725	0.0107
0.6453	0.027	0.027	- - -	0.0174	0.756	0.0166
0.9389	0.015	0.015	- - -	0.0141	0.969	0.0416
1.1513	0.016	0.016	- - -	0.0184	1.614	0.0306
Total	0.457	0.453	0.004	0.1773	1.908	0.2050

(Several weak gammas are not
accounted for.)

Many others 0.01

E_K = .0684 Mev ED = .1776 Mev/D
PH = .457 HED = 1776 Mev/D
HPH .457

SOURCE: NDS 5-3-16 and 5-3-24

78 Pt 191
3 days

E_γ Mev	N_K	N_γ	$N_\gamma E_\gamma$ Mev/D	E_β N_β Mev
0.0965	0.044	0.0220	0.0008	Decays by E. C.
0.1294	0.044	0.0220	0.0028	
0.175	- - -	0.0255	0.0045	
0.269	- - -	0.0072	0.0019	
0.360	- - -	0.0867	0.0312	
0.410	- - -	0.0510	0.0209	
0.457	- - -	0.0193	0.0088	
0.539	- - -	0.1734	0.0935	
0.624	- - -	0.0182	0.0114	
capture	1.0	- - -	- - -	
Total	1.044	0.4120	0.1758	

(Several weak gammas and some
L X-rays are not accounted for.)

$E_K = 0.0664$ Mev, $N_K E_K = 0.0693$ ED = 0.2451 Mev/D
PH = 1.456 HED = 0.2451 Mev/D
HPH = 1.456

SOURCE: NDS 61-3-97 and 61-3-104

78Pt 193m
4.4 days

E_{γ} Mev	N_T	N_K	N_{γ}	$N_{\gamma}E_{\gamma}$ Mev/D
0.1355	1.00	1.00	- -	- - -
0.0127	1.00	- -	1.00	0.0127
Total	2.00	1.00	1.00	0.0127

E_{β} N_{β}
Mev
Isomeric Transition

$E_K = 0.0684$ Mev
PH = 2.00
HPH = 1.00

$N_K E_K = 0.0684$
ED = 0.0811 Mev/D
HED = 0.0684 Mev/D

Source: NDS 61-4-92 and 61-4-98

78 Pt 195m
4.1 days

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β N_β (Mev)
0.130	1.00	0.812	0.188	0.1056	Isomeric Transition
0.0988	0.90	0.090	0.810	0.0089	
0.129	0.10	0.100	- - -	0.0129	
0.0308	0.90	0.300	- - -	0.0092	
Total	2.90	1.302	0.998	0.1366	

$$E_K = 0.0684 \text{ Mev}$$

$$PH = 2.30$$

$$HPH = 2.30$$

$$N_K E_K = 0.0583$$

$$ED = 0.2049 \text{ Mev/D}$$

$$HEP = 0.2049 \text{ Mev/D}$$

Source: NDS 5-1-17 and 5-1-21

78 Pt 197
20 hours

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.0773	1.00	0.227	- - -	0.0175	0.468	0.01
0.191	0.09	0.028	0.062	0.0053	0.479	0.09
0.279	0.01	0.010	- - -	0.0028	0.670	0.90
Total	1.10	0.265	0.062	0.0256		

$E_K = 0.0704$ Mev

$N_K E_K = 0.0044$

PH = 0.327

ED = 0.030 Mev/D

HPH = 0.327

HED = 0.030 Mev/D

Source: NDS 5-3-55 and 5-3-58

78 Pt 199m
14 sec

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.032	1.0	0.048	- - -	0.0015	Isomeric Transition	
0.393	1.0	0.920	0.080	0.3616		
Total	2.0	0.968	0.080	0.3631		
$E_K = 0.0684$ Mev			$N_K E_K = 0.0055$			
$PH = 1.048$			$ED = 0.3686$ Mev/D			
$HPH = 1.048$			$HED = 0.3686$ Mev/D			

Source: NDS 5-2-29 and 5-2-40

79 Au 196m
9.7 hr

E_{γ} (Mev)	N_T	N_{γ}	N_K	$N_{\gamma}E_{\gamma}$ (Mev/D)	E_{β} (Mev)	N_{β}
0.1749	1.00	- -	0.32	- - -	Isomeric Transition	
0.3162	0.08	0.08	- -	0.025		
0.2885	0.07	0.07	- -	0.020		
0.1478	0.85	0.28	0.21	0.041		
0.1882	0.65	0.21	0.36	0.040		
0.1683	0.18	0.05	0.11	0.008		
0.1377	0.03	- -	0.03	- - -		
0.0505	0.01	- -	- -	- - -		
0.0307	0.09	- -	- -	- - -		
0.0199	0.20	0.13	- -	0.003		
0.0846	1.00	0.06	- -	0.005		
Total	4.18	0.88	1.03	0.142		

$E_K = 0.0704$ Mev

PH = 1.91

HPH = 1.78

$N_K E_K = 0.073$

ED = 0.215 Mev

HED = 0.212 Mev

Source: NDS 5-2-28 and 5-2-37 and 38

79 Au 196
6.18 days

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)
0.3557	0.94	0.90	0.04	0.3201
0.3330	0.27	0.26	0.01	0.0866
0.4261	0.06	0.06	- -	0.0256
capture e^-	- -	- -	0.94	- - -
Total	1.27	1.22	0.99	0.4323
(Several weak gammas not accounted for)				
$E_K = 0.0684$ Mev			$N_K E_K = 0.0677$	
PH = 2.21			ED = 0.499 Mev/D	
HPH = 2.21			HED = 0.499 Mev/D	

E_β (Mev)	N_β
0.259	0.06

Source: NDS 5-2-48, 5-2-54 and 55

79 Au 198
2.7 days

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)
1.087	0.0018	0.0018	- -	0.0020
0.675	0.0082	0.0082	- -	0.0055
0.4118	0.9982	0.9710	0.0272	0.3999
Total	1.0082	0.9810	0.0272	0.4074
$E_K = 0.0725$ Mev			$N_K E_K = 0.0020$	
PH = 1.008			ED = 0.4094 Mev/D	
HPH = 1.008			HED = 0.4094 Mev/D	

E_β (Mev)	N_β
0.287	0.01
0.962	0.99

Source: NDS 5-3-55 and 5-3-59

79 Au 199
3.15 days

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.0498	0.053	- -	- -	- - -	0.251	0.23
0.1583	0.753	0.58	0.17	0.0918	0.302	0.70
0.2082	0.177	0.10	0.08	0.0208	0.460	0.76
Total	0.983	0.68	0.25	0.1126		

$E_K = 0.0725$ Mev

$N_K E_K = 0.0181$

PH = 0.93

ED = 0.1307 Mev/D

HPH = 0.93

HED = 0.1307 Mev/D

Source: NDS 5-1-17 and 5-1-27

80 Hg 197m
24 hours

E_{γ} (Mev)	N_T	N_{γ}	N_K	$N_{\gamma} E_{\gamma}$ (Mev/D)	E_{β} (Mev)	N_{β}
0.130	0.035	0.032	0.003	.0042	Isomeric Transition and E. C.	
0.279	0.035	0.023	0.012	.0064		
0.165	0.965	0.003	0.192	.0005		
0.134	0.965	0.311	0.242	.0417		
capture e^-	- - -	- - -	0.035	- - -		
Total	2.000	0.369	0.484	.0528		

$$E_K = 0.0725 \text{ Mev}$$

$$PH = .853$$

$$HPH = .853$$

$$N_{K K} E_K = .0351 \text{ Mev/D}$$

$$ED = .0879 \text{ Mev/D}$$

$$HED = .0879 \text{ Mev/D}$$

Source: NDS 5-1-17 and 5-1-26

80 Hg 197
65 hours

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β N_β (Mev)
0.191	0.017	0.006	0.012	.0011	Decays by E. C.
0.0773	1.000	0.233	- - -	.0180	
capture e^-	- - -	- - -	1.000		
Total	1.017	0.239	1.012	.0191	

$$E_K = 0.0725 \text{ Mev}$$

$$PH = 1.251$$

$$HPH = 1.251$$

$$N_K E_K = .0734 \text{ Mev/D}$$

$$ED = 0.0925 \text{ Mev/D}$$

$$HED = 0.0925 \text{ Mev/D}$$

Source: NDS 5-2-92

80 Hg 203
47 days

E_γ (Mev)	N_T	N_γ	N_K	$N_\gamma E_\gamma$ (Mev/D)	E_β (Mev)	N_β
0.279	1.0	0.86	0.14	0.240	0.212	1.0

$$E_K = 0.0746$$

$$N_K E_K = 0.0104$$

$$PH = 1.0$$

$$ED = 0.250 \text{ Mev/D}$$

$$HPH = 1.0$$

$$HED = 0.250$$

Source: NDS 5-2-92 and 5-2-98

82 Pb 203
52 hours

E_{γ} (Mev)	N_T	N_{γ}	N_K	$N_{\gamma}E_{\gamma}$ (Mev/D)
0.680	0.008	0.008	- -	0.0054
0.401	0.045	0.039	0.006	0.0156
0.279	0.990	0.853	0.137	0.2380
capture e^-	- - -	- - -	1.0	- - -
Total	1.043	0.900	1.143	0.2590

E_{β} N_{β}
(Mev)
Decays by E. C.

$E_K = 0.0746$ Mev
PH = 2.043
HPH = 2.043

$N_K E_K = 0.0853$
ED = 0.3443 Mev/D
HED = 0.3443 Mev/D

Source: NDS 5-1-36 and 5-1-41

82 Pb 204m
67 min

E_{γ} (Mev)	N_T	N_{γ}	N_K	$N_{\gamma}E_{\gamma}$ (Mev/D)
0.912	1.0	0.95	0.05	0.8664
0.375	1.0	0.96	0.04	0.3600
0.899	1.0	0.99	0.01	0.8900
Total	3.0	2.90	0.10	2.1164

E_{β} N_{β}
(Mev)
Isomeric Transition

$E_K = 0.0767$ Mev
PH = 3.0
HPH = 3.0

$N_K E_K = 0.0077$
ED = 2.124 Mev/D
HED = 2.124 Mev/D

Source: J. O. Rasmussen, F. L. Canavan and J. M. Hollander, 92 U 237
Phys. Rev. 107, 141 (1957). 6.75 days

E_γ (Mev)	N_γ	N_K	N_{L1}	N_{L2}	N_{L3}	N_M	$N_\gamma E_\gamma$	E_β (Mev)	N_β
0.060	0.360	- -	0.075	0.149	0.047	0.085	0.021	0.248	0.960
0.065	0.023	- -	0.003	0.003	0.003	- - -	0.001		
0.165	0.036	0.005	0.002	0.013	0.006	0.005	0.006		
0.208	0.240	0.620	0.108	0.014	0.001	0.022	0.050		
0.234	- - -	0.001	- - -	- - -					
0.267	- - -	0.005	0.002	- - -					
0.332	0.014	- - -	- - -				0.005		
0.335	0.002	- - -	- - -				0.001		
0.368	- - -	- - -							
0.371	- - -	- - -							
Total	0.675	0.631	0.190	0.179	0.057	0.112	0.084		

$$E_K = 0.103 \text{ Mev}$$

$$N_K E_K = 0.065$$

$$E_{L1} = 0.022 \text{ Mev}$$

$$N_{L1} E_{L1} = 0.004$$

$$E_{L2} = 0.022 \text{ Mev}$$

$$N_{L2} E_{L2} = 0.004$$

$$E_{L3} = 0.018 \text{ Mev}$$

$$N_{L3} E_{L3} = 0.001$$

$$E_M = 0.006 \text{ Mev}$$

$$N_M E_M = 0.001$$

$$PH = 1.844$$

$$ED = 0.159 \text{ Mev/D}$$

$$HPH = 1.675$$

$$HED = 0.157 \text{ Mev/D}$$

Source: C. F. Miller, USNRDL-TR-160, (1957).

92 U 239
23.5 Min.

E_γ (Mev)	N_γ	N_K	N_L	$N_\gamma E_\gamma$	E_β (Mev)	N_β
0.074	0.830	- -	0.170	0.062	1.210	1.000

$$E_L = 0.022$$

$$N_L E_L = 0.004$$

$$PH = 1.000$$

$$ED = 0.066 \text{ Mev/D}$$

$$HPH = 1.000$$

$$HED = 0.066 \text{ Mev/D}$$

Source: M. E. Bunker, et al.
Phys. Rev. 116, 143 (1959).

92 U 240
14.1 hrs.

E_γ (Mev)	N_γ	N_L	$N_\gamma E_\gamma$	E_β (Mev)	N_β
0.044	0.063	0.188	0.003	0.320	0.250

$E_L = 0.022$
PH = 0.251
HPH = 0.251

$N_L E_L = 0.004$
ED = 0.007 Mev/D
HED = 0.007 Mev/D

Source: J. Borggreen, O. B. Nielsen and H. Nordby
Nucl. Phys. 29, 515 (1962).

93 Np 238
2.1 Days

E_γ (Mev)	N_γ	N_K	$N_{L1 + L2}$	N_{L3}	N_M	N_N	$N_\gamma E_\gamma$	E_β (Mev)	N_β
0.044	-	-	0.145	0.106	0.175	0.036	-	1.240	0.580
1.010	-	-	0.019	0.009	0.010	0.002	-	0.260	0.420
0.885	0.009	-	-	-	-	-	0.008	-	-
0.925	0.025	-	-	-	-	-	0.023	-	-
0.986	0.241	0.003	0.001	-	-	-	0.238	-	-
1.030	0.174	0.002	0.001	-	-	-	0.180	-	-
Total	0.449	0.005	0.166	0.115	0.185	0.038	0.449	-	-

$E_K = 0.106$ Mev

$N_K E_K = 0.001$

$E_{L1 + L2} \text{ AVG} = 0.022$ Mev

$N_{L1 + L2} E_{L1 + L2} = 0.004$

$E_{L3} = 0.018$ Mev

$N_{L3} E_{L3} = 0.002$

$E_M = 0.006$ Mev

$N_M E_M = 0.001$

$E_N = 0.002$ Mev

$N_N E_N = 0.0001$

PH = 0.958

ED = 0.457 Mev/D

HPH = 0.620

HED = 0.454 Mev/D

Source: C. F. Miller, USNRDL-TR-160, (1957).
 R. D. Connor and I. L. Fairweather,
 Pro. Phys. Soc. (London) 74, 161 (1959).

93 Np 239
 56.0 hrs.

E_γ (Mev)	N_γ	N_K	N_{L+M}	$N_\gamma E_\gamma$	E_β (Mev)	N_β
0.045	0.001	-	0.046	-	0.713	0.065
0.049	0.001	-	0.079	-	0.654	0.040
0.057	0.001	-	0.213	-	0.437	0.480
0.061	0.059	-	0.002	0.004	0.393	0.135
0.068	0.002	-	0.136	-	0.332	0.280
0.106	0.314	-	0.072	0.033		
0.182	0.005	-	0.001	0.001		
0.210	0.029	0.080	0.026	0.006		
0.226	0.001	0.002	-	-		
0.228	0.083	0.187	0.055	0.019		
0.255	0.022	0.002	-	0.006		
0.273	0.008	0.012	0.003	0.002		
0.278	0.133	0.178	0.047	0.037		
0.286	0.012	0.025	0.010	0.003		
0.316	0.004	-	-	0.001		
0.335	0.021	0.001	-	0.007		
	0.696	0.487	0.690	0.119		

$$E_K = 0.106 \text{ Mev}$$

$$E_L = 0.022 \text{ Mev}$$

$$PH = 1.873$$

$$HPH = 1.873$$

$$N_K E_K = 0.052$$

$$N_L E_L = 0.015$$

$$ED = 0.186 \text{ Mev/D}$$

$$HED = 0.186 \text{ Mev/D}$$

Source: M. E. Bunker, B. J. Dropesky, J. D. Knight
J. W. Starner and B. Warren, Phys. Rev. 116, 143
(1959).

93 Wp 240
7.3 Min.

E_γ (Mev)	N_γ	N_K	$E_\gamma N_\gamma$	E_β (Mev)	N_β
0.260	0.019	0.001	0.005	2.180	0.520
0.304	0.009	- - -	0.003	1.600	0.310
0.554	0.214	0.002	0.119	1.300	0.100
0.597	0.126	0.001	0.075	0.650	0.070
0.758	0.013	- - -	0.010		
0.816	0.016	- - -	0.013		
0.820	0.003	- - -	0.002		
0.898	0.012	- - -	0.011		
0.936	0.003	- - -	0.003		
0.942	0.019	- - -	0.018		
1.490	0.015	- - -	0.022		
1.530	0.019	- - -	0.029		
1.620	0.007	- - -	0.011		
Total	0.475	0.004	0.321		

$$E_K = 0.479 \text{ Mev}$$

$$PH = 0.479$$

$$HPH = 0.479$$

$$N_K E_K = 0.0004$$

$$ED = 0.321$$

$$HED = 0.321$$

Source: F. Asaro and I. Perlman, Phys. Rev. 94, 381 (1954), $^{94}\text{Pu} 238$
 and D. C. Hoffman, G. P. Ford and F. O. Lawrence, 86.4 years
 J. Inorg. Nucl. Chem. 5, 6 (1957).

E_{γ} (Mev)	N_{γ}	N_K	N_L	$N_{\gamma}E_{\gamma}$	E_{α} (Mev)	N_{α}
0.099	0.0001	- -	0.0008	- -	Alpha decay	
0.0438	0.0004	- -	0.2796	- -	5.352	0.0009
Total	0.0005		0.2804		5.452	0.28
(Very weak 0.150 Mev gamma observed.)					5.495	0.72
$E_L = 0.017 \text{ Mev}$					$N_L E_L = 0.0048$	
$PH = 0.2809$					$ED = 0.0048$	
$HPH = 0.0005$					$HED = 0$	

APPENDIX II

EXPOSURE-RATE MULTIPLIERS

The following list gives an exposure-rate multiplier for each nuclide contained in Appendix I. The point of exposure is assumed to be 3 feet above an infinite plane uniformly contaminated with the nuclide in question. The units of the multiplier are roentgens-sec-cm²-hr⁻¹-disintegrations⁻¹. The multiplier will convert nuclide activities in disintegrations-sec⁻¹-cm⁻² to exposure rates in roentgens-hr⁻¹. The figure in parentheses indicates the number of zeros between the decimal point and the first significant figure; i.e., (6)297 is to be read 0.000000297 or 0.297×10^{-6} .

<u>Nuclide</u>	<u>Half-life</u>	<u>Multiplier</u>	<u>Nuclide</u>	<u>Half-life</u>	<u>Multiplier</u>
Be 7	53.4 d	(6)297	Ag 108m	≥ 5 y	(5)953
Na 22	2.6 y	(5)605	Ag 108	2.4 m	(7)943
Na 24	15.0 h	(4)171	Ag 109m	39.0 s	(7)805
Al 26	7.4x10 ⁵ y	(5)812	Ag 110m	253 d	(4)137
Si 31	2.6 h	(8)422	Ag 110	24 s	(6)175
Cl 34m	32.4 m	(5)617	Cd 107	6.5 h	(6)384
Cl 38	38 m	(5)642	Cd 109	470 d	(6)106
K 40	1.27x10 ⁹ y	(6)737	Cd 113m	14 y	(8)140
K 42	12.5 h	(5)126	In 113m	1.7 h	(5)144
Sc 44m	2.4 d	(5)127	In 114m ₂	2.5 s	(6)798
Sc 44	3.9 h	(5)589	In 114m ₁	50 d	(6)506
Sc 46m	20 s	(6)400	In 114	72 s	(7)248
Sc 46	84 d	(4)100	Sn 113m	27 m	(6)426
Ti 45	3.1 h	(8)923	Sn 113	118 d	(5)263
*V 49	330 d	-	Sb 120m	5.8 d	(4)123
Cr 49	42 m	(6)288	Sb 120	16 m	(6)143
Cr 51	28 d	(6)160	I 126	13 d	(5)230
Mn 54	291 d	(5)431	Cs 132	6.5 d	(5)366
Mn 56	2.58 h	(5)872	Pr 142	19.3 h	(6)283
*Fe 55	2.7 y	-	Eu 152m	9.3 h	(5)192
Fe 59	45 d	(5)580	Eu 152	13.0 y	(5)580
Co 57	270 d	(6)649	Gd 153	242 d	(6)617
*Co 58m	9.0 h	(6)120	Tb 158	150 y	(5)427
Co 58	71 d	(5)426	Dy 159	144 d	(6)337
Co 60	5.27 y	(4)119	Ho 166m	1200 y	(5)874
Ni 57	36.5 h	(5)682	Ho 166	27 h	(6)110
Ni 65	2.5 h	(5)286	*Er 169	9.3 d	-
Cu 64	1.3 h	(7)377	Er 171	7.5 h	(5)212
Zn 63	38.4 m	(6)508	Tm 168	86 d	(5)764
Zn 65	245 d	(5)267	Tm 170	127 d	(7)390
Zn 69m	14 h	(5)220	*Tm 171	1.9 y	(8)532
Zn 71m	4 h	(5)793	Lu 176	3.7 h	(6)333
Zn 71	2.45 m	(6)650	Lu 177	6.75 d	(6)204
As 74m	8.0 s	(5)150	Hf 173	24 h	(5)210
As 74	18 d	(5)246	Hf 175	70 d	(5)176
Y 88	105 d	(4)123	Hf 180m	5.5 h	(5)548
Rh 102	206 d	(5)299	Hf 181	45 d	(5)306
Ag 106m	8.3 d	(4)139	Ta 180m	8.15 h	(6)337
Ag 106	24 m	(5)278	Ta 182m	16 m	(5)190
Ag 107m	44 s	(6)141	Ta 182	115 d	(5)241

*All energies less than 75 Kev.

Nuclide	Half-life	Multiplier
W 181	145 d	(6)320
W 187	24 h	(5)306
Re 184	50 d	(5)488
Re 186	90 h	(6)417
*Re 188m	18.7 m	(6)319
Re 188	17 h	(6)251
Os 190m	10 m	(5)839
Os 191	15 d	(6)413
Os 193	32 h	(6)300
*Ir 190m	3.2 h	(6)281
Ir 190	12 d	(5)669
Ir 192m ₂	650 y	(6)362
Ir 192	74 d	(5)391
Ir 193m	12 d	(6)426
Ir 194	19 h	(6)940
Pt 191	3 d	(5)133
Pt 193m	4.4 d	(6)388
Pt 195m	4.1	(5)110
Pt 197	20 h	(6)163
Pt 199m	14 s	(5)196
Au 196m	9.7 h	(5)115
Au 196	6.18 d	(5)270
Au 198	2.7 d	(5)224
Au 199	3.15 d	(6)699
Hg 197m	24 h	(6)455
Hg 197	65 h	(6)482
Hg 203	47 d	(5)134
Pb 203	52 h	(5)182
Pb 204m	67 m	(4)109
U 237	6.75 d	(6)845
*U 239	23.5 m	(6)327
U 240	14.1 h	(7)333
Np 238	2.1 d	(5)227
Np 239	56.0 h	(6)966
Np 240	7.3 m	(5)165
Pu 238	86.4 y	(7)299

*All energies less than 75 Kev.

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Naval Radiological Defense Laboratory USNRDL-TR-888 GAMMA-EMISSION DATA FOR THE CALCULATION OF EXPOSURE RATES FROM NUCLEAR DEBRIS. VOLUME II. INDUCED ACTIVITIES, by G. R. Crocker and D. T. K. Wong 13 August 1965 89 p. 4 refs. UNCLASSIFIED Photon energies and photon abundances have been compiled and summarized for some induced activities which may result from nuclear events. The data are presented in tabular form, including photon energies and abundances for the gamma rays, X rays, and beta particles (over)	1. Gamma emission 2. Dose rate 3. Induced radio- activity 4. Decay scheme I. Crocker, G. R. II. Wong, D. T. K. III. Title IV. UNCLASSIFIED
emitted per disintegration. A list of multipliers is also presented for converting activities of the radionuclides to infinite-plane ex- posure rates.	emitted per disintegration. A list of multipliers is also presented for converting activities of the radionuclides to infinite-plane ex- posure rates. UNCLASSIFIED