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The GAMMON Activation Library

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***LASL Consultant.**

THE GAMMON ACTIVATION LIBRARY

by

M. E. Battat, R. J. LaBauve, and D. W. Muir

ABSTRACT

This report describes the GAMMON activation library that is specifically designed for fusion reaction application but is also adequate for many other design studies. The library contains multigroup cross sections (in 100 energy groups) for 420 neutron-induced reactions, multigroup gamma-ray spectra (in 25 energy groups) for 107 unique daughter products, maximum permissible concentrations (MPC's) for 200 reaction products, and absorbable decay energy ("sensible heat") for 85 products.

I. INTRODUCTION

The GAMMON activation library contains neutron activation cross sections, radioactive decay information, maximum permissible concentrations (MPC), and total absorbable (gamma + non-gamma) energy release. The starting point for the GAMMON library was the DLC-33/MONTAGE data file.¹ The latter contains 100-group neutron cross sections for 421 reactions and, where applicable, half-lives of the radioactive products. To this MONTAGE file we have appended the following information.

- MeV/dis of gamma radiation.
- MeV/dis of non-gamma radiation.
- For a gamma emitter, the photons per 100 disintegrations in a 25-group structure covering the energy range from 0 to 10 MeV.
- The MPC values as specified in the Code of Federal Regulations.

Before proceeding with a discussion of the data in the GAMMON file, some general comments would be in order. As with any data compilation, there will be as many "wish lists" for more information as there are users of the library. It is also certain that the choice of the number of groups and/or the energy group

structure will not be universally compatible with the wide diversity of in-house user codes. More importantly, there will inevitably be reactions of interest to some users that are not in the library. As a case in point, we are aware of certain reactions that are considered important for a particular TOKAMAK design² and which are not in the GAMMON library. Also, neutron cross sections for about 280 reactions in the file were calculated using the THRESH code;³ the use of this code was found to be convenient in the period prior to the initial release of the MONTAGE library in 1974. More sophisticated nuclear-model codes, for example, the GNASH code,⁴ are now available and should be employed in future updates and to replace any of the THRESH-generated cross sections in the GAMMON library that may be of practical interest. These admitted shortcomings exist in the library because of limited resources allotted to this task, but the library approaches the current state of the art. Furthermore, we feel that, before embarking on another major revision of the library, some consensus on what it should contain is necessary. However, this does not detract from the present usefulness of the library for fusion reactor calculations. With the addition of some user-supplied data for specific applications, the file should be adequate for most design studies. Any future update, revisions, and additions to the data should consider inputs from users so that the library can be useful to a larger number of the fusion-reactor community.

II. NEUTRON CROSS SECTIONS

The GAMMON file contains data for 420 reactions,^{*} of which about 100 were processed using ENDF/B-IV data. Approximately 40 of the reaction cross sections were obtained from other sources (see Ref. 1) with the rest calculated using the THRESH code. Activation cross sections are given for 100 energy groups (the GAM-II structure); the energy boundaries of the groups are listed in Table I. The weighting function is $1/E$ except near 14 MeV where a thermally broadened ($T = 20$ MeV) fusion peak is employed. A listing of the reactions for which data are given, together with other relevant information, is shown in Table II. This

* This is one less than the number of reactions in DLC-33/MONTAGE. We deleted the data for the $^{54}\text{Fe}(n,\gamma)^{55}\text{Fe}$ reaction because the cross-section behavior was incorrect, and the information could not be found in the reference cited for the data. A few typographical errors were also corrected, the main one being the group 100 cross section, 4.61×10^{-4} instead of 4.61×10^{-40} , for the $^2\text{H}(n,\gamma)^3\text{H}$ reaction.

TABLE I
NEUTRON MULTIGROUP STRUCTURE

GROUP	ENERGY RANGE				ENERGY WIDTH	
1	1.350E+01	MEV	T0	1.492E+01	MEV	1.420E+00
2	1.221E+01	MEV	T0	1.350E+01	MEV	1.285E+00
3	1.105E+01	MEV	T0	1.221E+01	MEV	1.162E+00
4	1.000E+01	MEV	T0	1.105E+01	MEV	1.052E+00
5	9.048E+00	MEV	T0	1.000E+01	MEV	9.516E-01
6	8.187E+00	MEV	T0	9.048E+00	MEV	8.611E-01
7	7.408E+00	MEV	T0	8.187E+00	MEV	7.791E-01
8	6.703E+00	MEV	T0	7.408E+00	MEV	7.050E-01
9	6.065E+00	MEV	T0	6.703E+00	MEV	6.379E-01
10	5.488E+00	MEV	T0	6.065E+00	MEV	5.772E-01
11	4.966E+00	MEV	T0	5.488E+00	MEV	5.223E-01
12	4.493E+00	MEV	T0	4.966E+00	MEV	4.726E-01
13	4.066E+00	MEV	T0	4.493E+00	MEV	4.276E-01
14	3.679E+00	MEV	T0	4.066E+00	MEV	3.869E-01
15	3.329E+00	MEV	T0	3.679E+00	MEV	3.501E-01
16	3.012E+00	MEV	T0	3.329E+00	MEV	3.168E-01
17	2.725E+00	MEV	T0	3.012E+00	MEV	2.866E-01
18	2.466E+00	MEV	T0	2.725E+00	MEV	2.593E-01
19	2.231E+00	MEV	T0	2.466E+00	MEV	2.347E-01
20	2.019E+00	MEV	T0	2.231E+00	MEV	2.123E-01
21	1.827E+00	MEV	T0	2.019E+00	MEV	1.921E-01
22	1.653E+00	MEV	T0	1.827E+00	MEV	1.738E-01
23	1.496E+00	MEV	T0	1.653E+00	MEV	1.573E-01
24	1.353E+00	MEV	T0	1.496E+00	MEV	1.423E-01
25	1.225E+00	MEV	T0	1.353E+00	MEV	1.288E-01
26	1.108E+00	MEV	T0	1.225E+00	MEV	1.165E-01
27	1.003E+00	MEV	T0	1.108E+00	MEV	1.054E-01
28	9.072E-01	MEV	T0	1.003E+00	MEV	9.541E-02
29	8.208E-01	MEV	T0	9.072E-01	MEV	8.633E-02
30	7.427E-01	MEV	T0	8.208E-01	MEV	7.811E-02
31	6.721E-01	MEV	T0	7.427E-01	MEV	7.068E-02
32	6.081E-01	MEV	T0	6.721E-01	MEV	6.395E-02
33	5.502E-01	MEV	T0	6.081E-01	MEV	5.787E-02
34	4.979E-01	MEV	T0	5.502E-01	MEV	5.236E-02
35	4.505E-01	MEV	T0	4.979E-01	MEV	4.738E-02
36	4.076E-01	MEV	T0	4.505E-01	MEV	4.287E-02
37	3.688E-01	MEV	T0	4.076E-01	MEV	3.879E-02
38	3.337E-01	MEV	T0	3.688E-01	MEV	3.510E-02
39	3.020E-01	MEV	T0	3.337E-01	MEV	3.176E-02
40	2.732E-01	MEV	T0	3.020E-01	MEV	2.874E-02
41	2.472E-01	MEV	T0	2.732E-01	MEV	2.600E-02
42	2.237E-01	MEV	T0	2.472E-01	MEV	2.353E-02
43	2.024E-01	MEV	T0	2.237E-01	MEV	2.129E-02
44	1.832E-01	MEV	T0	2.024E-01	MEV	1.926E-02
45	1.657E-01	MEV	T0	1.832E-01	MEV	1.743E-02
46	1.500E-01	MEV	T0	1.657E-01	MEV	1.577E-02
47	1.357E-01	MEV	T0	1.500E-01	MEV	1.427E-02
48	1.228E-01	MEV	T0	1.357E-01	MEV	1.291E-02
49	1.111E-01	MEV	T0	1.228E-01	MEV	1.168E-02

TABLE I (contd.)

GROUP	ENERGY RANGE				ENERGY WIDTH	
50	8.652E+01	KEV	T ₀	1.111E-01	MEV	2.457E+01 KEV
51	6.738E+01	KEV	T ₀	8.652E+01	KEV	1.914E+01 KEV
52	5.248E+01	KEV	T ₀	6.738E+01	KEV	1.490E+01 KEV
53	4.087E+01	KEV	T ₀	5.248E+01	KEV	1.161E+01 KEV
54	3.183E+01	KEV	T ₀	4.087E+01	KEV	9.040E+00 KEV
55	2.479E+01	KEV	T ₀	3.183E+01	KEV	7.040E+00 KEV
56	1.930E+01	KEV	T ₀	2.479E+01	KEV	5.483E+00 KEV
57	1.503E+01	KEV	T ₀	1.930E+01	KEV	4.270E+00 KEV
58	1.171E+01	KEV	T ₀	1.503E+01	KEV	3.326E+00 KEV
59	9.119E+00	KEV	T ₀	1.171E+01	KEV	2.590E+00 KEV
60	7.102E+00	KEV	T ₀	9.119E+00	KEV	2.017E+00 KEV
61	5.531E+00	KEV	T ₀	7.102E+00	KEV	1.571E+00 KEV
62	4.307E+00	KEV	T ₀	5.531E+00	KEV	1.223E+00 KEV
63	3.355E+00	KEV	T ₀	4.307E+00	KEV	9.528E-01 KEV
64	2.613E+00	KEV	T ₀	3.355E+00	KEV	7.420E-01 KEV
65	2.035E+00	KEV	T ₀	2.613E+00	KEV	5.779E-01 KEV
66	1.585E+00	KEV	T ₀	2.035E+00	KEV	4.501E-01 KEV
67	1.234E+00	KEV	T ₀	1.585E+00	KEV	3.505E-01 KEV
68	9.611E-01	KEV	T ₀	1.234E+00	KEV	2.730E-01 KEV
69	7.485E-01	KEV	T ₀	9.611E-01	KEV	2.126E-01 KEV
70	5.829E-01	KEV	T ₀	7.485E-01	KEV	1.656E-01 KEV
71	4.540E-01	KEV	T ₀	5.829E-01	KEV	1.289E-01 KEV
72	3.536E-01	KEV	T ₀	4.540E-01	KEV	1.004E-01 KEV
73	2.754E-01	KEV	T ₀	3.536E-01	KEV	7.821E-02 KEV
74	2.145E-01	KEV	T ₀	2.754E-01	KEV	6.091E-02 KEV
75	1.670E-01	KEV	T ₀	2.145E-01	KEV	4.744E-02 KEV
76	1.301E-01	KEV	T ₀	1.670E-01	KEV	3.694E-02 KEV
77	1.013E-01	KEV	T ₀	1.301E-01	KEV	2.877E-02 KEV
78	7.889E+01	EV	T ₀	1.013E-01	KEV	2.241E+01 EV
79	6.144E+01	EV	T ₀	7.889E+01	EV	1.745E+01 EV
80	4.785E+01	EV	T ₀	6.144E+01	EV	1.359E+01 EV
81	3.727E+01	EV	T ₀	4.785E+01	EV	1.058E+01 EV
82	2.902E+01	EV	T ₀	3.727E+01	EV	8.243E+00 EV
83	2.260E+01	EV	T ₀	2.902E+01	EV	6.420E+00 EV
84	1.760E+01	EV	T ₀	2.260E+01	EV	5.000E+00 EV
85	1.371E+01	EV	T ₀	1.760E+01	EV	3.894E+00 EV
86	1.068E+01	EV	T ₀	1.371E+01	EV	3.033E+00 EV
87	8.315E+00	EV	T ₀	1.068E+01	EV	2.362E+00 EV
88	6.476E+00	EV	T ₀	8.315E+00	EV	1.839E+00 EV
89	5.043E+00	EV	T ₀	6.476E+00	EV	1.432E+00 EV
90	3.928E+00	EV	T ₀	5.043E+00	EV	1.116E+00 EV
91	3.059E+00	EV	T ₀	3.928E+00	EV	8.688E-01 EV
92	2.382E+00	EV	T ₀	3.059E+00	EV	6.767E-01 EV
93	1.855E+00	EV	T ₀	2.382E+00	EV	5.270E-01 EV
94	1.445E+00	EV	T ₀	1.855E+00	EV	4.104E-01 EV
95	1.125E+00	EV	T ₀	1.445E+00	EV	3.196E-01 EV
96	8.764E-01	EV	T ₀	1.125E+00	EV	2.489E-01 EV
97	6.826E-01	EV	T ₀	8.764E-01	EV	1.939E-01 EV
98	5.316E-01	EV	T ₀	6.826E-01	EV	1.510E-01 EV
99	4.140E-01	EV	T ₀	5.316E-01	EV	1.176E-01 EV
100	THERMAL					

TABLE II

GAMMON LIBRARY - TITLE CARDS

H	2	(N,G)	H	3	12.33	Y	ENDF/B-IV	0.00000	1022	0
HE	3	(N,P)	H	3	2.00E-07		.00572	AERE		
LI	6	(N,P)	H	3	12.33	Y	ENDF/B-IV	0.00000	2033	0
LI	6	(N,P)	H	3	2.00E-07		.00572	AERE		
LI	6	(N,A)	HE	6	0.805	S	ENDF/B-IV	0.00000	3063	0
LI	6	(N,A)	HE	6	3.00E-06		1.40000	TISD7		
LI	7	(N,G)	H	3	12.33	Y	ENDF/B-IV	0.00000	3064	0
LI	7	(N,G)	H	3	2.00E-07		.00572	AERE		
LI	7	(N,NP+D)	LI	8	0.844	S	ENDF/B-IV	0.00000	3072	0
LI	7	(N,NP+D)	LI	8	3.00E-05		8.14000	TISD7		
BE	9	(N,G)	HE	6	0.805	S	ENDF/B-IV	0.00000	3075	0
BE	9	(N,P)	HE	6	3.00E-06		1.40000	TISD7		
BE	9	(N,P)	BE	10	1.6 E+5	Y	ENDF/B-IV	0.00000	4092	0
BE	9	(N,P)	BE	10	1.00E-10		.25200	AERE		
BE	9	(N,P)	LI	9	0.177	S	ENDF/B-IV	0.00000	4093	0
BE	9	(N,A)	LI	9	3.00E-06		5.35000	TISD7		
B	10	(N,P)	HE	6	0.805	S	ENDF/B-IV	0.00000	4094	0
B	10	(N,T)	HE	6	3.00E-06		1.40000	TISD7		
B	10	(N,T)	BE	10	1.6 E+6	Y	ENDF/B-IV	0.00000	5103	0
B	10	(N,T)	BE	10	1.00E-10		.25200	AERE		
B	11	(N,G)	BE	8	1. E-16	S	ENDF/B-3	0.00000	5107	0
B	11	(N,G)	BE	8	2.00E-14		.09200	TISD7		
B	11	(N,P)	B	12	0.0204	S	ENDF/B-IV	.05759	5112	0
B	11	(N,P)	B	12	3.00E-05		5.36000	TISD7		
B	11	(N,A)	BE	11	13.8	S	ENDF/B-IV	1.39541	5113	0
B	11	(N,A)	BE	11	3.00E-06		4.06000	TISD7		
N	14	(N,2N)	LI	8	0.844	S	ENDF/B-IV	0.00000	5114	0
N	14	(N,2N)	LI	8	3.00E-06		8.14000	TISD7		
N	14	(N,P)	N	13	9.97	M	ENDF/B-IV	1.02006	7141	0
N	14	(N,P)	N	13	3.00E-06		.49200	TM102		
N	14	(N,P)	C	14	5730.	Y	ENDF/B-IV	0.00000	7143	0
N	14	(N,P)	C	14	1.00E-07		.04930	AERE		
N	16	(N,P)	N	16	7.10	S	ENDF/B-IV	4.62313	8163	0
N	16	(N,P)	N	16	3.00E-06		2.69300	AERE		
N	17	(N,A)	C	14	5730.	Y	THRESH+1/V	0.00000	8174	0
N	17	(N,A)	C	14	1.00E-07		.04930	AERE		

TABLE II - CONTINUED

F	19	(N,2N)	F	19	109.8	M	ENDF/B-IV	.98827	9191	0
			F	18	9.00E-08		.24200	TM102		
F	19	(N,G)	F	20	11.0	S	ENDF/B-IV	1.63310	9192	0
			F	20	3.00E-06		2.16000	TISD7		
F	19	(N,P)	O	19	26.8	S	ENDF/B-IV	1.04495	9193	0
			C	19	3.00E-06		1.71800	AERE		
F	19	(N,A)	N	16	7.10	S	ENDF/B-IV	4.62313	9194	0
			N	16	3.00E-06		2.69300	AERE		
NA	23	(N,2N)	NA	22	2.6(1	Y	ENDF/B-IV	2.07177	11231	0
			NA	22	3.00E-10		.19500	AERE		
NA	23	(N,G)	NA	24	15.02	H	ENDF/B-IV	4.12161	11232	0
			NA	24	5.00E-09		.54900	AERE		
NA	23	(N,P)	NE	23	37.5	S	ENDF/B-IV	.16708	11233	0
			NE	23	3.00E-06		1.70000	TISD7		
NA	23	(N,A)	F	20	11.0	S	ENDF/B-IV	1.63310	11234	0
			F	20	3.00E-06		2.16000	TISD7		
AL	27	(N,2N)	AL	26	7.3 E+5	Y	ENDF/B-IV	2.67837	13271	0
			AL	26	1.00E-10		.44500	MEDLI		
AL	27	(N,G)	AL	28	2.24	M	ENDF/B-IV	1.77880	13272	0
			AL	28	3.00E-06		1.24700	MEDLI		
AL	27	(N,P)	MG	27	9.45	M	ENDF/B-IV	.89273	13273	0
			MG	27	3.00E-06		.69300	AERE		
AL	27	(N,A)	NA	24	15.02	H	ENDF/B-IV	4.12161	13274	0
			NA	24	5.00E-09		.54900	AERE		
SI	28	(N,P)	AL	28	2.24	M	UKAEA	1.77830	14283	0
			AL	28	3.00E-06		1.24700	MEDLI		
P	31	(N,P)	SI	31	2.62	H	UKAEA	.00089	15313	0
			SI	31	3.00E-09		.59000	TISD7		
S	32	(N,P)	P	32	14.28	D	ENDF/B-IV	0.00000	16323	0
			P	32	2.00E-09		.69500	TM102		
CL	35	(N,2N)	CL	34M	32.2	M	THRESH	2.56528	17351	0
			CL	34M	3.00E-06		.49000	TISD7		
CL	35	(N,G)	CL	36	3.01 E+5	Y	BNL-325	.00002	17352	0
			CL	36	3.00E-10		.27800	AERE		
CL	35	(N,P)	S	35	87.2	D	BNL-325	0.00000	17353	0
			S	35	9.00E-09		.04890	AERE		

TABLE II - CONTINUED

CL 35	(N,A)	P 32	14.28	D	THRESH	0.00000	17354	0
		P 32	2.00E-09		.69500	IM102		
CL 37	(N,2N)	CL 36	3.01 E+5	Y	THRESH	.00002	17371	0
		CL 36	8.00E-10		.27800	AERE		
CL 37	(N,P)	S 37	5.05	M	THRESH	2.80264	17373	0
		S 37	3.00E-06		.73000	TISD7		
K 39	(N,2N)	K 38	7.63	M	ENDF/B-3	3.18880	19391	0
		K 38	3.00E-04		1.03000	TISD7		
K 39	(N,G)	K 40	1.28 E+9	Y	ENDF/B-3	.15630	19392	0
		K 40	1.00E-10		.52400	AERE		
K 39	(N,P)	AR 39	269.	Y	ENDF/B-3	0.00000	19393	0
		AR 39	1.00E-10		.21900	AERE		
K 39	(N,A)	CL 36	3.01 E+5	Y	ENDF/B-3	.00002	19394	0
		CL 36	8.00E-10		.27800	AERE		
K 41	(N,G)	K 42	12.36	H	BNL-325	.27586	19412	0
		K 42	4.00E-09		1.42200	AERE		
K 41	(N,P)	AR 41	1.83	H	THRESH	1.28408	19413	0
		AR 41	4.00E-08		.46400	AERE		
CA 40	(N,G)	CA 41	1.3 E+5	Y	BNL-325	0.00000	20402	0
		CA 41	1.00E-10		.00330	AERE		
CA 40	(N,A)	AR 37	34.8	D	THRESH	0.00000	20404	0
		AR 37	1.00E-04		0.00000	TISD7		
CA 42	(N,2N)	CA 41	1.3 E+5	Y	THRESH	0.00000	20421	0
		CA 41	1.00E-10		.00330	AERE		
CA 42	(N,A)	AR 39	269.	Y	THRESH	0.00000	20424	0
		AR 39	1.00E-10		.21900	AERE		
CA 44	(N,G)	CA 45	163.	D	BNL-325	0.00000	20442	0
		CA 45	1.00E-09		.07700	AERE		
CA 46	(N,G)	CA 47	4.54	D	BNL-325	1.06933	20462	0
		CA 47	6.00E-09		.38000	DK		
CA 48	(N,2N)	CA 47	4.54	D	THRESH	1.06933	20481	0
		CA 47	6.00E-09		.38000	DK		
SC 45	(N,G)	SC 46	83.8	D	BNL-325	2.00980	21452	0
		SC 46	8.00E-10		.11200	AERE		
TI 46	(N,2N)	TI 45	3.078	H	THRESH	.88228	22461	0
		TI 45	1.00E-10		.48800	DK		

TABLE II - CONTINUED

TI	46	(N,P)	SC	46	33.8	D	ENDF/B-IV	2.00980	22463	0
			SC	46	8.00E-10		.11200	AERE		
TI	47	(N,P)	SC	47	3.41	D	ENDF/B-IV	.11158	22473	0
			SC	47	2.00E-08		.16100	AERE		
TI	47	(N,NP+D)	SC	46	*		THRESH		22475	0
			SC	46	3.00E-10					
TI	48	(N,P)	SC	48	43.7	H	ENDF/B-IV	3.35248	22483	0
			SC	48	5.00E-09		.21800	AERE		
TI	48	(N,A)	CA	45	163.	D	BNL-325	0.00000	22484	0
			CA	45	1.00E-09		.07700	AERE		
TI	48	(N,NP+D)	SC	47	3.41	D	THRESH	.11158	22485	0
			SC	47	2.00E-08		.16100	AERE		
TI	48	(N,T)	SC	46	*		THRESH		22487	0
			SC	46	8.00E-10					
TI	49	(N,P)	SC	49	57.3	M	THRESH	.00053	22493	0
			SC	49	1.30E-06	DK	.80000	DK		
TI	49	(N,NP+D)	SC	48	43.7	H	THRESH	3.35248	22495	0
			SC	48	5.00E-09		.21300	AERE		
TI	49	(N,NA)	CA	45	163.	D	THRESH	0.00000	22496	0
			CA	45	1.00E-09		.07700	AERE		
TI	49	(N,T)	SC	47	3.41	D	THRESH	.11158	22497	0
			SC	47	2.00E-08		.16100	AERE		
TI	50	(N,G)	TI	51	5.75	M	BNL-325	.35955	22502	0
			TI	51	3.00E-05		.62000	DK		
TI	50	(N,P)	SC	50	1.71	M	THRESH	3.13542	22503	0
			SC	50	1.10E-07	DK	1.67500	DK		
TI	50	(N,A)	CA	47	4.54	D	THRESH	1.06933	22504	0
			CA	47	5.00E-09		.38000	DK		
TI	50	(N,NP+D)	SC	49	57.3	M	THRESH	.00053	22505	0
			SC	49	1.30E-06	DK	.80000	DK		
TI	50	(N,T)	SC	48	43.7	H	THRESH	3.35248	22507	0
			SC	48	5.00E-09		.21800	AERE		
V	49	(N,2N)	V	48	15.98	D	THRESH	2.91406	23491	0
			V	48	2.00E-07		.14700	TI507		
V	49	(N,A)	SC	46	*		THRESH		23494	0
			SC	46	8.00E-10					

TABLE II - CONTINUED

V	50	(N, 2N)	V	49	331.	D	THRESH	0.00000	23501	0
V	49	(N, A)	V	49	2.50E-07	DK	.00500	DK		
V	50	(N, A)	SC	47	3.41	D	THRESH	.11158	23504	C
V	50	(N, NA)	SC	47	2.00E-08		.16100	AERE		
V	46		SC	46	*		THRESH		23506	0
V	51	(N, G)	SC	45	8.00E-10					
V	52		V	52	3.76	M	ENDF/B-IV	1.44694	23512	0
V	51	(N, P)	V	52	3.50E-07	DK	.73300	DK		
V	51	(N, A)	TI	51	5.75	M	ENDF/R-IV	.35955	23513	C
V	51	(N, A)	TI	51	3.00E-06		.62000	DK		
V	48		SC	48	43.7	H	ENDF/B-IV	3.35248	23514	0
V	48	(N, NA)	SC	48	5.00E-09		.21800	AERE		
V	47		SC	47	3.41	C	ENDF/B-IV	.11158	23516	0
CR	50	(N, 2N)	SC	47	2.00E-08		.16100	AEPE		
CR	49		CR	49	42.0	M	BNL-325	1.09205	24501	0
CR	51	(N, S)	CR	49	3.00E-06		.58000	TIS07		
CR	51		CR	51	27.71	D	BNL-325	.03137	24502	C
CR	50	(N, P)	CR	51	8.00E-09		.00500	AERE		
CR	50	(N, NP+D)	V	50	4.0	F+16 Y	THRESH	1.32273	24503	0
CR	50	(N, NP+D)	V	50	1.90E-10		.12000	TIS07		
CR	49		V	49	331.	D	THRESH	0.00000	24505	0
CR	49	(N, I)	V	49	2.50E-07	DK	.00500	DK		
CR	48		V	48	15.98		THRESH	2.91406	24507	0
CR	51	(N, NP+D)	V	48	2.00E-09		.14700	TIS07		
CR	50	(N, 2N)	V	50	4.0	E+16 Y	THRESH	1.32273	24515	0
CR	51	(N, P)	CR	51	1.00E-10	D	.12000	TIS07		
CR	52	(N, P)	CR	51	27.71		BNL-325	.03137	24521	0
CR	52	(N, P)	CR	51	3.76	M	BNL-325	AERE		
CR	52	(N, I)	V	52	3.50E-07	DK	.73300	DK		
CR	50	(N, P)	V	50	4.0	E+16 Y	THRESH	1.32273	24527	0
CR	53	(N, P)	V	50	1.00E-10		.12000	TIS07		
CR	53	(N, NP+D)	V	53	1.55	M	THRESH	1.03990	24533	0
CR	52		V	53	3.00E-06		1.00000	TIS07		
CR	52		V	52	3.76	M	THRESH	1.44694	24535	0
CR	52		V	52	3.50E-07	DK	.73300	DK		

TABLE II - CONTINUED

CR	54	(N,P)	V	54	43.	S	THRESH	4.04000	24543	0
			V	54	3.00E-06		.88000	TISO7		
CR	54	(N,A)	TI	51	5.75	M	THRESH	.35955	24544	0
			TI	51	3.00E-06		.62000	DK		
CR	54	(N,NP+D)	V	53	1.55	M	THRESH	1.03990	24545	0
			V	53	3.00E-06		1.00000	TISO7		
CR	54	(N,T)	V	52	3.76	M	THRESH	1.44694	24547	0
			V	52	3.50E-07	DK	.73300	DK		
MN	53	(N,2N)	MN	52	*		THRESH		25531	0
			MN	52	5.00E-09					
MN	53	(N,A)	V	50	4.	E+16 Y	THRESH	1.32273	25534	0
			V	50	1.00E-10		.12000	TISO7		
MN	53	(N,NA)	V	49	331.	D	THRESH	0.00000	25536	0
			V	49	2.50E-07	DK	.00500	DK		
MN	54	(N,2N)	MN	53	3.8	E+6 Y	THRESH	0.00000	25541	0
			MN	53	1.00E-10		0.00000	TISO7		
MN	54	(N,NA)	V	50	4.	E+16 Y	THRESH	1.32273	25546	0
			V	50	1.00E-10		.12000	TISO7		
MN	55	(N,2N)	MN	54	312.5	D	ENDF/B-IV	.83463	25551	0
			MN	54	1.00E-09		.00560	AERE		
MN	55	(N,G)	MN	56	2.580	H	ENDF/B-IV	1.78233	25552	0
			MN	56	2.00E-08		.80000	AERE		
MN	55	(N,P)	CR	55	3.55	M	ENDF/B-IV	.00078	25553	0
			CR	55	3.00E-06		1.00000	TISO7		
MN	55	(N,A)	V	52	3.76	M	ENDF/B-IV	1.44694	25554	0
			V	52	3.50E-07	DK	.73300	DK		
FE	54	(N,2N)	FE	53	*		THRESH		26541	0
			FE	53	3.00E-06					
FE	54	(N,P)	MN	54	312.5	D	ENDF/B-IV	.83463	26543	0
			MN	54	1.00E-09		.00560	AERE		
FE	54	(N,A)	CR	51	27.71	D	BNL-325	.03137	26544	0
			CR	51	8.00E-08		.00500	AERE		
FE	54	(N,NP+D)	MN	53	3.8	E+6 Y	THRESH	0.00000	26545	0
			MN	53	1.00E-10		0.00000	TISO7		
FE	54	(N,T)	MN	52	*		THRESH		26547	0
			MN	52	5.00E-09					

TABLE II - CONTINUED

FE	55	(N,NP+D)	MN	54	312.5	D	THRESH	.83463	26555	0
			MN	54	1.00E-09		.00560	AERE		
FE	55	(N,NA)	CR	51	27.71	D	THRESH	.03137	26556	0
			CR	51	8.00E-08		.00500	AERF		
FE	56	(N,2N)	FE	55	2.7	Y	THRESH	0.00000	26561	0
			FE	55	3.00E-08		.00590	AERE		
FE	56	(N,P)	MN	56	2.580	H	ENDF/B-IV	1.78233	26563	0
			MN	56	2.00E-08		.80000	AERE		
FE	56	(N,T)	MN	54	312.5	D	THRESH	.83463	26567	0
			MN	54	1.00E-09		.00560	AERE		
FE	57	(N,P)	MN	57	1.59	M	THRESH	.04673	26573	0
			MN	57	3.00E-06		.97000	TIS07		
FE	57	(N,NP+D)	MN	56	2.580	H	THRESH	1.78233	26575	0
			MN	56	2.00E-08		.80000	AERE		
FE	58	(N,G)	FE	59	44.6	D	ENDF/B-IV	1.19234	26582	0
			FE	59	2.00E-09		.11800	AERE		
FE	58	(N,P)	MN	58	65.	S	THRESH	2.53675	26583	0
			MN	58	3.00E-06		1.37000	TIS07		
FE	58	(N,A)	CR	55	3.55	M	THRESH	.00078	26584	0
			CR	55	3.00E-06		1.00000	TIS07		
FE	58	(N,NP+D)	MN	57	1.59	M	THRESH	.04673	26585	0
			MN	57	3.00E-06		.97000	TIS07		
FE	58	(N,T)	MN	56	2.580	H	THRESH	1.78233	26587	0
			MN	56	2.00E-08		.80000	AERE		
CD	57	(N,2N)	CD	56	78.5	D	THRESH	3.64227	27571	0
			CD	56	1.00E-10		.11000	TIS07		
CD	57	(N,A)	MN	54	312.5	D	THRESH	.83463	27574	0
			MN	54	1.00E-09		.00560	AERE		
CD	57	(N,NA)	MN	53	3.8 E+6	Y	THRESH	0.00000	27576	0
			MN	53	1.00E-10		0.00000	TIS07		
CD	59	(N,2N)	CD	58	70.8	D	ENDF/B-IV	.97420	27591	0
			CD	58	2.00E-09		.03650	AERE		
CD	59	(N,G)	CD	60	5.27	Y	ENDF/B-IV	2.50443	27592	0
			CD	60	3.00E-10		.09670	AERE		
CD	59	(N,P)	FE	59	44.6	D	ENDF/B-IV	1.19234	27593	0
			FE	59	2.00E-09		.11800	AERE		

TABLE II - CONTINUED

CO	59	(N,A)	MN	56	2.580	H	ENDF/B-IV	1.78233	27594	0
			MN	56	2.00E-08		.80000	AERE		
CO	60	(N,P)	FE	60	1. E+5	Y	THRESH	0.00000	27603	0
			FE	60	1.00E-10		.06000	TISO7		
CO	60	(N,A)	MN	57	1.59	M	THRESH	.04673	27604	0
			MN	57	3.00E-06		.97000	TISO7		
CO	60	(N,NP+D)	FE	59	44.6	D	THRESH	1.19234	27605	0
			FE	59	2.00E-09		.11800	AERE		
CO	60	(N,NA)	MN	56	2.580	H	THRESH	1.78233	27606	0
			MN	56	2.00E-08		.80000	AERE		
NI	58	(N,2N)	NI	57	36.1	H	ENDF/B-IV	2.10649	28581	0
			NI	57	1.00E-10		.13000	TISO7		
NI	58	(N,G)	NI	59	8. E+4	Y	BNL-325	0.00000	28582	0
			NI	59	2.00E-08		.00700	AERE		
NI	58	(N,P)	CO	58	70.8	D	ENDF/B-IV	.97420	28583	0
			CO	58	2.00E-09		.03650	AERE		
NI	58	(N,A)	FE	55	2.7	Y	THRESH	0.00000	28584	0
			FE	55	3.00E-08		.00590	AERE		
NI	58	(N,NP+D)	CO	57	271.	D	THRESH	.12148	28585	0
			CO	57	5.00E-09		.02230	AERE		
NI	58	(N,T)	CO	56	78.5	D	THRESH	3.64227	28537	0
			CO	56	1.00E-10		.11000	TISO7		
NI	59	(N,NP+D)	CO	58	*		THRESH		28595	0
			CO	58	2.00E-09					
NI	59	(N,NA)	FE	55	2.7	Y	THRESH	0.00000	28596	0
			FE	55	3.00E-08		.00590	AERE		
NI	60	(N,2N)	NI	59	8. E+4	Y	THRESH	0.00000	28601	0
			NI	59	2.00E-08		.00700	AERE		
NI	60	(N,P)	CO	60	5.27	Y	ENDF/B-IV	2.50443	28603	0
			CO	60	3.00E-10		.09670	AERE		
NI	60	(N,T)	CO	58	*		THRESH		28607	0
			CO	58	2.00E-09					
NI	61	(N,P)	CO	61	1.650	H	THRESH	.06066	28613	0
			CO	61	3.00E-06		.46000	TISO7		
NI	61	(N,NP+D)	CO	60	*		THRESH		28615	0
			CO	60	3.00E-10					

TABLE II - CONTINUED

NI	62	(N,G)	NI	63	100.	Y	BNL-325 .01710 THRESH	C.00000 AERE	28622	0
NI	62	(N,P)	NI	63	2.00E-09				28623	0
NI	62	(N,A)	CO	62	*					
NI	62	(N,A)	FE	59	2.00E-06	D	THRESH	1.19234 AERE	28624	0
NI	62	(N,NP+D)	FE	59	44.6		.11800			
NI	62	(N,NP+D)	CO	61	2.00E-09	H	THRESH	.06066 TISD7	28625	0
NI	62	(N,T)	CO	61	1.550		.46000		28627	0
NI	62	(N,T)	CO	60	3.00E-06		THRESH			
NI	62	(N,T)	CO	60	*					
NI	63	(N,P)	CO	60	3.00E-10	S	THRESH	.12514 TISD7	28633	0
NI	63	(N,P)	CO	63	27.		1.37000			
NI	63	(N,A)	CO	53	3.00E-06		THRESH	0.00000 TISD7	28634	0
NI	63	(N,A)	FE	60	1. E+5	Y	.06000			
NI	63	(N,NP+D)	FE	60	1.00E-10		THRESH		28635	0
NI	63	(N,NP+D)	CO	62	*					
NI	63	(N,NA)	CO	62	2.00E-06		THRESH	1.19234 AERE	28636	0
NI	63	(N,NA)	FE	59	44.6	D	THRESH	.06066 TISD7	28637	0
NI	63	(N,T)	FE	59	2.00E-09		.11800			
NI	63	(N,T)	CO	61	1.550	H	THRESH	0.00000 AERE	28641	0
NI	64	(N,2N)	CO	61	3.00E-06	Y	.46000			
NI	64	(N,2N)	NI	63	100.		THRESH	0.00000 AERE	28643	0
NI	64	(N,P)	NI	63	2.00E-09	S	.01710			
NI	64	(N,P)	CO	64	0.4		THRESH	0.00000 TISD7	28644	0
NI	64	(N,A)	CO	64	3.00E-06	M	2.73000			
NI	64	(N,A)	FE	61	6.0		THRESH	1.26947 TISD7	28645	0
NI	64	(N,NP+D)	FE	61	3.00E-06	S	1.05000			
NI	64	(N,NP+D)	CO	63	27.		THRESH	.12514 TISD7	28646	0
NI	64	(N,NA)	CO	63	3.00E-06		1.37000			
NI	64	(N,NA)	FE	60	1. E+5	Y	THRESH	0.00000 TISD7	28647	0
NI	64	(N,T)	FE	60	1.00E-10		.06000			
NI	64	(N,T)	CO	62	*		THRESH			
CU	63	(N,2N)	CO	62	2.00E-06					
CU	63	(N,2N)	CU	62	9.74	M	ENDF/B-3	1.00912 DK	29631	0
CU	63	(N,G)	CU	62	3.00E-06	DK	1.25000			
CU	63	(N,G)	CU	64	12.71	H	ENDF/B-IV	.19659 AERE	29632	0
CU	64	(N,G)	CU	64	4.00E-08		.13300			

TABLE II - CONTINUED

CU	63	(N,P)	NI	63	100.	Y	ENDF/B-3	0.00000	29633	0
CU	63	(N,A)	NI	63	2.00E-09	Y	.01710 AERE		29634	0
CU	65	(N,2N)	CD	60	5.27	Y	ENDF/B-IV	2.50443	29651	0
CU	65	(N,P)	CU	64	3.00E-10	H	.09670 AERE		29653	0
CU	65	(N,A)	CU	64	12.71	H	ENDF/B-IV	.19659	29654	0
CU	65	(N,P)	CU	64	4.00E-08	H	.13300 AERE		39391	0
CU	65	(N,A)	NI	55	2.520	H	ENDF/B-3	.58880	39892	0
CU	65	(N,A)	NI	65	2.00E-09	M	.63100 AERE		39893	0
CU	65	(N,A)	CU	62	13.9	M	ENDF/B-3	2.76048	39894	0
CU	65	(N,A)	CU	62	2.00E-06	D	1.13000 DK		39897	0
CU	65	(N,A)	CU	62	105.6	D	UKAEA	2.68835	39901	0
CU	65	(N,A)	CU	62	1.00E-10	D	.01570 AERE		39902	0
CU	65	(N,A)	CU	62	*	D	COOK		39903	0
CU	65	(N,A)	CU	62	3.00E-09	D	THRESH	.00003	39904	0
CU	65	(N,A)	CU	62	50.52	D	.58200 EN223		39905	0
CU	65	(N,A)	CU	62	3.00E-10	D	THRESH		39906	0
CU	65	(N,A)	CU	62	*	D	THRESH		39911	0
CU	65	(N,A)	CU	62	2.00E-09	D	THRESH		39912	0
CU	65	(N,A)	CU	62	*	D	THRESH			
CU	65	(N,A)	CU	62	1.00E-10	D	THRESH			
CU	65	(N,A)	CU	62	*	D	THRESH			
CU	65	(N,A)	CU	62	3.00E-06	D	THRESH			
CU	65	(N,A)	CU	62	*	D	THRESH			
CU	65	(N,A)	CU	62	1.00E-09	D	THRESH			
CU	65	(N,A)	CU	62	29.	D	THRESH	0.00000		
CU	65	(N,A)	CU	62	3.00E-11	D	.19500 TM102			
CU	65	(N,A)	CU	62	4.9	D	THRESH	0.00000		
CU	65	(N,A)	CU	62	2.00E-09	D	.07000 TM102			
CU	65	(N,A)	CU	62	50.52	D	THRESH	.00000		
CU	65	(N,A)	CU	62	3.00E-10	D	.58200 EN223			
CU	65	(N,A)	CU	62	*	D	THRESH			
CU	65	(N,A)	CU	62	2.00E-09	D	THRESH			
CU	65	(N,A)	CU	62	*	D	THRESH			
CU	65	(N,A)	CU	62	3.00E-09	D	THRESH			
CU	65	(N,A)	CU	62	3.54	D	COOK	.25752		
CU	65	(N,A)	CU	62	1.00E-03	D	1.44600 TM102			

TABLE II - CONTINUED

Y	91	(N,P)	SR	91	9.52	H	THRESH	1.02485	39913	0
			SR	91	9.00E-09		.65500	TM102		
Y	91	(N,A)	RB	88	17.7	M	THRESH	.65903	39914	0
			RB	88	3.00E-06		2.08100	TM102		
Y	91	(N,NP+D)	SR	90	29.	Y	THRESH	0.00000	39915	0
			SR	90	3.00E-11		.19600	TM102		
Y	91	(N,NA)	RB	87	4.9 E+10	Y	THRESH	0.00000	39916	0
			RB	87	2.00E-09		.07900	TM102		
Y	91	(N,T)	SR	89	50.52	D	THRESH	.00008	39917	0
			SR	89	3.00E-10		.58200	EN223		
ZR	90	(N,2N)	ZR	89	78.5	H	UKAEA	1.16581	40901	0
			ZR	89	1.00E-10		.08000	TISD7		
ZR	90	(N,P)	Y	90	*		THRESH		40903	0
			Y	90	3.00E-09					
ZR	90	(N,A)	SR	87	*		THRESH		40904	0
			SR	87	1.00E-10					
ZR	90	(N,NP+D)	Y	89	*		THRESH		40905	0
			Y	89	3.00E-06					
ZR	90	(N,T)	Y	88	*		THRESH		40907	0
			Y	88	1.00E-10					
ZR	91	(N,2N)	ZR	90	*		THRESH		40911	0
			ZR	90	3.00E-06					
ZR	91	(N,P)	Y	91	*		THRESH		40913	0
			Y	91	1.00E-09					
ZR	91	(N,NP+D)	Y	90	*		THRESH		40915	0
			Y	90	3.00E-09					
ZR	91	(N,NA)	SR	87	*		THRESH		40916	0
			SR	87	1.00E-10					
ZR	91	(N,T)	Y	89	*		THRESH		40917	0
			Y	89	3.00E-06					
ZR	92	(N,G)	ZR	93	1.5 E+6	Y	COOK	0.00000	40922	0
			ZR	93	4.00E-09		.01960	TM102		
ZR	92	(N,P)	Y	92	3.54	H	THRESH	.25752	40923	0
			Y	92	1.00E-08		1.44600	TM102		
ZR	92	(N,A)	SR	89	50.52	D	BNL-325	.00008	40924	0
			SR	89	3.00E-10		.58200	EN223		

TABLE II - CONTINUED

ZR	92	(N,NP+D)	Y	91	*		THRESH		40925	0
			Y	91	1.00E-09					
ZR	92	(N,T)	Y	90	*		THRESH		40927	0
			Y	90	3.00E-09					
ZR	93	(N,P)	Y	93	10.1	H	THRESH	.10224	40933	0
			Y	93	5.00E-09		1.17300	TM102		
ZR	93	(N,A)	SR	90	29.	Y	THRESH	0.00000	40934	0
			SR	90	3.00E-11		.19600	TM102		
ZR	93	(N,NP+D)	Y	92	3.54	H	THRESH	.25752	40935	0
			Y	92	1.00E-08		1.44600	TM102		
ZR	93	(N,NA)	SR	89	50.52	D	THRESH	.00008	40936	0
			SR	89	3.00E-10		.58200	EN223		
ZR	93	(N,T)	Y	91	*		THRESH		40937	0
			Y	91	1.00E-09					
ZR	94	(N,2N)	ZR	93	1.5 E+5	Y	THRESH	0.00000	40941	0
			ZR	93	4.00E-09		.01960	TM102		
ZR	94	(N,P)	Y	94	18.	M	THRESH	.74386	40943	0
			Y	94	3.00E-06		1.71700	EN223		
ZR	94	(N,A)	SR	91	9.52	H	THRESH	1.02485	40944	0
			SR	91	9.00E-09		.65500	TM102		
ZR	94	(N,NP+D)	Y	93	10.1	H	THRESH	.10224	40945	0
			Y	93	5.00E-09		1.17300	TM102		
ZR	94	(N,NA)	SR	90	29.	Y	THRESH	0.00000	40946	0
			SR	90	3.00E-11		.19600	TM102		
ZR	94	(N,T)	Y	92	3.54	H	THRESH	.25752	40947	0
			Y	92	1.00E-08		1.44600	TM102		
ZR	95	(N,P)	Y	95	10.4	M	THRESH	.42498	40953	0
			Y	95	3.00E-06		1.74600	EN223		
ZR	95	(N,A)	SR	92	2.71	H	THRESH	1.32514	40954	0
			SR	92	1.00E-08		.19600	TM102		
ZR	95	(N,NP+D)	Y	94	18.	M	THRESH	.74386	40955	0
			Y	94	3.00E-06		1.71700	EN223		
ZR	95	(N,NA)	SR	91	9.52	H	THRESH	1.02485	40956	0
			SR	91	9.00E-09		.65500	TM102		
ZR	95	(N,T)	Y	93	10.1	H	THRESH	.10224	40957	0
			Y	93	5.00E-09		1.17300	TM102		

TABLE II - CONTINUED

ZR	96	(N, 2N)	ZR	95	54.0	D	THRESH	.72460	40961	0
			ZR	95	1.00E-09		.11500	TM102		
ZR	96	(N, G)	ZR	97	16.8	H	COOK	.86769	40962	0
			ZR	97	3.00E-09		.69900	TM102		
ZR	96	(N, P)	Y	96	9.	S	THRESH	0.00000	40963	0
			Y	96	3.00E-06		2.40800	EN223		
ZR	96	(N, A)	SR	93	7.5	M	THRESH	2.12967	40964	0
			SR	93	3.00E-06		1.16100	EN223		
ZR	96	(N, NP+D)	Y	95	10.4	M	THRESH	.42498	40965	0
			Y	95	3.00E-06		1.74600	EN223		
ZR	96	(N, NA)	SR	92	2.71	H	THRESH	1.32514	40966	0
			SR	92	1.00E-08		.19600	TM102		
ZR	96	(N, T)	Y	94	18.	M	THRESH	.74386	40967	0
			Y	94	3.00E-06		1.71700	EN223		
NB	92	(N, 2N)	NB	91	*		THRESH		41921	0
			NB	91	1.00E-10					
NB	92	(N, A)	Y	89	*		THRESH		41924	0
			Y	89	3.00E-06					
NB	92	(N, NA)	Y	88	*		THRESH		41926	0
			Y	88	1.00E-10					
NB	92	(N, T)	ZR	90	*		THRESH		41927	0
			ZR	90	3.00E-06					
NB	92	(N, HE-3)	Y	90	*		THRESH		41929	0
			Y	90	3.00E-09					
NB	93	(N, N)	NB	93M	13.6	Y	FRNC-TH-228	0.00000	41930	0
			NB	93M	4.00E-09		.03010	AERE		
NB	93	(N, 2N)	NB	92M	10.13	D	ENDF/B-IV	.92186	41931	0
			NB	92M	3.70E-07	DK	.01260	DK		
NB	93	(N, G)	NB	94	2.0	E+4 Y	ENDF/B-IV	1.57360	41932	0
			NB	94	2.00E-09	DK	.16700	AERE		
NB	93	(N, P)	ZR	93	1.5	E+6 Y	ENDF/B-IV	0.00000	41933	0
			ZR	93	4.00E-09		.01960	TM102		
NB	93	(N, A)	Y	90	64.0	H	ENDF/B-IV	.00035	41934	0
			Y	90	3.00E-09		.93100	TM102		
NB	93	(N, NA)	Y	89	*		THRESH		41936	0
			Y	89	3.00E-06					

TABLE II - CONTINUED

NB	93	(N,HE-3)	Y	91	*	THRESH		41939	0
			Y	91	1.00E-09				
NB	94	(N,2N)	NB	93	*	THRESH		41941	0
			NB	93	1.00E-10				
NB	94	(N,A)	Y	91	*	THRESH		41944	0
			Y	91	1.00E-09				
NB	94	(N,NP+D)	ZR	93	1.5 E+6 Y	THRESH	0.00000	41945	0
			ZR	93	4.00E-09	.01960	TM102		
NB	94	(N,NA)	Y	93	*	THRESH		41946	0
			Y	90	3.00E-09				
MD	100	(N,2N)	MD	99	66.02 H	THRESH	.15380	42001	0
			MD	99	7.00E-09	.38500	TM102		
MD	100	(N,G)	MD	101	14.6 M	COOK	.86161	42002	0
			MD	101	3.00E-06	.59500	EN223		
MD	100	(N,P)	NB	100	*	THRESH		42003	0
			NB	100	3.00E-06				
MD	100	(N,A)	ZR	97	16.8 H	THRESH	.88769	42004	0
			ZR	97	3.00E-09	.69900	TM102		
MD	100	(N,NP+D)	NB	99	*	THRESH		42005	0
			NB	99	3.00E-06				
MD	100	(N,T)	NB	98	*	THRESH		42007	0
			NB	98	3.00E-06				
MD	92	(N,2N)	MD	91	*	THRESH		42921	0
			MD	91	3.00E-06				
MD	92	(N,G)	MD	93	3.5 E+3 Y	BENZI	0.00000	42922	0
			MD	93	1.00E-10	0.00000	TISO7		
MD	92	(N,P)	NB	92	*	THRESH		42923	0
			NB	92	3.50E-07 DK				
MD	92	(N,A)	ZR	89	*	THRESH		42924	0
			ZR	89	1.00E-10				
MD	92	(N,NP+D)	NB	91	*	THRESH		42925	0
			NB	91	1.00E-10				
MD	92	(N,NA)	ZR	88	83.4 D	THRESH	.38996	42926	0
			ZR	88	1.00E-10	0.00000	TISO7		
MD	92	(N,T)	NB	90	*	THRESH		42927	0
			NB	90	1.00E-10				

TABLE II - CONTINUED

MO	93	(N,P)	NB	93	*	THRESH		42933	0
			NB	93	1.00E-10				
MO	93	(N,A)	ZR	90	*	THRESH		42934	0
			ZR	90	3.00E-06				
MO	93	(N,NP+D)	NB	92	*	THRESH		42935	0
			NB	92	3.50E-07 DK				
MO	93	(N,NA)	ZR	89	*	THRESH		42936	0
			ZR	89	1.00E-10				
MO	93	(N,T)	NB	91	*	THRESH		42937	0
			NB	91	1.00E-10				
MO	94	(N,2N)	MO	93	*	THRESH		42941	0
			MO	93	1.00E-10				
MO	94	(N,P)	NB	94	*	THRESH		42943	0
			NB	94	2.00E-09 DK				
MO	94	(N,NP+D)	NB	93	*	THRESH		42945	0
			NB	93	1.00E-10				
MO	94	(N,NA)	ZR	90	*	THRESH		42946	0
			ZR	90	3.00E-06				
MO	94	(N,T)	NB	92	*	THRESH		42947	0
			NB	92	3.50E-07 DK				
MO	95	(N,P)	NB	95	*	THRESH		42953	0
			NB	95	3.00E-09				
MO	95	(N,NP+D)	NB	94	*	THRESH		42955	0
			NB	94	2.00E-09 DK				
MO	95	(N,T)	NB	93	*	THRESH		42957	0
			NB	93	1.00E-10				
MO	95	(N,HE-3)	ZR	93	1.5 E+5 Y	THRESH	0.00000	42959	0
			ZR	93	4.00E-09	.01960	TM102		
MO	96	(N,P)	NB	96	23.4 H	THRESH	2.58183	42963	0
			NB	96	1.00E-10	.24900	EN223		
MO	96	(N,A)	ZR	93	1.5 E+6 Y	THRESH	0.00000	42964	0
			ZR	93	4.00E-09	.01960	TM102		
MO	96	(N,NP+D)	NB	95	*	THRESH		42965	0
			NB	95	3.00E-09				
MO	96	(N,T)	NB	94	*	THRESH		42967	0
			NB	94	2.00E-09 DK				

TABLE II - CONTINUED

MD	97	(N,P)	NB	97	*		THRESH		42973	0
			NB	97	2.00E-07					
MD	97	(N,NP+D)	NB	96	23.4	H	THRESH	2.58183	42975	0
			NB	96	1.00E-10		.24900	EN223		
MD	97	(N,NA)	ZR	93	1.5 E+5	Y	THRESH	0.00000	42976	0
			ZR	93	4.00E-09		.01960	TM102		
MD	97	(N,T)	NB	95	*		THRESH		42977	0
			NB	95	3.00E-09					
MD	98	(N,G)	MD	99	66.02	H	CDC	.15380	42982	0
			MD	99	7.00E-09		.38600	TM102		
MD	98	(N,P)	NB	98	*		THRESH		42983	0
			NB	98	3.00E-06					
MD	98	(N,A)	ZR	95	64.6	D	THRESH	.72460	42984	0
			ZR	95	1.00E-09		.11500	TM102		
MD	98	(N,NP+D)	NB	97	*		THRESH		42985	0
			NB	97	2.00E-07					
MD	98	(N,T)	NB	96	23.4	H	THRESH	2.58183	42987	0
			NB	96	1.00E-10		.24900	EN223		
MD	99	(N,P)	NB	99	*		THRESH		42993	0
			NB	99	3.00E-06					
MD	99	(N,NP+D)	NB	98	*		THRESH		42995	0
			NB	98	3.00E-06					
MD	99	(N,NA)	ZR	95	64.0	D	THRESH	.72460	42996	0
			ZR	95	1.00E-09		.11500	TM102		
MD	99	(N,T)	NB	97	*		THRESH		42997	0
			NB	97	2.00E-07					
TC	97	(N,2N)	TC	96	*		THRESH		43971	0
			TC	96	8.00E-09					
TC	97	(N,A)	NB	94	*		THRESH		43974	0
			NB	94	2.00E-09	DK				
TC	97	(N,NA)	NB	93	*		THRESH		43976	0
			NB	93	1.00E-10					
TC	97	(N,HE-3)	NB	95	*		THRESH		43979	0
			NB	95	3.00E-09					
TC	98	(N,2N)	TC	97	*		THRESH		43981	0
			TC	97	1.00E-08					

TABLE II - CONTINUED

TC 98	(N,A)	NR 95	*	THRESH	43984	0
TC 98	(N,NA)	NB 95	3.00E-09			
TC 99	(N,2N)	NB 94	*	THRESH	43986	0
TC 99	(N,G)	NB 94	2.00E-09 DK			
TC 99	(N,P)	TC 98	4.2 F+5 Y			
TC 99	(N,A)	TC 98	1.00E-10	ENDF/B-IV .16000	43991	0
TC 99	(N,NA)	TC 100	15.8	COOK	43992	0
TC 99	(N,G)	TC 100	3.00E-06	1.40000		
TC 99	(N,P)	MD 99	55.02	THRESH	43993	0
TC 99	(N,A)	MD 99	7.00E-09	.38500		
TC 99	(N,NA)	NB 95	23.4	THRESH	42994	0
TC 99	(N,NA)	NB 96	1.00E-10	.24900		
TC 99	(N,NA)	NB 95	*	THRESH	43996	0
TC 99	(N,NA)	NB 95	3.00E-09			
TC 99	(N,NA)	RU 105	4.44	COOK	44042	0
TC 99	(N,NA)	RU 105	2.00E-08	.39700		
TC 99	(N,NA)	AG 106	*	ENDF/B-IV	47071	0
TC 99	(N,NA)	AG 106	1.00E-10			
TC 99	(N,NA)	AG 108	*	ENDF/B-IV	47072	0
TC 99	(N,NA)	AG 108	1.00E-10			
TC 99	(N,NA)	PD 107	*	ENDF/B-IV	47073	0
TC 99	(N,NA)	PD 107	1.00E-10			
TC 99	(N,NA)	RH 104	*	ENDF/B-IV	47074	0
TC 99	(N,NA)	RH 104	3.00E-06			
TC 99	(N,NA)	AG 108	*	ENDF/B-IV	47091	0
TC 99	(N,NA)	AG 108	1.00E-10			
TC 99	(N,NA)	AG 110	*	ENDF/B-IV	47092	0
TC 99	(N,NA)	AG 110	1.00E-10			
TC 99	(N,NA)	PD 109	*	ENDF/B-IV	47093	0
TC 99	(N,NA)	PD 109	1.00E-10			
TC 99	(N,NA)	RH 106	*	ENDF/B-IV	47094	0
TC 99	(N,NA)	RH 106	3.00E-06			
TC 99	(N,NA)	SN 111	35.3	THRESH	50121	0
TC 99	(N,NA)	SN 111	3.00E-06	.18000		
TC 99	(N,NA)	SN 113	115.	BENZI	50122	0
TC 99	(N,NA)	SN 113	2.00E-09	.00500		
TC 99	(N,NA)	SN 113		MEDI		

TABLE II - CONTINUED

SN 112	(N,P)	IN 112	*	THRESH	50123	0
		IN 112	3.00E-06			
SN 112	(N,A)	CD 109	453.	D THRESH	.02678	50124 0
		CD 109	2.00E-09	.02460 EN223		
SN 112	(N,NP+D)	IN 111	*	THRESH	50125	0
		IN 111	1.00E-10			
SN 112	(N,T)	IN 110	*	THRESH	50127	0
		IN 110	1.00E-10			
SN 114	(N,2N)	SN 113	*	THRESH	50141	0
		SN 113	2.00E-09			
SN 114	(N,P)	IN 114	*	THRESH	50143	0
		IN 114	1.00E-10			
SN 114	(N,A)	CD 111	*	THRESH	50144	0
		CD 111	3.00E-06			
SN 114	(N,NP+D)	IN 113	*	THRESH	50145	0
		IN 113	3.00E-06			
SN 114	(N,T)	IN 112	*	THRESH	50147	0
		IN 112	3.00E-06			
SN 115	(N,P)	IN 115	*	THRESH	50153	0
		IN 115	1.00E-09			
SN 115	(N,NP+D)	IN 114	*	THRESH	50155	0
		IN 114	1.00E-10			
SN 115	(N,NA)	CD 111	*	THRESH	50156	0
		CD 111	3.00E-06			
SN 115	(N,T)	IN 113	*	THRESH	50157	0
		IN 113	3.00E-06			
SN 116	(N,G)	SN 117	*	COOK	50162	0
		SN 117	1.00E-10			
SN 116	(N,P)	IN 116	*	THRESH	50163	0
		IN 116	3.00E-06			
SN 116	(N,A)	CD 113	*	THRESH	50164	0
		CD 113	1.00E-10			
SN 116	(N,NP+D)	IN 115	*	THRESH	50165	0
		IN 115	1.00E-09			
SN 116	(N,T)	IN 114	*	THRESH	50167	0
		IN 114	1.00E-10			

TABLE II - CONTINUED

SN 117	(N,P)	IN 117	*	THRESH	50173	0
		IN 117	3.00E-06			
SN 117	(N,NP+D)	IN 116	*	THRESH	50175	0
		IN 116	3.00E-06			
SN 117	(N,NA)	CD 113	*	THRESH	50176	0
		CD 113	1.00E-10			
SN 117	(N,T)	IN 115	*	THRESH	50177	0
		IN 115	1.00E-09			
SN 118	(N,2N)	SN 117	*	THRESH	50181	0
		SN 117	1.00E-10			
SN 118	(N,G)	SN 119	*	COOK	50182	0
		SN 119	1.00E-10			
SN 118	(N,P)	IN 118	*	THRESH	50183	0
		IN 118	3.00E-06			
SN 118	(N,A)	CD 115	*	THRESH	50184	0
		CD 115	6.00E-09			
SN 118	(N,NP+D)	IN 117	*	THRESH	50185	0
		IN 117	3.00E-06			
SN 119	(N,T)	IN 116	*	THRESH	50187	0
		IN 116	3.00E-06			
SN 119	(N,P)	IN 119	*	THRESH	50193	0
		IN 119	3.00E-06			
SN 119	(N,NP+D)	IN 118	*	THRESH	50195	0
		IN 118	3.00E-06			
SN 119	(N,NA)	CD 115	*	THRESH	50196	0
		CD 115	6.00E-09			
SN 119	(N,T)	IN 117	*	THRESH	50197	0
		IN 117	3.00E-06			
SN 120	(N,2N)	SN 119	*	THRESH	50201	0
		SN 119	1.00E-10			
SN 120	(N,G)	SN 121	*	COOK	50202	0
		SN 121	1.00E-10			
SN 120	(N,P)	IN 120	*	THRESH	50203	0
		IN 120	3.00E-06			
SN 120	(N,A)	CD 117	*	THRESH	50204	0
		CD 117	1.00E-10			

TABLE II - CONTINUED

SN 120	(N,NP+D)	IN 119	*	THRESH		50205	0
		IN 119	3.00E-06				
SN 120	(N,T)	IN 118	*	THRESH		50207	0
		IN 118	3.00E-06				
SN 122	(N,2N)	SN 121	*	THRESH		50221	0
		SN 121	1.00E-10				
SN 122	(N,G)	SN 123	*	COCK		50222	0
		SN 123	1.00E-10				
SN 122	(N,P)	IN 122A	10.	S THRESH	0.00000	50223	0
		IN 122A	3.00E-06		2.0940C EN223		
SN 122	(N,A)	CD 119	*	THRESH		50224	0
		CD 119	3.00E-06				
SN 122	(N,NP+D)	IN 121	*	THRESH		50225	0
		IN 121	3.00E-06				
SN 122	(N,NA)	CD 118	50.3	M THRESH	0.00000	50226	0
		CD 118	3.00E-06		.21300 EN223		
SN 122	(N,T)	IN 120	*	THRESH		50227	0
		IN 120	3.00E-06				
SN 124	(N,2N)	SN 123	*	THRESH		50241	0
		SN 123	1.00E-10				
SN 124	(N,G)	SN 125	*	COCK		50242	0
		SN 125	3.00E-09				
SN 124	(N,P)	IN 124	3.2	S THRESH	0.00000	50243	0
		IN 124	3.00E-06		2.25500 EN223		
SN 124	(N,NP+D)	IN 123	*	THRESH		50245	0
		IN 123	3.00E-06				
CS 133	(N,2N)	CS 132	6.47	D ENDF/B-IV	.73256	55331	0
		CS 132	1.00E-10		.00500 MEDLI		
CS 133	(N,G)	CS 134	*	ENDF/B-IV		55332	0
		CS 134	4.00E-10				
CS 133	(N,P)	XE 133	*	ENDF/B-IV		55333	0
		XE 133	3.00E-07				
CS 133	(N,A)	I 130	*	ENDF/B-IV		55334	0
		I 130	1.00E-10				
HF 174	(N,2N)	HF 173	23.6	H THRESH	.41530	72741	0
		HF 173	1.00E-10		0.00000 TISO7		

TABLE II - CONTINUED

HF 174	(N,G)	HF 175	70.	D	ENDF/B-1	.34422	72742	0
		HF 175	1.00E-10		.09630	AERE		
HF 174	(N,P)	LU 174	3.3	Y	THRESH	.16842	72743	0
		LU 174	1.00E-10		0.00000	TIS07		
HF 176	(N,2N)	HF 175	70.	D	ENDF/B-1	.34422	72761	0
		HF 175	1.00E-10		.09630	AERE		
HF 177	(N,P)	LU 177M	161.	D	THRESH	.99467	72773	0
		LU 177M	1.00E-10		.05100	TIS07		
HF 180	(N,G)	HF 181	42.4	D	ENDF/B-1	.52421	72802	0
		HF 181	1.00E-09		.21800	AERE		
TA 181	(N,2N)	TA 180M	8.12	H	ENDF/B-IV	.04808	73811	0
		TA 180M	1.00E-10		.03500	TIS07		
TA 181	(N,G)	TA 182	115.	D	ENDF/B-IV	1.36620	73812	0
		TA 182	7.00E-10		.22400	AERE		
TA 181	(N,P)	HF 181	42.4	D	ENDF/B-IV	.52421	73813	0
		HF 181	1.00E-09		.21800	AERE		
TA 181	(N,A)	LU 178	28.4	M	ENDF/B-3	.25449	73814	0
		LU 178	3.00E-06		.73000	TIS07		
TA 181	(N,NP+D)	HF 180	*		THRESH		73815	0
		HF 180	1.00E-10					
TA 181	(N,NA)	LU 177	*		THRESH		73816	0
		LU 177	2.00E-08					
TA 181	(N,T)	HF 179	*		THRESH		73817	0
		HF 179	1.00E-10					
TA 182	(N,G)	TA 183	5.0	D	ENDF/B-IV	.29277	73822	0
		TA 183	1.00E-10		.23000	TIS07		
TA 182	(N,A)	LU 179	4.6	H	ENDF/B-IV	0.00000	73824	0
		LU 179	1.00E-10		.53000	TIS07		
W 182	(N,2N)	W 181	121.0	D	ENDF/B-IV	.04612	74821	0
		W 181	4.00E-09		.05180	AERE		
W 182	(N,P)	TA 182	115.	D	ENDF/B-IV	1.36620	74823	0
		TA 182	7.00E-10		.22400	AERE		
W 182	(N,A)	HF 179	*		ENDF/B-IV		74824	0
		HF 179	1.00E-10					
W 182	(N,NA)	HF 178	*		THRESH		74826	0
		HF 178	1.00E-10					

TABLE II - CONTINUED

W 182	(N,T)	TA 180	*		THRESH		74827	0
		TA 180	1.00E-10					
W 183	(N,P)	TA 183	5.0	D	ENDF/B-IV	.29277	74833	0
		TA 183	1.00E-10		.23000	TIS07		
W 183	(N,A)	HF 180	*		ENDF/B-IV		74834	0
		HF 180	1.00E-10					
W 183	(N,NP+D)	TA 182	*		ENDF/B-IV		74835	0
		TA 182	7.00E-10					
W 183	(N,NA)	HF 179	*		THRESH		74836	0
		HF 179	1.00E-10					
W 183	(N,3N)	W 181	121.0	D	ENDF/B-IV	.04612	74838	0
		W 181	4.00E-00		.05130	AERE		
W 184	(N,G)	W 185	75.1	D	ENDF/B-IV	.00002	74842	0
		W 185	4.00E-09		.12700	AERE		
W 184	(N,P)	TA 184	8.7	H	ENDF/B-IV	1.67131	74843	0
		TA 184	1.00E-10		.48000	TIS07		
W 184	(N,A)	HF 181	42.4	D	ENDF/B-IV	.52421	74844	0
		HF 181	1.00E-00		.21800	AERE		
W 184	(N,NP+D)	TA 183	5.0	D	ENDF/B-IV	.29277	74845	0
		TA 183	1.00E-10		.23000	TIS07		
W 184	(N,NA)	HF 180	*		THRESH		74846	0
		HF 180	1.00E-10					
W 184	(N,T)	TA 182	*		THRESH		74847	0
		TA 182	7.00E-10					
W 186	(N,2N)	W 185	75.1	D	ENDF/B-IV	.00002	74861	0
		W 185	4.00E-09		.12700	AERE		
W 186	(N,G)	W 187	23.9	H	ENDF/B-IV	.51611	74862	0
		W 187	1.00E-08		.23900	AERE		
W 186	(N,P)	TA 186	10.5	M	ENDF/B-IV	1.65516	74863	0
		TA 186	3.00E-06		.88000	TIS07		
W 186	(N,A)	HF 183	54.	M	ENDF/B-IV	.75196	74864	0
		HF 183	3.00E-06		.51000	TIS07		
W 186	(N,NP+D)	TA 185	49.	M	ENDF/B-IV	0.00000	74865	0
		TA 185	3.00E-06		.60000	TIS07		
W 186	(N,NA)	HF 182	9.	E+6 Y	THRESH	.23653	74866	0
		HF 182	1.00E-10		.20000	TIS07		

TABLE II - CONTINUED

W 186	(N,T)	TA 184	8.7	H	THRESH	1.67131	74867	0
		TA 184	1.00E-10		.48000	TIS07		
RE 185	(N,2N)	RE 184	*		ENDF/B-IV		75851	0
		RE 184	1.00E-10					
RE 185	(N,G)	RE 186	*		ENDF/B-IV		75852	0
		RE 186	8.00E-09					
RE 185	(N,3N)	RE 183	70.	D	ENDF/B-IV	.17818	75858	0
		RE 183	5.00E-09		0.00000	TIS07		
RE 187	(N,2N)	RE 186	*		ENDF/B-IV		75871	0
		RE 186	8.00E-09					
RE 187	(N,G)	RE 188	*		ENDF/B-IV		75872	0
		RE 188	6.00E-09					
AU 197	(N,2N)	AU 196	*		ENDF/B-IV		79971	0
		AU 196	2.00E-03					
AU 197	(N,G)	AU 198	*		ENDF/B-IV		79972	0
		AU 198	8.00E-09					
AU 197	(N,P)	PT 197	*		ENDF/B-IV		79973	0
		PT 197	2.00E-08					
PB 204	(N,2N)	PB 203	*		THRESH		82041	0
		PB 203	5.00E-08					
PB 204	(N,P)	TL 204	3.77	Y	THRESH	.00114	82043	0
		TL 204	9.00E-10		.30000	TIS07		
PB 204	(N,T)	TL 202	12.23	H	THRESH	.48007	82047	0
		TL 202	8.00E-09		0.00000	TIS07		
PB 206	(N,2N)	PB 205	1.4 E+7	Y	THRESH	0.00000	82061	0
		PB 205	1.00E-10		0.00000	TIS07		
PB 206	(N,P)	TL 206	*		THRESH		82063	0
		TL 206	3.00E-06					
PB 206	(N,A)	HG 203	46.60	D	THRESH	.23765	82064	0
		HG 203	2.00E-09		.10900	AERE		
PB 206	(N,T)	TL 204	3.77	Y	THRESH	.00114	82067	0
		TL 204	9.00E-10		.30000	TIS07		
PB 207	(N,P)	TL 207	*		THRESH		82073	0
		TL 207	3.00E-06					
PB 207	(N,NP+D)	TL 206	4.20	M	THRESH	.00005	82075	0
		TL 206	3.00E-06		.54400	AERE		

TABLE II - CONTINUED

PB 207	(N,NA)	HG 203	46.60	D	THRESH	.23765	82076	0
		HG 203	2.00E-09		.10900	AERE		
PB 208	(N,2N)	PB 207	*		THRESH		82081	0
		PB 207	3.00E-06					
PB 208	(N,P)	TL 208	3.053	M	THRESH	3.38539	82083	0
		TL 208	3.00E-06		.59400	TM102		
PB 208	(N,A)	HG 205	5.2	M	THRESH	.00529	82084	0
		HG 205	3.00E-06		.64000	TIS07		
PB 208	(N,NP+D)	TL 207	*		THRESH		82085	0
		TL 207	3.00E-06					
PB 208	(N,T)	TL 206	*		THRESH		82087	0
		TL 206	3.00E-06					

table displays the two title cards that precede the neutron and gamma-ray data, where appropriate, for each reaction. Definitions and format specifications for the items contained in the title cards are given in the Appendix. The thermal cross section (group 100) was computed in the following way. For those reactions for which 2200 m/s cross sections were available, either from the ENDF/B-IV files or the Chart of the Nuclides (Twelfth Edition, 1977 Revision), the thermal cross sections was taken as $(\sqrt{\pi}/2) \times \sigma_{2200}$, the average value for a 1/v absorber at 293 K. In cases where the 2200 m/s data were not easily available, the group 99 cross section was assigned an energy of 0.469 eV, corresponding to the lethargy midpoint (16.875) of the group. Assuming a 1/v behavior, the average cross section at 293 K is then equal to $\sigma_{99} \times 3.84$.

III. RADIOACTIVE DECAY DATA

The half-lives assigned to the radioactive products were those shown in the Twelfth Edition of the Chart of the Nuclides (1977 Revision). In cases where a reaction led to isomeric states, and the branching ratio was not known, no half-life value was given, and the reaction was flagged with an asterisk (see Appendix). The latter situation was true for essentially all of the reactions calculated with the THRESH code. Hence, a large number of reactions have data only for neutron cross sections and lower limits for the MPC.

The gamma-ray intensities were derived, except for ^{50}V , from the Jülich library of gamma-ray and X-ray lines for 1313 radionuclides.^{5,6} Although not used by us, the Jülich file also gives data on half-lives, parent and daughter nuclides, generating reactions, and escape lines associated with pair production processes. A code was written to bin the discrete intensities (photons/100 dis) into the 25-group structure shown in Table III. Where the file contained relative intensity data, we disregarded the entry. It is of interest to note that a much expanded and revised gamma-ray data file for 2055 radionuclides, GAMDAT-78,⁷ has just been made available by the Jülich group. Our experience with the Jülich data has been very satisfactory, based on checks we have made for several radioisotopes. We recommend that the GAMDAT-78 compilation be used for future work until such time as the ENDF/B gamma-ray data is much more complete, and retrieval codes have been written to translate the information into a readily usable form. The GAMDAT-78 file is quite comprehensive -- approximately 48 000 lines for 2055 radioisotopes.

TABLE III
DECAY ENERGY GROUP STRUCTURE

GROUP	ENERGY RANGE				ENERGY WIDTH		
1	9.0000	MEV	T0	10.0000	MEV	1.0000	MEV
2	8.0000	MEV	T0	9.0000	MEV	1.0000	MEV
3	7.0000	MEV	T0	8.0000	MEV	1.0000	MEV
4	6.0000	MEV	T0	7.0000	MEV	1.0000	MEV
5	5.0000	MEV	T0	6.0000	MEV	1.0000	MEV
6	4.0000	MEV	T0	5.0000	MEV	1.0000	MEV
7	3.5000	MEV	T0	4.0000	MEV	.5000	MEV
8	3.0000	MEV	T0	3.5000	MEV	.5000	MEV
9	2.6660	MEV	T0	3.0000	MEV	.3340	MEV
10	2.3330	MEV	T0	2.6660	MEV	.3330	MEV
11	2.0000	MEV	T0	2.3330	MEV	.3330	MEV
12	1.8750	MEV	T0	2.0000	MEV	.1250	MEV
13	1.6600	MEV	T0	1.8750	MEV	.2150	MEV
14	1.5000	MEV	T0	1.6600	MEV	.1600	MEV
15	1.3300	MEV	T0	1.5000	MEV	.1700	MEV
16	1.1250	MEV	T0	1.3300	MEV	.2050	MEV
17	1.0000	MEV	T0	1.1250	MEV	.1250	MEV
18	.9000	MEV	T0	1.0000	MEV	.1000	MEV
19	.7000	MEV	T0	.9000	MEV	.2000	MEV
20	.5000	MEV	T0	.7000	MEV	.2000	MEV
21	.4000	MEV	T0	.5000	MEV	.1000	MEV
22	.3000	MEV	T0	.4000	MEV	.1000	MEV
23	.1000	MEV	T0	.3000	MEV	.2000	MEV
24	.0100	MEV	T0	.1000	MEV	.0900	MEV
25	0.0000	MEV	T0	.0100	MEV	.0100	MEV

The gamma energy (MeV) per disintegration was computed from the data in the Jülich library. This was done by summing over the products of gamma-ray energy and intensity prior to binning into the 25-group structure. For the non-gamma energy entries, we drew heavily on the published literature, especially those reported by Nichols⁸ and Kocher.⁹ Because the Jülich library accounts for both gamma rays (including annihilation radiation) and x rays, we needed only the energies of the Auger and conversion electrons and alphas. For the 50 reactions for which non-gamma energies were not found in the literature, we used the Table of Isotopes.¹⁰ In view of the limited time available, we assumed the mean beta energy to be 0.4 times the endpoint energy and ignored the contribution from Auger and conversion electrons. The neglect of the latter contribution is not serious since this component is usually very small compared to the total (gamma + non-gamma) energy release.

IV. MAXIMUM PERMISSIBLE CONCENTRATIONS

The Code of Federal Regulations¹¹ specifies limits, in air and water, for radioactivity in effluents to unrestricted areas. We used the latter values for air; where MPCs for soluble and insoluble forms were given, the lower value was chosen. For isotopes not assigned specific MPC values, the code recommends numbers whose magnitudes depend on whether (1) the half-life is less than 2 hours, (2) the half-life is greater than 2 hours, and (3) the decay is by alpha emission or spontaneous fission. In those cases where the reaction leads to meta-stable states and the branching ratio is unknown, the lower figure for the MPC was used.

APPENDIX

GAMMON FORMAT SPECIFICATIONS

	<u>Column</u>	<u>Format</u>	<u>Content</u>
<u>Title Card 1</u>			
Target symbol	1-2	A2	Element - H, PU, etc.
	3	A1	Blank
	4-6	A3	Mass - 1, 239, etc.
Reaction	9-16	A8	(N,G), (N,2N), (N,NP+D), etc.

Product symbol	19-20	A2	Element
	21	A1	Blank
	22-24	A3	Mass
	25	A1	M for isomeric state
Half-life	27-36	F or E10,3	Numerical value. An asterisk in column 28 indicates that the half-life of the reaction product cannot be uniquely specified because of the existence of important isomeric states.
	38	A1	Half-life units: S - second M - minute H - hour D - day Y - year
Data source	43-53	A6,A5	ENDF/B-IV, THRESH, etc.
Gamma MeV/dis	54-61	F8.5	MeV of gamma radiation per disintegration. Blank if * in column 28.
Target identifier and reaction type	73-74	I2	Z of target
	75-76	I2	Mass of target. For M > 99, omit first digit.
	77	I1	Reaction type: 0 - (n,n') to isomer 1 - (n,2n) 2 - (n, γ) 3 - (n,p) 4 - (n, α) 5 - (n,n'p)+(n,d) 6 - (n,n' α) 7 - (n,n'd)+(n,t) 8 - (n,3n) 9 - unassigned
	80	I1	0 (zero)
<u>Title Card 2</u>			
Product symbol	19-25	A7	See Title Card 1.
MPC	27-35	E9.2	Maximum permissible concentration in units of $\mu\text{Ci/ml}$.
MPC reference	37-38	A2	Unless otherwise noted, values are from Ref. 11. The entry DK denotes data are from Ref. 13.
Non-gamma MeV/dis	43-50	F8.5	MeV per disintegration, excluding photons. Blank if * in column 28 of Title Card 1.

Reference for above	53-57	A5	AERE - Ref. 8
			TM102 - Ref. 9
			TIS07 - Ref. 10
			MEDLI - Ref. 12
			DK - Ref. 13
			EN223 - Ref. 14

Cards 3-19. 100-Group Neutron Cross Sections

Cross sections	1-72	6E12.5	
Target identifier and reaction type	73-77	I5	See Title Card 1
	78	Blank	
Sequence numbers	79-80	I2	1 to 17

Cards 20-23. 25-Group Gamma Intensities

These cards not present if gamma MeV/dis 0.0 or there is an * in column 28 of Title Card 1.

Intensities	1-70	7F10.5	Photons per 100 disintegrations
Product symbol	73-79	A7	See Title Card 1

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