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Title: **Evaluation and Compilation of Fission Product Yields 1993**

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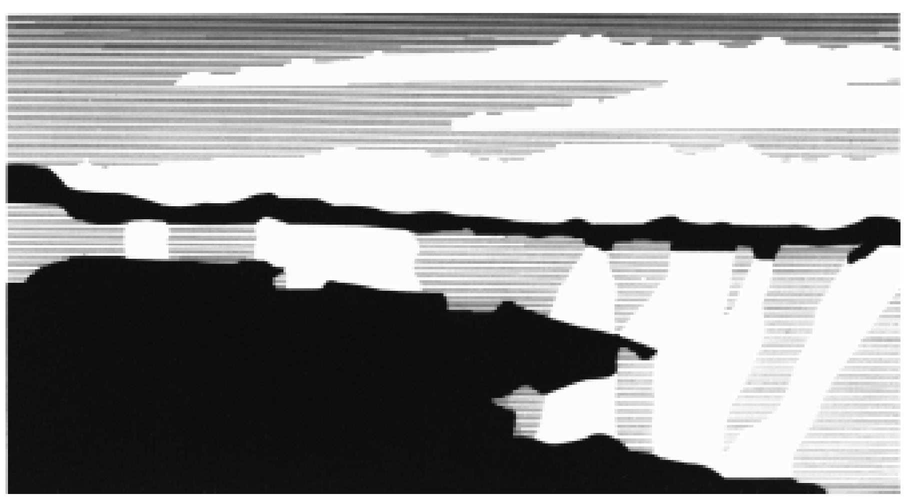

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Evaluation and Compilation of Fission Product Yields
1993

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Abstract

This document is the latest in a series of compilations of fission yield data. Fission yield measurements reported in the open literature and calculated charge distributions have been used to produce a recommended set of yields for the fission products. The original data with reference sources, and the recommended yields are presented in tabular form. These include many nuclides which fission by neutrons at several energies. These energies include thermal energies (T), fission spectrum energies (F), 14 meV High Energy (H or HE), and spontaneous fission (S), in six sets of ten each. Set A includes U235T, U235F, U235HE, U238F, U238HE, Pu239T, Pu239F, Pu241T, U233T, Th232F. Set B includes U233F, U233HE, U236F, Pu239H, Pu240F, Pu241F, Pu242F, Th232H, Np237F, Cf252S. Set C includes U234F, U237F, Pu240H, U234HE, U236HE, Pu238F, Am241F, Am243F, Np238F, Cm242F. Set D includes Th227T, Th229T, Pa231F, Am241T, Am241H, Am242MT, Cm245T, Cf249T, Cf251T, Es254T. Set E includes Cf250S, Cm244S, Cm248S, Es253S, Fm254S, Fm255T, Fm256S, Np237H, U232T, U238S. Set F includes Cm243T, Cm246S, Cm243F, Cm244F, Cm246F, Cm248F, Pu242H, Np237T, Pu240T, and Pu242T to complete fission product yield evaluations for 60 fissioning systems in all. This report also serves as the primary documentation for the second evaluation of yields in ENDF/B-VI released in 1993.

This report was originally intended to be printed full sized including all evaluated and compiled data. However, it contains more than 80,000 single spaced lines, most extending over 132 columns (about 1300 pages). The main text, tabular data in the text, evaluated chain yields, and an extensive, annotated bibliography are retained in this text. All evaluated and compiled data have been relegated to six appendices for the six groups of fissioning nuclides noted above. These are available to anyone having access to the internet. The anonymous node is t2.lanl.gov under the subnode yields. The files will also be available from BNL, IAEA and other sites. Please consult the "readme.yld" file in t2.lanl.gov yields node for additional information.

General

In recent years, there has been great interest in fission yields. They are used in the calculation of odd-even pairing effects, the number of prompt neutrons per fission (nubar), of delayed neutron precursor yields, and of delayed neutron spectra. Yields are used in the calculation of waste disposal inventories, and in the calculation of beta and gamma ray spectra of fission-product inventories. Fission yields are also used in the calculation of decay heat, especially in the time from 1 to 1000 seconds after a loss-of-coolant accident in a nuclear power plant. Such a calculation requires a value for the independent yield of every fission product nuclide with a half-life longer than a few tenths of a second. This work includes a recommended independent (RI) yield for every fission product nuclide to satisfy the requirements of decay heat calculations. The recommended independent yield values have been transmitted to the National Nuclear Data Center's Evaluated Nuclear Data File (ENDF/B-VI) at Brookhaven National Laboratory. The Cross Section Evaluation Working Group (CSEWG) Fission Product Yield and Decay Data Subcommittee has reviewed this work.

Several tests have been applied to the data including checks of atom, neutron, and proton balances. First, except for the very small ternary fission contribution the total of chain yields in the light and heavy mass peaks should each add to 100% or 200% when combined. Second, the average mass of the heavy fission product, plus the average of the light fission product, plus the average number of neutrons emitted in fission (nubar) should equal the mass of the fissioning nuclide plus the mass of the neutron inducing the fission. Third, the Z of each fission product, times the independent yield of that fission product, summed over all fission products including ternary fission products with Z = 1 through 4, and divided by 100 (to remove percent) should equal Z of the fissioning nuclide. These tests were satisfied for thermal fission, and within experimental error for other fission energies. Test results appear in the following table in order of the amount of data available (the order of appearance in this document):

Table 1.
Atom, Neutron and Proton Balances

Nuclide	Sum of Z*Yields	Atomic Number	Compound Nucleus	Minus Av. Light Mass	Minus Av. Heavy Mass	Equals Apparent Nubar	Evaluated Nubar	Error on Eval. Nubar
U235t	92.05	92.00	236	-94.9072	-138.6923	2.40	2.42 *	0.12 *
U235f	92.00	92.00	236	-95.0549	-138.4740	2.47	2.47 *	0.12 *
U235h	92.00	92.00	236	-96.5733	-135.3098	4.12	4.38 *	0.22 *
U238f	92.00	92.00	239	-97.3361	-138.7285	2.93	2.79 *	0.14 *
U238h	92.00	92.00	239	-97.8840	-136.6967	4.42	4.42 *	0.22 *
Pu239t	94.00	94.00	240	-98.9910	-138.1044	2.90	2.88 *	0.14 *
Pu239f	94.00	94.00	240	-98.9995	-138.0987	2.90	2.94 *	0.15 *
Pu241t	94.00	94.00	242	-100.2773	-138.7588	2.96	2.87 *	0.14 *
U233t	92.01	92.00	234	-93.3624	-138.1835	2.45	2.50 *	0.12 *
Th232f	90.00	90.00	233	-91.0555	-139.7144	2.23	2.42 *	0.12 *
U233f	92.00	92.00	234	-93.6925	-137.7976	2.51	2.52 *	0.12 *
U233h	91.99	92.00	234	-95.9442	-134.5816	3.47	4.27 *	0.21 *
U236f	91.99	92.00	237	-95.7290	-138.5854	2.69	2.78 *	0.14 *
Pu239h	93.99	94.00	240	-100.1713	-135.2287	4.60	4.90 *	0.25 *
Pu240f	93.99	94.00	241	-99.6395	-138.3988	2.96	2.94 *	0.15 *
Pu241f	94.00	94.00	242	-100.3500	-138.6715	2.98	2.95 *	0.15 *
Pu242f	93.99	94.00	243	-100.8390	-138.8155	3.35	3.31 *	0.17 *
Th232h	90.00	90.00	233	-93.8282	-136.2661	2.91	3.92 *	0.20 *
Np237f	93.00	93.00	238	-97.1469	-138.1594	2.69	3.05 *	0.15 *
Cf252s	97.97	98.00	252	-106.1231	-141.9496	3.93	3.82 **	0.12 **
U234f	92.00	92.00	235	-93.9101	-138.3704	2.72	2.67 *	0.13 *
U237f	91.99	92.00	238	-96.5407	-138.7426	2.72	(2.74)	-------
Pu240h	93.98	94.00	241	-100.3305	-136.0709	4.60	(4.62)	-------

U234h	92.00	92.00	235	-96.1547	-134.6481	4.20	(4.20)	-------
U236h	92.00	92.00	237	-97.2126	-135.5432	4.24	(4.26)	-------
Pu238f	94.00	94.00	239	-98.4958	-138.5021	2.00	2.90 *	0.15 *
Am241f	95.00	95.00	242	-100.1916	-138.6766	3.13	2.91 *	0.15 *
Am243f	95.00	95.00	244	-101.0691	-138.9113	4.02	3.83 *	0.19 *
Np238f	93.00	93.00	239	-98.0812	-138.5612	2.36	(2.32)	-------
Cm242f	96.00	96.00	243	-100.6843	-138.7155	3.60	(3.64)	-------
Th227t	90.00	90.00	228	- 88.8781	-137.7444	1.38	(1.42)	-------
Th229t	90.06	90.00	230	- 87.9144	-139.8130	2.27	(2.30)	-------
Pa231f	91.01	91.00	232	- 91.1277	-138.3961	2.48	(2.53)	-------
Am241t	94.93	95.00	242	-100.5866	-138.4968	2.92	(2.79)	-------
Am241h	94.98	95.00	242	-102.0261	-135.5191	4.45	(4.70)	-------
A242Mt	95.03	95.00	243	-100.9831	-139.0693	2.95	(3.04)	-------
Cm245t	95.98	96.00	246	-103.0413	-139.6600	3.30	(3.36)	-------
Cf249t	97.92	98.00	250	-105.9351	-139.9612	4.10	(4.02)	-------
Cf251t	98.05	98.00	252	-107.4799	-140.9040	3.62	(3.84)	-------
Es254t	98.96	99.00	255	-110.8090	-140.2389	3.95	(3.92)	-------
Cf250s	97.99	98.00	250	-105.1358	-141.5797	3.28	(3.30)	-------
Cm244s	95.99	96.00	244	-103.1063	-138.7409	2.15	2.60 **	0.11 **
Cm248s	96.00	96.00	248	-104.4495	-140.0049	3.55	(3.69)	-------
Es253s	99.01	99.00	253	-106.1086	-142.5211	4.37	(4.38)	-------
Fm254s	100.00	100.00	254	-108.8178	-140.9429	4.24	4.05 **	0.19 **
Fm255t	99.99	100.00	256	-114.5118	-138.4055	3.08	(2.83)	-------
Fm256s	100.00	100.00	256	-110.8021	-140.8390	4.36	(4.36)	-------
Np237h	92.99	93.00	238	- 99.0015	-135.5333	3.47	(3.61)	-------
U232t	92.05	92.00	233	- 92.1640	-138.0498	2.79	(2.96)	-------
U238s	91.99	92.00	238	- 96.0861	-140.2738	1.64	1.97 **	0.07 **
Cm243t	95.99	96.00	244	-101.5684	-139.4839	2.95	--------	-------
Cm246s	96.00	96.00	246	-103.8193	-139.1668	3.01	--------	-------
Cm243f	95.99	96.00	244	-100.9917	-139.3143	3.69	--------	-------
Cm244f	95.99	96.00	245	-101.4387	-139.8775	3.68	--------	-------
Cm246f	95.99	96.00	247	-102.8016	-140.5408	3.66	--------	-------
Cm248f	95.99	96.00	249	-104.1974	-141.0867	3.72	--------	-------
Pu242h	93.99	94.00	243	-101.5694	-137.2259	4.20	--------	-------
Np237t	93.00	93.00	238	- 97.4744	-138.5703	1.96	--------	-------
Pu240t	94.00	94.00	241	- 99.6713	-138.4571	2.87	--------	-------
Pu242t	94.00	94.00	242	-100.8876	-139.0490	2.06	--------	-------

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* Reference ENDF/B-V; ** Reference (64HYD1); For more nubar data see (77HOW1).

Yields are also checked to see if they sum to 100% per fission under each peak. Fifty-one do sum to 100.00%. U235t, U235f Es253s, Fm256s are off by 0.01%, Pu240h, Cf249t, and Np237h by 0.04%, U232t by 0.02% and cf251t by 0.05%. For ENDF/B-VI, even these small deviations do not apply because of the final normalization.

Independent yields are taken from a calculated charge distribution model. The model independent yields are normalized so their sum equals the chain yield. Large errors are given to the model yields. These model yields are merged statistically with weighted averages of measured yields. One set of cumulative yields is calculated by adding independent yields starting with the initial nuclide and ending with the chain yield. A second set of cumulative yields is calculated by starting with the chain yields and subtracting independent yields ending with the initial nuclide. These two sets are averaged using reciprocal variance weighting. The first set dominates the initial nuclide yield averages. The second set dominates the final chain member yield averages because of the small errors caused by the constraint imposed at 0% and 100% of the chain yield, respectively. The powerful and constrained merging technique and resulting error analysis used is that recommended by Professor B. I. Spinrad of Oregon State University. He was chairman of the Subcommittee for ENDF/B-V

Fission Yield Errors (77SPI1). Other refinements treat delayed neutron emission, partition direct yields between metastable and ground state isomers, handle internal transition, and accomodate beta decay branching ratios.

Light Ternary Fission Products

A survey was made by Madland (77MAD1) of experimental information on the probability of ternary fission and the charge distribution of the light ternary fission products. A new prescription was presented for the ternary fission probability as a function of incident particle energy and certain compound nucleous properties. Based upon systematics, a method for obtaining charge distributions of the light ternary products was presented. Although Madland's study is yet incomplete, his current yield recommendations are listed together with the charge balances for all sixty fissionable nuclides. We have adjusted Wahl-recommended Zp values (88WAH1, 89WAH1) by a small adder to get a satisfactory charge balance. We have included the charge carried with the light ternary fission products because accurate calculation of decay heat requires a good charge balance.

Table 2.
Light Ternary Fission Products

Nuclide	Zp Adder	Ternary Yield,%*	Standard Dev.*	H (Z=1) Yield,%*	He(Z=2) Yield,%*	Li(Z=3) Yield,%*	Be(Z=4) Yield,%*	Ternary Charge	Binary Charge	Total Charge
U235t	0.00000	0.2137	0.0196	0.01541	0.19755	0.00012	0.00062	0.0041	91.9959	92
U235f	-0.13397	0.1873	0.0123	0.01253	0.17395	0.00018	0.00065	0.0036	91.9964	92
U235h	-0.06979	0.1456	0.0070	0.00974	0.13522	0.00014	0.00050	0.0028	91.9972	92
U238f	-0.01255	0.1667	0.0233	0.01115	0.15481	0.00016	0.00058	0.0032	91.9968	92
U238h	-0.01379	0.1258	0.0055	0.00841	0.11683	0.00012	0.00044	0.0024	91.9976	92
Pu239t	+0.01551	0.2326	0.0108	0.01556	0.21602	0.00022	0.00081	0.0045	93.9955	94
Pu239f	-0.01490	0.2092	0.0249	0.01399	0.19428	0.00020	0.00073	0.0041	93.9959	94
Pu241t	+0.01660	0.2273	0.0145	0.01520	0.21109	0.00022	0.00079	0.0044	93.9956	94
U233t	-0.15331	0.2427	0.0094	0.01134	0.23010	0.00021	0.00104	0.0048	91.9952	92
Th232f	-0.09410	0.0840	0.0031	0.00562	0.07801	0.00008	0.00029	0.0016	89.9984	90
U233f	-0.00839	0.2257	0.0260	0.01509	0.20961	0.00022	0.00078	0.0044	91.9956	92
U233h	-0.16821	0.2180	0.0550	0.01458	0.20246	0.00021	0.00076	0.0042	91.9958	92
U236f	-0.02958	0.1600	0.0400	0.01070	0.14859	0.00015	0.00055	0.0031	91.9969	92
Pu239h	-0.06819	0.2560	0.0640	0.01712	0.23775	0.00025	0.00089	0.0050	93.9950	94
Pu240f	-0.00630	0.2400	0.0600	0.01605	0.22289	0.00023	0.00083	0.0047	93.9953	94
Pu241f	+0.00078	0.2200	0.0550	0.01471	0.20431	0.00021	0.00076	0.0043	93.9957	94
Pu242f	-0.01025	0.2000	0.0560	0.01338	0.18574	0.00019	0.00069	0.0039	93.9961	94
Th232h	-0.23784	0.0958	0.0088	0.00641	0.08897	0.00009	0.00033	0.0019	89.9981	90
Np237f	-0.07769	0.2200	0.0550	0.01471	0.20431	0.00021	0.00076	0.0042	92.9958	93
Cf252s	+0.05678	0.3459	0.0857	0.02830	0.31601	0.00051	0.00108	0.0067	97.9933	98
U234f	+0.00820	0.2009	0.0502	0.01308	0.20479	0.00018	0.00070	0.0041	91.9959	92
U237f	-0.01426	0.1405	0.0351	0.00915	0.13074	0.00013	0.00050	0.0027	91.9973	92
Pu240h	-0.01140	0.2369	0.0592	0.01542	0.22043	0.00021	0.00083	0.0046	93.9954	94
U234h	-0.00096	0.1997	0.0499	0.01300	0.18582	0.00018	0.00070	0.0039	91.9961	92
U236h	-0.00662	0.1625	0.0406	0.01058	0.15121	0.00015	0.00056	0.0032	91.9968	92
Pu238f	-0.17529	0.2815	0.0704	0.01833	0.26194	0.00025	0.00098	0.0055	93.9945	94
Am241f	+0.04430	0.3016	0.0754	0.01963	0.28064	0.00027	0.00106	0.0059	94.9941	95
Am243f	+0.03270	0.2613	0.0653	0.01701	0.24314	0.00024	0.00091	0.0051	94.9949	95
Np238f	+0.00516	0.2211	0.0553	0.01439	0.20573	0.00020	0.00077	0.0043	92.9957	93
Cm242f	-0.00877	0.3620	0.0905	0.02357	0.33684	0.00033	0.00127	0.0070	95.9930	96
Th227t	-0.00159	0.1808	0.0452	0.01209	0.16791	0.00017	0.00061	0.0035	89.9965	90
Th229t	-0.01446	0.1405	0.0351	0.00940	0.13050	0.00013	0.00048	0.0027	89.9973	90
Pa231f	-0.00939	0.1808	0.0452	0.01209	0.16791	0.00017	0.00061	0.0035	90.9965	91

Am241t	-0.01644	0.3016	0.0754	0.02018	0.28014	0.00029	0.00103	0.0059	94.9941	95
Am241h	-0.08272	0.2927	0.0732	0.01958	0.27186	0.00029	0.00100	0.0057	94.9943	95
A242mt	-0.01968	0.2815	0.0704	0.01883	0.26144	0.00027	0.00096	0.0054	94.9946	95
Cm245t	-0.06246	0.3016	0.0754	0.02018	0.28014	0.00029	0.00103	0.0059	95.9941	96
Cf249t	-0.03369	0.3822	0.0955	0.02557	0.35497	0.00037	0.00130	0.0074	97.9926	98
Cf251t	-0.03388	0.3419	0.0855	0.02287	0.31756	0.00033	0.00116	0.0066	97.9934	98
Es254t	-0.02367	0.3620	0.0905	0.02422	0.33626	0.00035	0.00123	0.0070	98.9930	99
Cf250s	-0.02719	0.3822	0.0956	0.02165	0.35330	0.00021	0.00111	0.0073	97.9927	98
Cm244s	-0.08967	0.3419	0.0855	0.02465	0.31606	0.00019	0.00099	0.0066	95.9934	96
Cm248s	-0.03380	0.2613	0.0653	0.01885	0.24159	0.00015	0.00076	0.0051	95.9949	96
Es253s	-0.00325	0.4023	0.1006	0.02901	0.37191	0.00023	0.00117	0.0078	98.9922	99
Fm254s	+0.02698	0.4627	0.1157	0.03337	0.42777	0.00026	0.00134	0.0090	99.9910	100
Fm255t	+0.02939	0.4225	0.1056	0.03046	0.39053	0.00024	0.00123	0.0082	99.9918	100
Fm256s	-0.00696	0.4225	0.1056	0.03046	0.39053	0.00024	0.00123	0.0082	99.9918	100
Np237h	-0.04309	0.2183	0.0546	0.01574	0.20180	0.00012	0.00063	0.0042	92.9958	93
U232t	-0.00930	0.2412	0.0603	0.01739	0.22297	0.00014	0.00070	0.0047	91.9953	92
U238s	-0.10342	0.1405	0.0351	0.01013	0.12988	0.00008	0.00041	0.0027	91.9973	92
Cm243t	-0.13983	0.3000	0.0750	0.02163	0.27733	0.00017	0.00087	0.0058	95.9942	96
Cm246s	+0.00183	0.2899	0.0725	0.02090	0.26799	0.00016	0.00084	0.0056	95.9944	96
Cm243f	+0.03686	0.3200	0.0800	0.02307	0.29582	0.00093	0.00093	0.0062	95.9938	96
Cm244f	-0.02517	0.3120	0.0780	0.02249	0.28842	0.00017	0.00090	0.0062	95.9938	96
Cm246f	-0.00881	0.2960	0.0740	0.02134	0.27363	0.00017	0.00086	0.0057	95.9943	96
Cm248f	-0.00855	0.2800	0.0700	0.02019	0.25884	0.00016	0.00081	0.0054	95.9946	96
Pu242h	-0.05084	0.4600	0.1150	0.03317	0.42524	0.00026	0.00133	0.0089	93.9911	94
Np237t	-0.11936	0.1800	0.0450	0.01298	0.16639	0.00010	0.00052	0.0035	92.9965	93
Pu240t	-0.00995	0.2000	0.0500	0.01442	0.18489	0.00012	0.00058	0.0039	93.9961	94
Pu242t	-0.01672	0.1600	0.0400	0.01153	0.14790	0.00009	0.00046	0.0031	93.9969	94

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*From Reference (77MAD1)

Treatment of Data

The original values reported in the literature have been tabulated with the reference value (if any) against which they were determined. An updated value was then calculated by using the current recommended value for the fission yield of the reference nuclide from the file. All the updated values were adjusted by a small adder to ensure that the chain yields would total 100% except for the small difference between iterations. To find this adder, the variance of the sum is obtained by summing the variances of each chain yield. Any difference from 100% is apportioned to each chain yield in the proportion its variance bears to the total variance. That is, to a chain yield whose variance contributes 10% to the total variance, is added 10% of the total difference from 100%. This method results in a negligible adjustment to any accurately determined absolute yield. It ensures that the adjustment is made mainly in the lesser known yields where most of the error lies. Yet these lesser known values are adjusted by only a fraction of their standard deviation or well within their experimental error.

The relative standard deviation reported in the literature is not allowed to be smaller than 0.5% for mass spectrometric measurements or 5% for Ge(Li)-era radiochemical measurements made since 1965. A lower limit of 10% is set for sodium-iodide-era measurements between 1955 and 1965, and 20% for Geiger-counter-era measurements before 1955. Estimates are generally no better than ±10% and are defaulted at ±30%. If the relative standard deviation is not reported in the literature, and is not supplied by the evaluator, it defaults to three times these lower limits. If separate plus and minus errors are reported, the smaller value plus two-thirds the difference is used as the relative standard deviation. For relative values, the resultant error is combined statistically with the error in the recommended yield of the reference nuclide from the previous iteration to give an error of the updated value. For absolute values, a 2% upper limit of conceivable systematic error is combined with the reported random error. Average experimental independent yields and experimental cumulative yields are determined for each nuclide. The individual values in the average are weighted by the inverse square of the relative standard deviation. If more than the above standardized treatment is required, a special treatment number is assigned so that these various cases can be individually treated. Detailed meanings of the special treatment numbers are given in a later section.

Various compilers/evaluators (74MEE1, 73WAL1, 73CRO1, 73NET2) have agreed within experimental error on all but a few yields, principally: Pu239T, Ru-103; Th232F, Cs-137; U235T, I-129, and Te-130. These discrepancies have been resolved by later measurements. Spinrad and Wu (78SPI1) have developed a general correlation for independent fission product yield uncertainties. Measurements of independent fission product yields from thermal-neutron fission of U235 (79 values), Pu239 (48 values), U233 (41 values), Pu241 (21 values) were compared to expected yields from the semiempirical model used in our evaluation. A general correlation between experimental to theoretical ratio and the distance of the nuclide from Zp (most probable charge in a fission product mass chain), was prepared. This correlation serves as a basis for assigning uncertainties to theoretical yield estimates. The FORTRAN code correlation is ABS(LN (YT(I)/YE(I))) = 0.143 + 0.108 * (Z(I) - Zp) **2, where YT and YE are theoretical and experimental fractional independent yields of nuclide(I). The Z(I) and Zp are charge of nuclide(I) and the most probable charge for that mass chain, respectively. Further details on the independent yield model have been published (74WOL1, 76MAD1, 76MAD2).

For this edition, all published values previously not used (NU) have been reevaluated. Several previously unused values were found consistent with new measurements and are now used. All values that remain unused are given an explanation of why in the note column (by symbols described under note definitions). Many are merely superseded by later work of the same author or are upper limits. Others are outliers that are inconsistent with the model or other measurements.

When our independent yields were used, calculations of decay heat for U-235 thermal neutron fission have shown excellent agreement with experimental measurement from 20 to 100,000 seconds after reactor shutdown (77BJE1, 92ENG3).

Half-Lives

The half-lives were taken from the 14th edition of the General Electric Chart of the Nuclides (89WAL1) unless otherwise noted. Half-lives in ENDF/B-VI decay files may differ in some cases. Half-lives are not important to the yield evaluation but we have tried to provide accurate values.

Decay Chains and Branching Fractions

The three rows of numbers tabulated immediately below the half-lives are the percent of the precursor nuclides that decay to the labeled nuclide. The precursors covered by these three rows are, respectively, the ground state nuclide with an atomic number one unit smaller than the listed nuclide (Z-1G); the first isomeric nuclide with an atomic number one unit smaller than the listed nuclide (Z-1M); and the first isomer of the nuclide listed, i.e., same atomic number (Z-0M). The branching fractions permit beta-decay and isomeric transitions to be considered. If the value listed is negative, the nuclide decays by positron emission or electron capture to the Z-1 nuclide. The value listed is then the percentage of the atoms of the listed nuclide that decay to the respective Z-1 isomers. Charged particle emission was not considered.

Calculated Yields

A Gaussian charge distribution was calculated by using the most probable charge and Gaussian width parameter listed at the extreme left-hand side of the tabular section. These Zp values were obtained using preliminary ENDF/B-VI data as described in 89WAH1 and by subsequent private communications from A. C. Wahl to the authors. A small adder was applied to every Zp to adjust the proton balance to equal the atomic number. Sigma values vary by mass as listed by A. C. Wahl (89WAH1). Where isomerism occurs, the independent yield of each isomer depends on a non-linear function of the angular momentum of each isomer. Madland (76MAD2) finds such a model to predict the isomer split (metastable/ground state) within plus or minus 50%. The Madland Model is used to divide isomeric yields between metastable and ground states except where the isomeric yields have been measured. Where angular momentum for each isomer is not known, it is divided equally between the ground state and a single metastable state. The decay chains listed at the top of the tables were then used to obtain fractional cumulative yields. These yields were modified by the neutron and proton odd-even effect (76MAD1) and renormalized to unity. Pairing effects applied to the Gaussian model are given in Table 3.

Table 3.
Neutron and Proton Odd-Even Effect

Nuclide	Proton Effect,X	Neutron Effect,Y	Odd Z-Odd N	Odd Z-Even N	Even Z-Odd N	Even Z-Even N
U235t	0.273 +- 0.034	0.071 +- 0.034	-0.344	-0.202	+0.202	+0.344
U235f	0.260 +- 0.179	0.070 +- 0.039	-0.330	-0.190	+0.190	+0.330
U235h	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
U238f	0.080 +- 0.479	0.020 +- 0.100	-0.100	-0.060	+0.060	+0.100
U238h	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Pu239t	0.144 +- 0.206	0.046 +- 0.044	-0.190	-0.098	+0.098	+0.190
Pu239f	0.160 +- 0.143	0.040 +- 0.031	-0.200	-0.120	+0.120	+0.200
Pu241t	0.100 +- 0.256	0.000 +- 0.000	-0.100	-0.100	+0.100	+0.100
U233t	0.269 +- 0.264	0.072 +- 0.056	-0.341	-0.197	+0.197	+0.341
Th232f	0.140 +- 0.469	0.040 +- 0.098	-0.180	-0.100	+0.100	+0.180
U233f	0.250 +- 0.168	0.060 +- 0.037	-0.310	-0.190	+0.190	+0.310
U233h	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
U236f	0.220 +- 0.200	0.050 +- 0.043	-0.270	-0.170	+0.170	+0.270
Pu239h	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Pu240f	0.160 +- 0.321	0.040 +- 0.021	-0.200	-0.120	+0.120	+0.200
Pu241f	0.160 +- 0.166	0.040 +- 0.036	-0.200	-0.120	+0.120	+0.200
Pu242f	0.110 +- 0.554	0.030 +- 0.114	-0.140	-0.080	+0.080	+0.140
Th232h	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Np237f	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Cf252s	0.050 +- 0.040	0.000 +- 0.000	-0.050	-0.050	+0.050	+0.050
U234f	0.230 +- 0.089	0.060 +- 0.020	-0.290	-0.170	+0.170	+0.290
U237f	0.220 +- 0.116	0.050 +- 0.024	-0.270	-0.170	+0.170	+0.270
Pu240h	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
U234h	0.000 +- 0.000	0.000 +- 0.005	-0.000	-0.000	+0.000	+0.000
U236h	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Pu238f	0.170 +- 0.019	0.040 +- 0.004	-0.210	-0.130	+0.130	+0.210
Am241f	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Am243f	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Np238f	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Cm242f	0.030 +- 0.074	0.010 +- 0.016	-0.040	-0.020	+0.020	+0.040
Th227t	0.440 +- 0.044	0.110 +- 0.011	-0.550	-0.330	+0.330	+0.550
Th229t	0.570 +- 0.301	0.080 +- 0.058	-0.650	-0.490	+0.490	+0.650
Pa231f	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Am241t	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000

Am241h	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
A242mt	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Cm245t	0.070 +- 0.007	0.020 +- 0.002	-0.090	-0.050	+0.050	+0.090
Cf249t	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Cf251t	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Es254t	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Cf250s	0.050 +- 0.005	0.000 +- 0.000	-0.050	-0.050	+0.050	+0.050
Cm244s	0.180 +- 0.018	0.050 +- 0.005	-0.230	-0.130	+0.130	+0.230
Cm248s	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Es253s	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Fm254s	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Fm255t	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Fm256s	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Np237h	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
U232t	0.190 +- 0.019	0.050 +- 0.005	-0.240	-0.140	+0.140	+0.240
U238s	0.080 +- 0.008	0.000 +- 0.000	-0.080	-0.080	+0.080	+0.080
Cm243t	0.060 +- 0.006	0.015 +- 0.002	-0.075	-0.045	+0.045	+0.075
Cm246s	0.120 +- 0.012	0.030 +- 0.003	-0.150	-0.090	+0.090	+0.150
Cm243f	0.050 +- 0.005	0.010 +- 0.001	-0.060	-0.040	+0.040	+0.060
Cm244f	0.050 +- 0.005	0.010 +- 0.001	-0.060	-0.040	+0.040	+0.060
Cm246f	0.020 +- 0.002	0.000 +- 0.000	-0.020	-0.020	+0.020	+0.020
Cm248f	0.020 +- 0.002	0.000 +- 0.000	-0.020	-0.020	+0.020	+0.020
Pu242h	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Np237t	0.000 +- 0.000	0.000 +- 0.000	-0.000	-0.000	+0.000	+0.000
Pu240t	0.170 +- 0.017	0.040 +- 0.004	-0.210	-0.130	+0.130	+0.210
Pu242t	0.140 +- 0.014	0.035 +- 0.004	-0.175	-0.105	+0.105	+0.175

The calculated independent yield division between metastable and ground states of isomers for known spin isomers were as follows:

Table 4.
Independent Yield Division between Metastable and Ground States
of Isomers Having Known Spin States

Isotope	Meta- State Spin	Ground State Spin	JM-JG	Integer Odd/Even	JM>JG=+ JM<JG=-	Odd or Even A	Formula Number*	Frac. of Yield Metastable (M/M+G) Thermal	Fast	High E.
68Cu	6	1	5	O	+	E	7	0.70	0.73	0.82
69Zn	9/2	1/2	4	E	+	O	1	0.81	0.83	0.89
70Cu	5	1	4	E	+	E	5	0.75	0.78	0.85
71Zn	9/2	1/2	4	E	+	O	1	0.81	0.83	0.89
73Se	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
73Ge	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
74As	5	2	3	O	+	E	7	0.70	0.73	0.82
75Ge	7/2	1/2	3	O	+	O	3	0.87	0.88	0.92
77Br	9/2	3/2	3	O	+	O	3	0.77	0.79	0.86
77Ge	1/2	7/2	3	O	-	O	4	0.13	0.12	0.07
77Se	7/2	1/2	3	O	+	O	3	0.87	0.88	0.92
79Se	1/2	7/2	3	O	-	O	4	0.13	0.12	0.07
79Kr	7/2	1/2	3	O	+	O	3	0.87	0.88	0.92
79Br	9/2	3/2	3	O	+	O	3	0.77	0.79	0.86
80Br	5	1	4	E	+	E	5	0.75	0.78	0.85
81Rb	9/2	3/2	3	O	+	O	3	0.77	0.79	0.86
81Se	7/2	1/2	3	O	+	O	3	0.87	0.88	0.92
81Kr	1/2	7/2	3	O	-	O	4	0.13	0.12	0.07
82Rb	5	1	4	E	+	E	5	0.30	0.27	0.18
82Br	2	5	3	O	-	E	8	0.30	0.27	0.18
83Se	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
83Kr	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11

84Br	6	2	4	E	+	E	5	0.64	0.68	0.78
84Y	1	4	3	O	-	E	8	0.19	0.17	0.11
84Rb	6	2	4	E	+	E	5	0.64	0.68	0.78
85Kr	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
85Sr	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
85Y	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
85Zr	1/2	7/2	3	O	-	O	4	0.13	0.12	0.07
86Rb	6	2	4	E	+	E	5	0.64	0.68	0.78
86Y	8	4	4	E	+	E	5	0.42	0.47	0.61
87Sr	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
87Y	9/2	1/2	4	E	+	O	1	0.81	0.83	0.89
89Y	9/2	1/2	4	E	+	O	1	0.81	0.83	0.89
89Zr	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
89Nb	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
90Rb	4	1	3	O	+	E	7	0.81	0.83	0.89
90Y	7	2	5	O	+	E	7	0.59	0.63	0.74
90Zr	5	0	5	O	+	E	7	0.81	0.83	0.89
90Nb	4	8	4	E	-	E	6	0.58	0.53	0.39
91Y	9/2	1/2	4	E	+	O	1	0.81	0.83	0.89
91Nb	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
91Mo	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
92Nb	2	7	5	O	-	E	8	0.41	0.37	0.26
93Nb	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
93Mo	21/2	5/2	8	E	+	O	1	0.38	0.43	0.58
93Tc	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
94Nb	3	6	3	O	-	E	8	0.41	0.37	0.26
94Tc	2	7	5	O	-	E	8	0.41	0.37	0.26
95Nb	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
95Tc	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
96Y	3	0	3	O	+	E	7	0.90	0.91	0.94
96Tc	4	7	3	O	-	E	8	0.53	0.48	0.34
97Nb	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
97Tc	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
98Nb	1	5	4	E	-	E	6	0.25	0.22	0.15
99Tc	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
99Rh	9/2	1/2	4	E	+	O	1	0.81	0.83	0.89
99Nb	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
101Rh	9/2	1/2	4	E	+	O	1	0.81	0.83	0.89
103Rh	7/2	1/2	3	O	+	O	3	0.87	0.88	0.92
103Ag	1/2	7/2	3	O	-	O	4	0.13	0.12	0.07
104Rh	5	1	4	E	+	E	5	0.75	0.78	0.85
104Ag	2	5	3	O	-	E	8	0.30	0.27	0.18
105Rh	1/2	7/2	3	O	-	O	4	0.13	0.12	0.07
105Ag	7/2	1/2	3	O	+	O	3	0.87	0.88	0.92
106Ag	6	1	5	O	+	E	7	0.70	0.73	0.82
107Ag	7/2	1/2	3	O	+	O	3	0.87	0.88	0.92
107Pd	11/2	5/2	3	O	+	O	3	0.65	0.69	0.79
108Ag	6	1	5	O	+	E	7	0.70	0.73	0.82
109Pd	11/2	5/2	3	O	+	O	3	0.65	0.69	0.79
109Ag	7/2	1/2	3	O	+	O	3	0.87	0.88	0.92
109In	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
110Ag	6	1	5	O	+	E	7	0.70	0.73	0.82
111Pd	11/2	5/2	3	O	+	O	3	0.65	0.69	0.79
111Ag	7/2	1/2	3	O	+	O	3	0.87	0.88	0.92
111Cd	11/2	1/2	5	O	+	O	3	0.77	0.79	0.86
111In	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
112In	4	1	3	O	+	E	7	0.81	0.83	0.89
113Ag	7/2	1/2	3	O	+	O	3	0.87	0.88	0.92
113In	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
113Cd	11/2	1/2	5	O	+	O	3	0.77	0.79	0.86
113Sn	7/2	1/2	3	O	+	O	3	0.87	0.88	0.92
114In	5	1	4	E	+	E	5	0.75	0.78	0.85
115Cd	11/2	1/2	5	O	+	O	3	0.77	0.79	0.86
115In	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
117Cd	11/2	1/2	5	O	+	O	3	0.77	0.79	0.86
117In	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11

117Sn	11/2	1/2	5	O	+	O	3	0.77	0.79	0.86
118In	1	5	4	E	-	E	6	0.25	0.22	0.15
118Sb	8	1	7	O	+	E	7	0.59	0.63	0.74
119In	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
119Sn	11/2	1/2	5	O	+	O	3	0.77	0.79	0.86
119Te	11/2	1/2	5	O	+	O	3	0.77	0.79	0.86
120Sb	8	1	7	O	+	E	7	0.59	0.63	0.74
121In	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
121Sn	11/2	3/2	4	E	-	O	1	0.71	0.74	0.82
121Te	11/2	1/2	5	O	+	O	3	0.77	0.79	0.86
122Sb	8	2	6	E	+	E	5	0.53	0.57	0.70
123In	1/2	9/2	4	E	-	O	2	0.19	0.17	0.11
123Te	11/2	1/2	5	O	+	O	3	0.77	0.79	0.86
123Sn	3/2	11/2	4	E	-	O	2	0.29	0.26	0.18
125Sn	3/2	11/2	4	E	-	O	2	0.29	0.26	0.18
125Te	11/2	1/2	5	O	+	O	3	0.77	0.79	0.86
125Xe	9/2	1/2	4	E	+	O	1	0.81	0.83	0.89
126Sb	5	8	3	O	-	E	8	0.63	0.58	0.43
127Sn	3/2	11/2	4	E	-	O	2	0.29	0.26	0.18
127Te	11/2	3/2	4	E	+	O	1	0.71	0.74	0.82
127Xe	9/2	1/2	4	E	+	O	1	0.81	0.83	0.89
128Sb	5	8	3	O	-	E	8	0.63	0.58	0.43
129Sn	11/2	3/2	4	E	+	O	1	0.71	0.74	0.82
129Te	11/2	3/2	4	E	+	O	1	0.71	0.74	0.82
129Xe	11/2	1/2	5	O	+	O	3	0.77	0.79	0.86
129Ba	11/2	1/2	5	O	+	O	3	0.77	0.79	0.86
130Sn	7	0	7	O	+	E	7	0.70	0.73	0.82
130Sb	5	8	3	O	-	E	8	0.63	0.58	0.43
130I	2	5	3	O	-	E	8	0.30	0.27	0.18
131Te	11/2	3/2	4	E	+	O	1	0.71	0.74	0.82
131Xe	11/2	3/2	4	E	+	O	1	0.71	0.74	0.82
132Sb	8	4	4	E	+	E	5	0.42	0.47	0.61
133Te	11/2	3/2	4	E	+	O	1	0.71	0.74	0.82
133I	19/2	7/2	6	E	+	O	1	0.38	0.43	0.58
133Xe	11/2	3/2	4	E	+	O	1	0.71	0.74	0.82
133Ba	11/2	1/2	5	O	+	O	3	0.77	0.79	0.86
134I	8	4	4	E	+	E	5	0.42	0.47	0.61
134Xe	7	0	7	O	+	E	7	0.70	0.73	0.82
134Cs	8	4	4	E	+	E	5	0.42	0.47	0.61
135Ba	11/2	3/2	4	E	+	O	1	0.71	0.74	0.82
135Xe	11/2	3/2	4	E	+	O	1	0.71	0.74	0.82
135Cs	19/2	7/2	6	O	+	O	1	0.38	0.43	0.58
136Ba	7	0	7	O	+	E	7	0.70	0.73	0.82
137Ba	11/2	3/2	4	E	+	O	1	0.71	0.74	0.82
137Ce	11/2	3/2	4	E	+	O	1	0.71	0.74	0.82
139Ce	11/2	3/2	4	E	+	O	1	0.71	0.74	0.82
141Nd	11/2	3/2	4	E	+	O	1	0.71	0.74	0.82
141Sm	11/2	1/2	5	O	+	O	3	0.77	0.79	0.86
142Pr	5	2	3	O	+	E	7	0.70	0.73	0.82
143Sm	11/2	3/2	4	E	+	O	1	0.71	0.74	0.82
144Pr	3	0	3	O	+	E	7	0.90	0.91	0.94
148Pm	6	1	5	O	+	E	7	0.70	0.73	0.82
154Eu	8	3	5	O	+	E	7	0.47	0.52	0.66
156Tb	0	3	3	O	-	E	8	0.10	0.09	0.06
158Ho	2	5	3	O	-	E	8	0.30	0.27	0.18
158Tb	0	3	3	O	-	E	8	0.10	0.09	0.06
159Ho	1/2	7/2	3	O	-	O	4	0.13	0.12	0.07
160Ho	2	5	3	O	-	E	8	0.30	0.27	0.18
161Ho	1/2	7/2	3	O	-	O	4	0.13	0.12	0.07
162Ho	6	1	5	O	+	E	7	0.70	0.73	0.82
163Ho	1/2	7/2	3	O	-	O	4	0.13	0.12	0.07
164Ho	6	1	5	O	+	E	7	0.70	0.73	0.82
165Dy	1/2	7/2	3	O	-	O	4	0.13	0.12	0.07
166Ho	7	0	7	O	+	E	7	0.70	0.73	0.82
167Er	1/2	7/2	3	O	-	O	4	0.13	0.12	0.07
169Yb	1/2	7/2	3	O	-	O	4	0.13	0.12	0.07

169Lu	1/2	7/2	3	O	-	O	4	0.13	0.12	0.07
170Lu	4	0	4	E	+	E	5	0.85	0.86	0.91

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* Reference (76MAD2, 77MAD2).

Delayed Neutron Emission

Delayed neutron emission is included for the first time in this compilation. Delayed neutron precursors, which from the early days have been divided into six half-life groups, are by now well-defined. A total of 271 delayed neutron precursors identified to date are listed together with the approximate half-life group, percent probability of neutron emission of daughter nuclides, and precursor half-lives ranging from 0.074 to 58.2 seconds as proposed for ENDF/B-VI as follows:

Table 5

271 Delayed Neutron Precursors, Their Half-lives and Delayed Neutron Emission Probabilities (Pn), and Uncertainties (dPn) As Found in Table I of Reference 86ENG1 (updated on January 7, 1987).

Nuclide	T 1/2	Pn	dPn	GP	Pn Source	QB	S(n)	Mass Tables M1	M2	M3
Co-72g	0.1235	11.5322	0.0000	6	sys.	15.030	7.391	MN	MN	MN
Cu-72g	6.4891	0.0001	0.0000	3	sys.	8.964	8.880	MN	W81	W81
Co-73g	0.1290	25.1220	0.0000	6	sys.	12.800	3.771	MN	MN	MN
Ni-73g	0.4906	0.0047	0.0000	5	sys.	8.170	7.731	MN	MN	MN
Cu-73g	5.1136	0.5588	0.0000	3	sys.	6.174	4.942	MN	W81	W81
Co-74g	0.0920	17.4326	0.0000	6	sys.	16.440	6.781	MN	MN	MN
Ni-74g	0.9002	0.3560	0.0000	4	sys.	5.980	4.591	MN	MN	MN
Cu-74g	0.6482	0.2949	0.0000	5	sys.	10.221	8.638	MN	W81	W81
Co-75g	0.0817	31.3124	0.0000	6	sys.	14.810	3.451	MN	MN	MN
Ni-75g	0.2312	1.0022	0.0000	6	sys.	9.560	7.031	MN	MN	MN
Cu-75g	0.9274	3.4700	0.6300	4	meas.	8.055	4.866	MN	W81	W81
Ni-76g	0.3046	3.5113	0.0000	5	sys.	7.700	4.221	MN	MN	MN
Cu-76g	0.2602	2.8418	0.0000	6	sys.	12.004	8.171	MN	W81	W81
Ni-77g	0.1033	4.7115	0.0000	6	sys.	11.050	6.341	MN	MN	MN
Cu-77g	0.3052	12.3119	0.0000	5	sys.	10.185	4.522	MN	W81	W81
Ni-78g	0.1318	9.2984	0.0000	6	sys.	9.070	3.631	MN	MN	MN
Cu-78g	0.1179	9.9093	0.0000	6	sys.	13.673	7.119	MN	W81	W81
Zn-78g	1.9855	0.0041	0.0000	4	sys.	6.010	5.629	W81	W81	W81
Cu-79g	0.1351	24.2057	0.0000	6	sys.	10.770	3.399	MN	MN	W81
Zn-79g	0.3130	1.1459	0.0000	5	sys.	9.465	6.854	MN	W81	W81
Ga-79g	3.0000	0.0890	0.0200	4	meas.	6.770	5.740	W83	W83	W83
Cu-80g	0.0899	15.0430	0.0000	6	sys.	16.680	7.181	MN	MN	MN
Zn-80g	0.4873	1.0983	0.0000	6	sys.	7.087	4.803	MN	W81	W81
Ga-80g	1.6600	0.8300	0.0700	4	meas.	10.000	7.920	W83	W83	W83
Cu-81g	0.0742	52.9504	0.0000	6	sys.	14.900	1.521	MN	MN	MN
Zn-81g	0.1227	5.7372	0.0000	6	sys.	12.125	6.559	MN	W81	W81
Ga-81g	1.2300	11.9000	0.9400	4	meas.	8.320	4.990	W83	W83	W83
Zn-82g	0.1268	21.2264	0.0000	6	sys.	10.420	2.477	MN	MN	W81
Ga-82g	0.6000	21.1000	1.8300	5	meas.	12.993	7.149	MN	W81	W81
Zn-83g	0.0836	22.8749	0.0000	6	sys.	13.710	4.141	MN	MN	MN
Ga-83g	0.3100	56.2000	9.9000	5	meas.	11.970	3.119	MN	MN	W81
Ge-83g	1.9000	0.0235	0.0000	4	sys.	8.640	7.880	W83	W83	W83
Ga-84g	0.0984	28.0232	0.0000	6	sys.	15.130	4.971	MN	MN	MN
Ge-84g	1.2000	5.2055	0.0000	4	sys.	8.855	4.369	MN	W81	W81

As-84g	5.3000	0.0860	0.0430	3	meas.	9.872	8.681	W83	W83	W83
Ga-85g	0.0870	44.9654	0.0000	6	sys.	13.390	2.031	MN	MN	MN
Ge-85g	0.2500	16.4540	0.0000	6	BETA	11.050	4.226	MN	MN	W81
As-85g	2.0300	50.0000	50.0000	4	meas.	8.910	4.540	W83	W83	W83
Ge-86g	0.2470	15.2148	0.0000	6	sys.	9.450	2.911	MN	MN	MN
As-86g	0.9000	8.5030	1.6104	4	meas.	13.372	6.196	MN	W81	W81
Ge-87g	0.1339	15.1329	0.0000	6	sys.	12.610	4.861	MN	MN	MN
As-87g	0.3000	44.3600	20.2170	6	meas.	10.730	2.220	MN	MN	W81
Se-87g	5.6000	0.1880	0.0210	3	meas.	7.170	6.310	W83	W83	W83
Br-87g	55.7000	2.5400	0.1600	1	meas.	6.826	5.515	W83	W83	W83
Ge-88g	0.1290	21.6551	0.0000	6	sys.	10.850	2.531	MN	MN	MN
As-88g	0.1348	19.9068	0.0000	6	sys.	13.730	5.531	MN	MN	MN
Se-88g	1.5000	0.9660	0.0210	4	meas.	8.567	4.912	MN	W81	W81
Br-88g	16.0000	6.2600	0.3800	2	meas.	8.967	7.053	W83	W83	W83
As-89g	0.1212	33.2722	0.0000	6	sys.	11.910	2.761	MN	MN	MN
Se-89g	0.4270	7.7000	2.4000	5	meas.	11.378	5.573	MN	W81	W81
Br-89g	4.3800	14.0000	0.8400	3	meas.	8.300	5.110	W83	W83	W83
As-90g	0.0911	24.3493	0.0000	6	sys.	15.080	5.291	MN	MN	MN
Se-90g	0.5550	9.1321	0.0000	5	sys.	10.204	4.117	MN	W81	W81
Br-90g	1.8000	24.6000	1.8500	4	meas.	10.700	6.310	W83	W83	W83
Se-91g	0.2700	24.4382	0.0000	6	sys.	11.250	3.398	MN	MN	W81
Br-91g	0.6000	18.1000	1.4800	5	meas.	11.795	4.493	MN	W81	W81
Rb-91g	58.2000	0.0001	0.0000	1	sys.	5.859	5.796	W81	W81	W81
Se-92g	0.1682	13.2333	0.0000	6	sys.	9.480	3.181	MN	MN	MN
Br-92g	0.3600	42.7344	9.7464	5	meas.	13.963	5.350	MN	W81	W81
Kr-92g	0.3600	0.0332	0.0031	5	meas.	6.156	5.113	W83	W83	W83
Rb-92g	4.5300	0.0099	0.0005	3	meas.	8.120	7.366	W83	W83	W83
Se-93g	0.0968	12.0321	0.0000	6	sys.	12.440	5.271	MN	MN	MN
Br-93g	0.1760	25.0885	0.0000	6	sys.	12.211	3.518	MN	W81	W81
Kr-93g	1.2900	2.0100	0.1600	4	meas.	8.529	5.914	W83	W83	W83
Rb-93g	5.8600	1.3500	0.0700	3	meas.	7.442	5.237	W83	W83	W83
Br-94g	0.1108	29.8035	0.0000	6	sys.	13.580	4.411	MN	MN	W81
Kr-94g	0.2100	6.1300	2.4100	6	meas.	8.199	4.080	MN	W81	W81
Rb-94g	2.7600	10.0000	0.5000	4	meas.	10.307	6.786	W83	W83	W83
Br-95g	0.1069	27.0797	0.0000	6	sys.	11.990	3.271	MN	MN	MN
Kr-95g	0.7800	7.5051	0.0000	5	BETA	10.078	5.151	MN	W81	W81
Rb-95g	0.3800	8.6200	0.4200	5	meas.	9.282	4.330	W83	W83	W83
Br-96g	0.0888	21.9195	0.0000	6	sys.	14.960	5.491	MN	MN	MN
Kr-96g	0.2931	7.7473	0.0000	6	sys.	8.066	8.066	MN	W81	W81
Rb-96g	0.2040	14.0000	0.7100	6	meas.	11.750	5.860	W83	W83	W83
Sr-96g	1.1000	0.0011	0.0000	4	sys.	5.413	5.176	W81	W81	W81
Kr-97g	0.1000	8.3925	0.0000	6	sys.	10.331	5.086	MN	W81	W81
Rb-97g	0.1700	26.6000	1.4800	6	meas.	10.520	3.980	W83	W83	W83
Sr-97g	0.4000	0.0054	0.0021	5	meas.	7.470	6.040	W83	W83	W83
Y -97g	3.7000	0.0540	0.0028	3	meas.	6.680	5.579	W83	W83	W83
Y -97m	1.1100	0.1090	0.0300	4	meas.	0.000	0.000	Y97		
Kr-98g	0.1602	8.2989	0.0000	6	sys.	9.480	3.980	MN	W81	W81
Rb-98g	0.1100	13.3000	1.2000	6	meas.	12.430	5.760	W83	W83	W83
Sr-98g	0.6500	0.3260	0.0340	5	meas.	5.880	4.180	W83	W83	W83
Y -98g	2.0000	0.2280	0.0120	4	meas.	8.918	6.409	W83	W83	W83
Y -98m	0.6500	0.2280	0.9600	5	meas.	0.000	0.000	Y98		
Rb-99g	0.1450	17.1000	4.2000	6	meas.	11.320	3.760	W83	W83	W83
Sr-99g	0.6000	0.1290	0.1110	5	meas.	7.950	5.820	W83	W83	W83
Y -99g	1.4000	2.0200	1.4500	4	meas.	7.570	4.552	W81	W81	W81
Rb-100g	0.0984	4.9500	1.0200	6	meas.	13.733	6.053	MN	W81	W81
Sr-100g	0.6180	0.7430	0.0860	5	meas.	6.700	4.660	W83	W83	W83
Y -100g	0.8000	0.8420	0.0990	5	meas.	9.900	6.950	W83	W83	W83
Rb-101g	0.0939	28.3215	0.0000	6	sys.	12.310	3.178	MN	MN	W81
Sr-101g	0.1941	2.4700	0.2800	6	meas.	9.026	5.605	MN	W81	W81
Y -101g	0.6071	2.0500	0.2300	5	meas.	8.720	4.525	W81	W81	W81
Sr-102g	0.2871	4.7600	2.2900	6	meas.	8.830	5.005	MN	MN	W81
Y -102g	0.9000	5.9400	1.7100	4	meas.	10.442	6.727	MN	W81	W81
Sr-103g	0.1196	8.8758	0.0000	6	sys.	11.590	5.491	MN	MN	MN
Y -103g	0.2604	12.3656	0.0000	6	sys.	8.879	3.929	MN	W81	W81
Zr-103g	1.3377	0.0242	0.0000	4	sys.	7.500	6.839	W81	W81	W81
Nb-103g	1.5000	0.0137	0.0000	4	sys.	5.500	5.120	W83	W83	W83

Sr-104g	0.1629	13.4698	0.0000	6	sys.	10.150	3.371	MN	MN	MN
Y -104g	0.1283	8.7769	0.0000	6	sys.	11.890	6.382	MN	MN	W81
Zr-104g	2.5730	0.1824	0.0000	4	sys.	5.846	4.728	MN	W81	W81
Nb-104g	4.8000	0.0406	0.0000	3	sys.	8.700	7.940	W83	W83	W83
Y -105g	0.1469	19.7529	0.0000	6	sys.	10.430	3.591	MN	MN	MN
Zr-105g	0.4930	1.0879	0.0000	5	BETA	8.285	6.030	MN	W81	W81
Nb-105g	2.8000	2.2322	0.0000	4	sys.	7.000	4.730	W83	W83	W83
Y -106g	0.0894	15.6613	0.0000	6	sys.	13.100	5.721	MN	MN	MN
Zr-106g	0.9071	1.5242	0.0000	4	sys.	7.230	4.667	MN	MN	W81
Nb-106g	1.0000	0.9402	0.0000	4	sys.	10.099	7.766	MN	W81	W81
Y -107g	0.0923	25.9442	0.0000	6	sys.	11.700	3.261	MN	MN	MN
Zr-107g	0.2430	3.7127	0.0000	6	sys.	9.900	5.931	MN	MN	MN
Nb-107g	0.7660	8.7806	0.0000	5	sys.	8.324	4.156	MN	W81	W81
Zr-108g	0.3781	7.0302	0.0000	5	sys.	8.590	3.841	MN	MN	MN
Nb-108g	0.2423	6.4669	0.0000	6	sys.	10.810	6.327	MN	MN	W81
Mo-108g	1.5000	0.0001	0.0000	4	sys.	5.251	5.228	MN	W81	W81
Zr-109g	0.1300	7.3940	0.0000	6	sys.	10.940	5.501	MN	MN	MN
Nb-109g	0.3154	12.6533	0.0000	5.	sys.	9.340	4.031	MN	MN	MN
Mo-109g	1.4090	0.1359	0.0000	4	sys.	8.189	6.970	MN	W81	W81
Tc-109g	1.4000	0.0879	0.0000	4	sys.	5.900	5.180	W83	W83	W83
Nb-110g	0.1298	10.0525	0.0000	6	sys.	11.900	6.121	MN	MN	MN
Mo-110g	2.7720	1.3758	0.0000	4	sys.	6.010	3.942	MN	MN	W81
Tc-110g	0.8300	0.6210	0.0000	4	sys.	9.646	7.689	MN	W81	W81
Nb-111g	0.1718	18.3948	0.0000	6	sys.	10.710	3.781	MN	MN	MN
Mo-111g	0.4664	1.0303	0.0000	5	sys.	8.280	6.051	MN	MN	MN
Tc-111g	1.9824	5.6954	0.0000	4	sys.	8.147	4.552	MN	W81	W81
Mo-112g	0.9754	2.0788	0.0000	4	sys.	7.060	4.321	MN	MN	MN
Tc-112g	0.4314	5.2031	0.0000	5	sys.	10.010	6.184	MN	MN	W81
Mo-113g	0.2287	3.7966	0.0000	6	sys.	9.940	5.911	MN	MN	MN
Tc-113g	0.6524	7.1864	0.0000	5	sys.	8.590	4.491	MN	MN	MN
Ru-113g	3.0000	0.0005	0.0000	4	sys.	7.391	7.185	MN	W81	W81
Tc-114g	0.2023	6.5358	0.0000	6	sys.	11.320	6.511	MN	MN	MN
Ru-114g	8.1365	0.1039	0.0000	3	sys.	5.420	4.540	MN	MN	W81
Rh-114g	1.7000	0.0020	0.0000	4	sys.	8.263	7.963	MN	W81	W81
Tc-115g	0.2704	14.3371	0.0000	6	sys.	9.930	4.001	MN	MN	MN
Ru-115g	0.8784	0.2276	0.0000	4	sys.	8.170	6.751	MN	MN	MN
Rh-115g	8.3154	0.7746	0.0000	3	sys.	6.405	4.893	MN	W81	W81
Tc-116g	0.1155	12.2226	0.0000	6	sys.	12.670	6.011	MN	MN	MN
Ru-116g	1.7004	1.0811	0.0000	4	sys.	6.730	4.571	MN	MN	MN
Rh-116g	0.9492	0.5379	0.0000	4	sys.	9.417	7.583	MN	W81	W81
Tc-117g	0.1518	21.2499	0.0000	6	sys.	11.010	3.531	MN	MN	MN
Ru-117g	0.3428	2.0509	0.0000	5	sys.	9.480	6.281	MN	MN	MN
Rh-117g	1.2174	4.8201	0.0000	4	sys.	7.530	4.395	MN	MN	W81
Ru-118g	0.6623	4.1092	0.0000	5	sys.	7.800	4.111	MN	MN	MN
Rh-118g	0.3156	2.9167	0.0000	5	sys.	10.380	6.961	MN	MN	MN
Ru-119g	0.1950	4.3580	0.0000	6	sys.	10.460	6.001	MN	MN	MN
Rh-119g	0.4654	8.2971	0.0000	5	sys.	8.740	4.361	MN	MN	MN
Pd-119g	1.7587	0.0001	0.0000	4	sys.	7.160	7.060	MN	W81	W81
Ag-119g	2.1000	0.0001	0.0000	4	sys.	5.370	5.300	W81	W81	W81
Ru-120g	0.3503	7.5652	0.0000	5	sys.	8.940	3.891	MN	MN	MN
Rh-120g	0.1725	5.9282	0.0000	6	sys.	11.590	6.741	MN	MN	MN
Pd-120g	3.9065	0.0068	0.0000	3	sys.	5.687	5.269	MN	W81	W81
Ag-120g	1.1700	0.0015	0.0000	4	m<.003	8.210	8.109	W81	W81	W81
Rh-121g	0.2496	13.5677	0.0000	6	sys.	10.160	4.151	MN	MN	MN
Pd-121g	0.6437	0.2722	0.0000	5	sys.	8.331	6.795	MN	W81	W81
Ag-121g	0.8000	0.0753	0.0048	5	meas.	6.400	5.050	W83	W83	W83
Rh-122g	0.1071	8.3012	0.0000	6	sys.	12.900	6.781	MN	MN	MN
Pd-122g	1.4112	0.4377	0.0000	4	sys.	6.280	4.731	MN	MN	W81
Ag-122g	1.5000	0.1840	0.0110	4	meas.	9.427	7.768	MN	W81	W81
Rh-123g	0.1343	17.1070	0.0000	6	sys.	10.990	3.961	MN	MN	MN
Pd-123g	0.3004	0.6897	0.0000	5	sys.	9.410	7.091	MN	MN	MN
Ag-123g	0.3900	0.5450	0.0340	5	meas.	7.730	5.394	MN	MN	W81
Pd-124g	0.5140	2.6986	0.0000	5	sys.	7.500	4.361	MN	MN	MN
Ag-124g	0.2495	2.2881	0.0000	6	sys.	10.780	7.411	MN	MN	MN
Pd-125g	0.1660	2.2664	0.0000	6	sys.	10.310	6.671	MN	MN	MN
Ag-125g	0.3335	6.3167	0.0000	5	sys.	8.830	4.721	MN	MN	MN

Pd-126g	0.2520	5.0310	0.0000	6	sys.	8.690	4.331	MN	MN	MN
Ag-126g	0.1398	4.6380	0.0000	6	sys.	11.500	7.001	MN	MN	MN
Ag-127g	0.1753	9.8629	0.0000	6	sys.	9.840	4.541	MN	MN	MN
Cd-127g	0.5719	0.0101	0.0000	5	sys.	7.720	7.178	MN	W81	W81
In-127g	3.7600	0.6600	0.0630	3	meas.	6.494	5.555	W83	W83	W83
In-127m	1.3000	0.0001	0.0000	4	In-127	0.000	0.000	In-127		
Ag-128g	0.0943	6.8861	0.0000	6	sys.	12.050	6.691	MN	MN	MN
Cd-128g	1.0530	0.1215	0.0000	4	sys.	6.049	5.021	MN	W81	W81
In-128g	0.8400	0.0610	0.0370	4	meas.	9.310	7.880	W83	W83	W83
Cd-129g	0.2987	0.1519	0.0000	6	sys.	8.468	7.140	MN	W81	W81
In-129g	0.9900	2.9200	0.3700	4	meas.	7.600	5.390	W83	W83	W83
In-129m	2.5000	0.7600	2.5000	4	meas.	0.000	0.000	In-129		
Cd-130g	0.4767	0.9676	0.0000	5	sys.	7.295	5.029	MN	W81	W81
In-130g	0.5800	1.0400	0.9500	5	meas.	10.200	7.630	W83	W83	W83
In-130m	0.5100	1.4800	0.1050	5	meas.	0.000	0.000	In-130		
Cd-131g	0.1062	4.8728	0.0000	6	sys.	12.068	6.635	MN	W81	W81
In-131g	0.2800	1.8400	1.0700	6	meas.	8.820	5.250	W83	W83	W83
In-131m	0.1110	1.7300	0.2400	6	meas.	0.000	0.000	In-131		
Cd-132g	0.1357	20.5597	0.0000	6	sys.	11.820	2.893	MN	MN	W81
In-132g	0.1200	5.3600	0.8300	6	meas.	13.235	7.308	MN	W81	W81
In-133g	0.1116	31.6560	0.0000	6	sys.	12.600	2.777	MN	MN	W81
Sn-133g	1.4700	0.2549	0.0000	4	sys.	9.050	7.380	W83	W83	W83
In-134g	0.0806	33.7565	0.0000	6	sys.	14.740	3.841	MN	MN	MN
Sn-134g	1.0400	18.3000	13.9000	4	meas.	6.925	3.091	MN	W81	W81
Sb-134g	10.2000	0.1040	0.0350	2	meas.	8.410	7.500	W83	W83	W83
Sn-135g	0.4180	9.2929	0.0000	5	sys.	9.580	4.507	MN	MN	W81
Sb-135g	1.8200	17.8700	2.1600	4	meas.	7.540	3.510	W83	W83	W83
Sn-136g	0.7172	16.3918	0.0000	5	sys.	8.300	2.431	MN	MN	MN
Sb-136g	0.8200	28.9788	3.1138	4	meas.	9.611	4.642	MN	W81	W81
Te-136g	19.0000	1.1400	0.4300	2	meas.	5.100	3.760	W83	W83	W83
Sb-137g	0.4780	18.0322	0.0000	5	sys.	9.020	3.270	MN	MN	W81
Te-137g	3.5000	2.6900	0.6300	3	meas.	7.020	5.070	W83	W83	W83
I -137g	24.5000	6.9700	0.4200	2	meas.	5.885	4.025	W83	W83	W83
Sb-138g	0.1734	22.0114	0.0000	6	sys.	11.610	4.371	MN	MN	MN
Te-138g	1.6000	6.7800	2.2600	4	meas.	6.432	3.913	MN	W81	W81
I -138g	6.5000	5.3800	0.4300	3	meas.	7.820	5.820	W83	W83	W83
Sb-139g	0.2178	41.6934	0.0000	6	sys.	9.640	1.721	MN	MN	MN
Te-139g	0.5800	7.9624	0.0000	5	sys.	9.321	4.610	MN	W81	W81
Te-140g	0.8038	15.4961	0.0000	4	sys.	7.360	2.240	MN	MN	W81
I -140g	0.8600	9.2700	0.7900	4	meas.	9.967	5.392	MN	W81	W81
Te-141g	0.2726	10.4723	0.0000	6	sys.	10.050	4.491	MN	MN	MN
I -141g	0.4600	21.3000	3.2000	5	meas.	8.892	3.417	MN	W81	W81
Xe-141g	1.7200	0.0353	0.0061	4	meas.	6.155	5.510	W83	W83	W83
Cs-141g	24.9000	0.0474	0.0550	2	meas.	5.256	4.548	W83	W83	W83
Te-142g	0.5901	15.0790	0.0000	5	sys.	8.330	2.581	MN	MN	MN
I -142g	0.2000	13.8601	0.0000	6	sys.	11.553	5.242	MN	W81	W81
Xe-142g	1.2200	0.4040	0.0380	4	meas.	5.040	4.146	W83	W83	W83
Cs-142g	1.6900	0.0949	0.0940	4	meas.	7.320	6.210	W83	W83	W83
I -143g	0.4010	38.4989	0.0000	5	sys.	8.900	1.819	MN	MN	W81
Xe-143g	0.9600	3.0557	0.0000	4	sys.	8.510	5.289	MN	W81	W81
Cs-143g	1.7800	1.6000	0.0800	4	meas.	6.280	4.240	W83	W83	W83
I -144g	0.1460	15.2394	0.0000	6	sys.	11.280	4.971	MN	MN	MN
Xe-144g	1.1000	4.6118	0.0000	4	sys.	7.236	3.697	MN	W81	W81
Cs-144g	1.0010	3.1300	0.1700	4	meas.	8.460	5.870	W83	W83	W83
I -145g	0.1934	24.0859	0.0000	6	sys.	9.930	2.930	MN	MN	MN
Xe-145g	0.9000	6.1090	0.0000	4	sys.	9.191	4.886	MN	W81	W81
Cs-145g	0.5900	13.5900	0.9000	5	meas.	7.800	4.240	W83	W83	W83
Xe-146g	0.5627	6.5048	0.0000	5	sys.	8.122	3.732	MN	W81	W81
Cs-146g	0.3400	13.3000	1.7200	5	meas.	9.410	5.130	W83	W83	W83
Ba-146g	2.0000	0.0100	0.0000	4	m<0.02	4.270	3.770	**		
La-146g	11.0000	0.0035	0.0000	2	m<.007	6.650	6.591	MN	MN	MN
Xe-147g	0.1991	8.7056	0.0000	6	sys.	10.151	4.810	MN	W81	W81
Cs-147g	0.5460	26.1000	2.5000	5	meas.	8.880	4.240	W83	W83	W83
Ba-147g	1.7550	0.0210	0.0020	4	meas.	5.710	5.670	W83	W83	W83*
La-147g	5.0000	0.0330	0.0060	3	meas.	5.190	4.480	W83	W83	W83
Cs-148g	0.2056	25.1000	2.8000	6	meas.	11.777	5.766	MN	W81	W81

Ba-148g	3.3250	0.0060	0.0020	3	meas.	5.400	5.010	W83	W83	W83
La-148g	1.3000	0.1330	0.0100	4	meas.	6.500	6.320	W83	W83	W83
Cs-149g	0.2442	32.7567	0.0000	6	sys.	9.420	2.195	MN	MN	W81
Ba-149g	0.6950	0.5750	0.0840	5	meas.	7.800	5.800	W83	W83	W83
La-149g	2.4080	1.0600	0.1400	4	meas.	6.100	4.950	W83	W83	W83
Cs-150g	0.1238	15.0881	0.0000	6	sys.	11.480	5.021	MN	MN	MN
Ba-150g	0.9620	10.9278	0.0000	4	sys.	6.740	2.504	MN	MN	W81
La-150g	0.6080	0.3991	0.0000	5	sys.	7.620	6.300	W83	W83	W83
Ba-151g	0.3327	3.7569	0.0000	5	sys.	8.760	5.211	MN	MN	MN
La-151g	0.7194	6.5495	0.0000	5	sys.	7.670	4.089	MN	MN	W81
Ba-152g	0.4205	5.7209	0.0000	5	sys.	7.680	3.681	MN	MN	MN
La-152g	0.2850	6.0393	0.0000	6	sys.	9.650	5.661	MN	MN	MN
La-153g	0.3258	10.6885	0.0000	5	sys.	8.640	3.901	MN	MN	MN
Ce-153g	1.4688	0.6219	0.0000	4	sys.	7.040	5.404	MN	MN	W81
La-154g	0.1493	10.2702	0.0000	6	sys.	10.680	5.381	MN	MN	MN
Ce-154g	2.0161	0.6373	0.0000	4	sys.	6.030	4.371	MN	MN	MN
Pr-154g	1.0614	0.1110	0.0000	4	sys.	7.575	6.668	MN	W81	W81
La-155g	0.1540	16.7592	0.0000	6	sys.	9.600	3.511	MN	MN	MN
Ce-155g	0.5278	1.6004	0.0000	5	sys.	8.050	5.531	MN	MN	MN
Pr-155g	1.1224	1.5427	0.0000	4	sys.	6.790	4.746	MN	MN	W81
Ce-156g	0.5963	2.9922	0.0000	5	sys.	7.000	3.981	MN	MN	MN
Pr-156g	0.3793	2.7170	0.0000	5	sys.	8.780	5.971	MN	MN	MN
Ce-157g	0.2144	4.4528	0.0000	6	sys.	9.050	5.171	MN	MN	MN
Pr-157g	0.3800	6.3874	0.0000	5	sys.	7.750	4.141	MN	MN	MN
Pr-158g	0.1685	6.4230	0.0000	6	sys.	9.810	5.641	MN	MN	MN
Nd-158g	2.6949	0.0053	0.0000	4	sys.	4.960	4.621	MN	MN	MN
Pr-159g	0.1806	12.3634	0.0000	6	sys.	8.720	3.711	MN	MN	MN
Nd-159g	0.6146	0.2361	0.0000	5	sys.	7.090	5.841	MN	MN	MN
Pm-159g	3.0005	0.0185	0.0000	3	sys.	5.290	4.871	MN	MN	W81
Nd-160g	0.7886	0.9469	0.0000	5	sys.	5.990	4.141	MN	MN	MN
Pm-160g	0.7289	0.2676	0.0000	5	sys.	7.430	6.281	MN	MN	MN
Nd-161g	0.3113	1.6982	0.0000	5	sys.	8.020	5.461	MN	MN	MN
Pm-161g	0.7899	1.7504	0.0000	5	sys.	6.360	4.391	MN	MN	MN
Pm-162g	0.3243	2.1452	0.0000	5	sys.	8.400	5.911	MN	MN	MN
Sm-164g	1.3850	0.0124	0.0000	4	sys.	5.010	4.571	MN	MN	MN
Eu-164g	1.5327	0.0001	0.0000	4	sys.	6.590	6.571	MN	MN	MN
Sm-165g	0.4536	0.2491	0.0000	5	sys.	6.930	5.691	MN	MN	MN
Eu-165g	1.3546	0.1911	0.0000	4	sys.	5.650	4.751	MN	MN	MN

This table contains the latest evaluated Pn values (1/7/87). Values indicated as derived from systematics are based on a least squares fit of the evaluated Pn values to the parameters in the Herrmann-Kratz equation as given in Kratz, K.-L., and Herrmann, G., "Systematics of Neutron Emission Probabilities from Delayed Neutron Precursors," Z. Physik 263, 435 (1973). This equation can be expressed: Pn = a[(QB - S(n))/(QB - K)]**b, where (b = 3.44) and (a = 54.0) from a new fit to the evaluated Pn's resulting from the Birmingham meeting Sept 1986 and K=0 for even-even precursor, 13/A**1/2 for even-odd precursor, and 26/A**1/2 for odd-odd precursor.

T 1/2 - half life in seconds, for nuclides with evap spec taken from ENDF/B-V
Pn - probability of delayed neutron emission in percent
dPn - uncertainty in Pn value (0.0000 for calculated values)
GP - lists which of six temporal groups the nuclide probably belongs in.
QB - Maximum beta decay energy of precursor (meV)
S(n) - neutron binding energy in daughter (meV)

M1 source of mass of Z,A
M2 source of mass of Z+1,A

MN - Moeller-Nix
W81 - Wapstra81

W83 - Wapstra83

* BETA Code would not execute with these mass values so Ba146 spectrum was used for Ba147.
** A fictitious S(n) was given this nuclide to obtain a positive energy window. Moeller-Nix masses give a negative energy window, however, this precursor has a measured Pn value.

Some thought was given to the method of including delayed neutron emission for more than seventy of the most important nuclides in the existing format. One problem faced is that Pn data is given for the precursors but we need to know it when processing the daughter. For instance, As-85 decays to Se-85 by beta decay and Se-84 by neutron emission. Se-84 is processed first since masses are processed one at a time in increasing order. A special box was created similar to a metastable state but labeled SE84D (for delayed neutron emission product). Pn for its formation from As-85 is listed in the third row of its decay scheme (Z-0 is the only empty space), and the RC row contains the absolute yield calculated from Pn multiplied by the As-85 cumulative yield from the previous iteration. Se-84 g contains the information in the third row of its decay scheme that 100.0% of Dn emission (Z-0 box) adds to Se-84 g cumulative yield. When processing mass 85, Se-85 has listed in the first row of its decay scheme that 68.8% (1-Pn) of Z-1 g (As-85) is to be added to its cumulative yield, instead of 100% (the other 31.2% having left this mass chain for mass chain 84). The facts are now correctly represented. The independent yields are all before delayed neutron emission. The cumulative yields are after delayed neutron emission. Also, the chain yield is redefined as the sum of the independent yields plus delayed neutron decay gains from the A+1 chain, minus the delayed neutron decay losses to the A-1 chain. Now the chain yields retain their traditional after-delayed-neutron-emission value as measured by traditional radiochemistry and mass spectrometry. A special problem arises for on-line mass spectrometers that measure instantaneous mass yields such as Hiawatha (76DII1). These pre-delayed-neutron chain yields must be corrected to post-delayed-neutron chain yields by hand.

One can predict the delayed neutron yield from delayed neutron precursor yields multiplied by probability of neutron emission, (Pn) summed over all 271 precursors. If the yields are correct, good agreement should be found between predicted and measured delayed neutron emission. Agreements for most types of fission evaluated are as follows:

Table 6.
Delayed Neutron Yields per 100 Fissions
Calculated Values Using Yields and Pn Values Listed in this Report

Fissionable Nuclide	Using Pn and yc	From Yield Evaluation	Waldo Fit	Fissionable Nuclide	Using Pn and yc	From Yield Evaluation	Waldo Fit
U235t	1.80 +- 0.17	1.67 +- 0.08	1.50	Th227t	0.59 +- 0.10	0.59 +- 0.07	0.72
U235f	1.70 +- 0.16	1.66 +- 0.09	1.50	Th229t	1.09 +- 0.19	1.06 +- 0.10	1.53
U235h	1.24 +- 0.19	1.18 +- 0.11	----	Pa231f	1.34 +- 0.20	1.32 +- 0.12	1.04
U238f	4.06 +- 0.34	3.85 +- 0.23	4.60	Am241t	0.55 +- 0.07	0.53 +- 0.06	0.46
U238h	2.72 +- 0.27	2.53 +- 0.16	----	Am241h	0.37 +- 0.07	0.34 +- 0.04	----
Pu239t	0.70 +- 0.04	0.68 +- 0.03	0.68	Am242t	0.74 +- 0.09	0.72 +- 0.07	0.67
Pu239f	0.61 +- 0.07	0.60 +- 0.05	0.68	Cm245t	0.70 +- 0.08	0.67 +- 0.06	0.66
Pu241t	1.29 +- 0.08	1.24 +- 0.06	1.45	Cf249t	0.28 +- 0.04	0.25 +- 0.03	0.30
U233t	0.71 +- 0.08	0.70 +- 0.06	0.70	Cf251t	0.82 +- 0.09	0.76 +- 0.08	0.65
Th232f	5.92 +- 0.97	5.78 +- 0.43	4.70	Es254t	0.77 +- 0.09	0.71 +- 0.07	0.64
U233f	0.67 +- 0.09	0.66 +- 0.07	0.70	Cf250s	0.42 +- 0.05	0.41 +- 0.05	0.30
U233h	0.70 +- 0.12	0.67 +- 0.08	----	Cm244s	0.43 +- 0.06	0.42 +- 0.05	0.31

U236f	2.06 +- 0.20	1.99 +- 0.15	2.17	Cm248s	1.49 +- 0.14	1.39 +- 0.12	1.41
Pu239h	0.53 +- 0.11	0.51 +- 0.07	----	Es253s	0.32 +- 0.04	0.31 +- 0.03	0.30
Pu240f	0.85 +- 0.99	0.83 +- 0.07	0.99	Fm254s	0.14 +- 0.03	0.13 +- 0.03	0.14
Pu241f	1.32 +- 0.13	1.27 +- 0.10	1.45	Fm255t	0.63 +- 0.08	0.60 +- 0.08	0.30
Pu242f	1.71 +- 0.17	1.61 +- 0.13	2.11	Fm256s	0.36 +- 0.05	0.34 +- 0.04	0.30
Th232h	5.48 +- 1.25	5.12 +- 0.32	----	Np237h	1.00 +- 0.12	0.96 +- 0.09	----
Np237f	1.18 +- 0.13	1.15 +- 0.10	1.01	U232t	0.43 +- 0.07	0.43 +- 0.05	0.49
Cf252s	0.66 +- 0.07	0.60 +- 0.05	0.65	U238s	4.64 +- 0.32	4.47 +- 0.28	3.17
U234f	0.94 +- 0.13	0.92 +- 0.11	1.02	Cm243t	0.46 +- 0.06	---- +- ----	----
U237f	2.87 +- 0.26	2.76 +- 0.21	3.17	Cm246s	0.68 +- 0.08	---- +- ----	----
Pu240h	0.67 +- 0.11	0.63 +- 0.07	----	Cm243f	0.28 +- 0.04	---- +- ----	----
U234h	0.72 +- 0.13	0.68 +- 0.08	----	Cm244f	0.46 +- 0.06	---- +- ----	----
U236h	1.58 +- 0.21	1.49 +- 0.14	----	Cm246f	1.07 +- 0.12	---- +- ----	----
Pu238f	0.60 +- 0.08	0.58 +- 0.06	0.47	Cm248f	2.08 +- 0.19	---- +- ----	----
Am241f	0.43 +- 0.05	0.42 +- 0.05	0.46	Pu242h	1.59 +- 0.21	---- +- ----	----
Am243f	0.83 +- 0.10	0.79 +- 0.09	0.98	Np237t	1.60 +- 0.16	---- +- ----	----
Np238f	1.77 +- 0.18	1.71 +- 0.16	1.47	Pu240t	0.89 +- 0.11	---- +- ----	----
Cm242f	0.17 +- 0.03	0.17 +- 0.03	0.21	Pu242t	1.90 +- 0.18	---- +- ----	----

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** Reference 92ENG1.

The calculation of delayed neutrons is very sensitive to the amount of odd-even effect (proton and neutron pairing effect) applied. U235 and Pu239 delayed neutron calculations are in good agreement. U238F and TH232F are low. These have large pairing effects that result from the use of fission neutron energies that are very close to large fission threshold energies. The model for energy dependence of pairing tends to blow-up near the fission threshold and is very sensitive to assumed fission neutron energy. Inadequate pairing treatment may therefore account for these poorer agreements.

The moving force behind the 1993 revision was decay heat calculation by summation codes such as CINDER-10 that use fission yields, decay constants, and heat of disintegration (Q values). A test of goodness for independent yields is whether such summation agrees with experiment. The original 1974 fit was good except at 10 and 15 seconds where calculations were low. An important thrust of the 1978 revision was to improve the fit below 15 seconds. Four sources of error in ENDF/B-IV yields were suspected to be responsible for the 4% underestimate at 10 seconds:

1. Ternary Fission was not treated. Ternary fission carries a small amount of charge away. This means Zp's must be lowered a bit.

2. Charge balance tests showed some Zp values were slightly high. If Zp is reduced to a proper value, the yields on the left shoulder of the Gaussian charge distribution rise abruptly where very short-lived energetic nuclides are found far from stability. The right shoulder yields fall where long-lived low energy nuclides are found near stability.

3. Independent yields were arbitrarily split 50-50 between short lived metastable states and long-lived ground states. In several measured cases like Xe-133, Xe-135 and Te-133, the short half-life (high energy) metastable state is favored.

4. Delayed neutrons were not treated, and 264 out of 271 of the delayed neutron precursors have half-lives under 10 seconds.

By correcting these shortcomings, ENDF/B-VI (ENDF-349) yields have greatly improved agreement down to 6 seconds. The refinement effort appears to have been worth while. It has contributed toward development of a new ANS Decay Heat Standard with errors reduced from 20% in the 1973 Standard to under 2% in the 1993 Standard.

Recommended Yields

The weighted average experimental independent yields, the weighted average experimental cumulative yields, and the calculated cumulative yields (where no data were available) were combined statistically to form a single, self-consistent recommended value. The following is a summary of the procedure used to obtain the recommended values. The calculated charge distribution was used only when no data were available. Even then it was normalized to the nearest experimentally determined yields to ensure the experimental and recommended values will closely agree. A large error was assumed for the calculated yields to ensure any respectable data would dominate. The contributions of all precursors were added. The total precursor contribution was then subtracted from the experimental cumulative yield when available or the normalized calculated yield to obtain an independent yield. (Note: independent yields so obtained which are less than 0.1% are given no weight and negative values are discarded). This independent yield was then averaged with the experimental independent yield (if available) or the calculated independent yield and stored for later use. A cumulative yield was then obtained by adding the precursor contribution to the independent yield just obtained. This cumulative yield was averaged with the experimental cumulative yields (if available) or the calculated cumulative yield to obtain a cumulative yield. This cumulative yield was stored as input for the next member of the chain. After this procedure had been done for all members of the chain, the chain yield was obtained by adding the stored cumulative yields of all stable nuclides. The stored independent yields were then normalized so that their total equals the chain yield (after adjustment for delayed neutron emission). The recommended cumulative yields were obtained by adding the independent yield of all precursors to the independent yield of the nuclide. The total of the chain yields of each peak was then obtained. The difference between 100% and this total was distributed among the chain yields in proportion to their variances. This method ensures the reported chain yields will total 100%. This procedure preserves the independent yield significance of the differences between the recommended yields. It also allows unstable nuclides to affect the chain yields if independent yields have been determined, or if the calculated charge distribution shows the yield of the nuclide to be very near the chain yield.

ENDF/B-VI and Mass Chain Yields

As noted, the evaluated and compiled yields and distribution parameters (sigma, Zp, branchings, etc) are available for 60 yield sets in groups of 10 fissioning systems in the six appendices. All measured data are also listed in the appendices. Any user consulting these files should also check the reference indicated there in the annotated bibliography to possibly explain the reason for any change (update) to measured data.

We are making the compiled data freely available to users. These data have been collected over several decades and updated or corrected as noted in the bibliography and appendices. We request that users of these computer files acknowledge this printed document and also inform the authors of any errors or new data.

The recommended and cumulative yields (RI and RC lines in the appendices) are the basis for the second evaluation and release of ENDF/B-VI (1993). Values in ENDF/B-VI have been extended to cover all nuclides in the ENDF/B-VI decay files and also four charge units from Zp, but the extension does not alter the values in this document for the specific nuclides listed in the appendices.

ENDF/B-VI does not contain mass chain yields and these are difficult to determine from the RI and RC values using decay branchings from decay files. Tables 7 through 12 below list the chain yields. The letters a-p following the yield values indicate the accuracy of weighted yields; these are defined in a later section of this document.

Table 7
Set A Mass Chain Yields

mass	u235t	u235f	u235he	u238f	u238he	pu239t	pu239f	pu241t	u233t	th232f
66	7.22e-08n	7.23e-07m	0.000288j	3.71e-06n	7.82e-05k	2.21e-07o	8.68e-07l	1.67e-07l	2.50e-07o	1.13e-06n
67	3.61e-07m	2.32e-06m	0.000604j	2.15e-05n	0.000139l	4.48e-07n	2.87e-06l	5.05e-07l	1.12e-06o	3.90e-06n
68	7.16e-07n	4.03e-06m	0.000887k	2.80e-05n	0.000299l	1.62e-06n	8.42e-06l	1.41e-06l	3.43e-06o	1.43e-05n
69	1.57e-06n	8.70e-06m	0.001320n	3.58e-05n	0.000501l	5.89e-06n	3.12e-05l	3.64e-06l	9.41e-06o	3.30e-05n
70	3.62e-06m	1.89e-05m	0.002361k	4.41e-05m	0.000901l	1.99e-05m	8.69e-05l	1.40e-05l	3.67e-05o	6.54e-05m
71	8.38e-06n	4.65e-05m	0.003946k	4.95e-05n	0.001592l	3.67e-05n	0.000203n	5.24e-05l	0.000162o	0.000166m
72	2.65e-05k	0.000166m	0.006014j	6.05e-05n	0.002706k	0.000122o	0.000520n	2.43e-05m	0.000416n	0.000414l
73	0.000102m	0.000524l	0.011346k	0.000206m	0.005230k	0.000262m	0.000706m	5.78e-05l	0.001155l	0.000621l
74	0.000339m	0.001190m	0.017011k	0.000277n	0.008006l	0.000636n	0.001736l	9.48e-05m	0.002708m	0.001154l
75	0.001067k	0.003530m	0.026986k	0.000462n	0.013869l	0.001372l	0.002548m	0.000284m	0.007981m	0.002835l
76	0.003097j	0.017577k	0.040021k	0.000800m	0.021990l	0.002936l	0.005810l	0.000948m	0.013847m	0.006739l
77	0.007961j	0.031808k	0.066594k	0.003301k	0.031293j	0.007235k	0.012692j	0.001896m	0.025959l	0.011765j
78	0.020966j	0.057118k	0.099752k	0.011222m	0.057133l	0.018776m	0.022929m	0.011521l	0.053838l	0.035280k
79	0.044732i	0.090857k	0.167953k	0.032673m	0.133283l	0.043651f	0.060771j	0.014959l	0.143515l	0.076873k
80	0.128832h	0.175956k	0.253418k	0.042741l	0.212880l	0.093888m	0.092512l	0.029235l	0.234071l	0.194213l
81	0.203680g	0.228000k	0.341500k	0.086208m	0.333000k	0.183643l	0.141870k	0.062121l	0.367786h	0.469835k
82	0.324569g	0.340196k	0.593200k	0.213784l	0.453127l	0.229687m	0.218850j	0.136745j	0.586339g	1.075426l
83	0.536435b	0.576795d	1.100956h	0.396237e	0.667981g	0.296793b	0.315587c	0.201544e	1.014543d	2.169280f
84	1.002093c	1.030822e	1.509030k	0.825770e	1.123985g	0.480359d	0.498717d	0.351325f	1.689426d	4.026097e
85	1.318713a	1.363796c	1.666312g	0.743050d	1.005966e	0.574068a	0.604191b	0.406488e	2.237148d	4.167428e
86	1.965113b	1.946855d	1.828273m	1.296448d	1.571025g	0.766201b	0.789466d	0.594552f	2.844415e	6.587601f
87	2.560298b	2.543847d	2.450685h	1.625506d	1.686410f	1.003923b	1.043375d	0.752828f	4.018205e	7.073593g
88	3.575006c	3.494430c	3.430017i	2.028030e	2.175602f	1.329789d	1.329720c	0.990303e	5.465197e	7.260472f
89	4.733074d	4.373684e	4.123095g	2.761051e	2.921217f	1.722836f	1.725338f	1.233109g	6.340165e	7.467815g
90	5.782353d	5.465049c	4.594181g	3.246924e	3.189564g	2.104298f	2.048497c	1.535820e	6.789072e	7.924058h
91	5.828245c	5.733461c	4.823241h	4.039440f	3.867595f	2.486500d	2.516537d	1.864133e	6.485957d	7.363992f
92	6.021674c	5.846002c	5.103359j	4.312441g	3.879351f	3.009177c	3.037739c	2.308494e	6.552445d	6.920399g
93	6.346743c	6.254059c	5.193751i	4.913253f	4.529122g	3.797575c	3.825724c	2.978050e	6.978996d	6.697280h
94	6.472653c	6.300219c	5.097699k	4.610062g	4.694998i	4.321833d	4.233177c	3.391152e	6.831345e	5.562996h
95	6.503326c	6.432034b	5.175438g	5.140443d	4.891811f	4.818517d	4.671429d	3.925621e	6.349605d	5.652666f
96	6.340230d	6.202490c	5.207079j	6.017329h	5.575470k	4.893751d	4.856321c	4.401147e	5.678962d	4.776764l
97	5.997223c	6.002914b	5.520253i	5.562461c	5.280014e	5.414114d	5.297278b	4.801799e	5.515746d	4.425500f
98	5.790300c	5.923745b	5.436396k	5.944993d	5.464244k	5.830892d	5.633049c	5.035685f	5.189312d	3.680042i
99	6.109164d	5.943191d	5.136274g	6.168192e	5.705377d	6.211806e	5.982639f	5.961885f	4.910973e	2.944060f
100	6.292781c	6.298379d	3.950416k	6.697326d	4.998117k	6.774621e	6.544341c	6.254494f	4.459033e	1.370638i
101	5.172919d	5.124290e	3.452705k	6.209007e	5.697793g	6.019171e	6.669887d	6.231942f	3.171242e	0.713542k
102	4.298778d	4.359081d	3.254026k	6.447346d	4.621668j	6.126339e	6.731884d	6.655272f	2.402804d	0.367805k
103	3.031149d	3.243933e	3.205137g	6.275279e	4.615807f	6.994895f	6.829040e	6.776879g	1.573207f	0.155461h
104	1.880825d	2.072379d	2.479191l	5.035980d	4.026081h	6.094829d	6.584723c	7.179518f	0.980193f	0.090313k
105	0.964228e	1.196323g	1.872265h	4.051243e	3.215881e	5.643815f	5.361104g	6.074350g	0.495809g	0.051481g
106	0.401576d	0.532399d	1.609732h	2.489722e	2.454599g	4.350214f	4.365499e	6.103987f	0.246245f	0.048561j
107	0.146202g	0.302329k	1.285484k	1.445866j	1.694368i	3.330057h	3.221088i	4.886322j	0.114532h	0.051075k
108	0.054129h	0.130816l	1.178097k	0.601420l	1.222461l	2.163956h	2.002769j	3.769599j	0.075767h	0.061347l
109	0.031223i	0.081546h	1.173138i	0.252140i	1.122826i	1.477898h	1.036285k	2.587597h	0.039405l	0.066215h
110	0.025445h	0.064915l	1.083704k	0.140760l	1.027439k	0.645132i	0.647332j	1.325114j	0.038664h	0.070997l
111	0.017432g	0.042577f	1.079385g	0.071214f	0.992245g	0.295993f	0.357018e	0.585511g	0.021600j	0.071619i
112	0.013043h	0.037712f	1.075936j	0.055901h	1.032693g	0.128508f	0.188927f	0.218486g	0.013304j	0.078263i
113	0.014205h	0.032614g	1.091408j	0.046111k	0.914336i	0.081664g	0.127662f	0.151924h	0.013562k	0.078066h
114	0.011833h	0.032294g	1.057132k	0.039257l	0.718885k	0.060254g	0.094265f	0.071086m	0.012860k	0.073423l
115	0.012584g	0.033878g	1.091665g	0.037548f	0.857044g	0.042600i	0.081409h	0.038087j	0.014982i	0.077003g
116	0.013249h	0.034004f	1.056328k	0.039314k	0.675634k	0.050678j	0.060358g	0.027787n	0.013202l	0.073801l
117	0.012762h	0.036819j	1.065332j	0.037732k	0.604700h	0.044459j	0.069871j	0.023626k	0.014124k	0.073822g
118	0.011346j	0.033632j	1.081950k	0.043176k	0.831012k	0.032488k	0.059864k	0.023157n	0.015417k	0.063281k

119	0.012874j	0.035020j	1.084139k	0.039720k	0.725951k	0.032249j	0.055017k	0.023156n	0.018558l	0.057210l
120	0.012609j	0.035292j	1.090448k	0.038713k	0.777414k	0.030585k	0.055690k	0.025623m	0.021829j	0.054327l
121	0.013047i	0.036811j	1.054143h	0.036927j	0.833461h	0.037808j	0.063088k	0.025882n	0.023082j	0.048821i
122	0.015485j	0.040409k	1.146120k	0.041073k	0.850253k	0.044695j	0.069905k	0.025882n	0.040969j	0.036527l
123	0.015658g	0.044063k	1.192724k	0.044534l	0.921818k	0.044120l	0.076809k	0.026704n	0.060415m	0.029354l
124	0.026788j	0.063333k	1.290173k	0.046461k	1.034995k	0.078717k	0.120774k	0.032352n	0.074624l	0.026475l
125	0.034022f	0.068030i	1.460497j	0.048524i	1.196325h	0.111659j	0.177846j	0.046901j	0.116962j	0.032954k
126	0.058518j	0.097545j	1.863928h	0.054089i	1.325201l	0.202324i	0.266786i	0.082238m	0.226118j	0.048129l
127	0.156991g	0.306279f	2.179644g	0.136294h	1.493819i	0.506298i	0.500864j	0.232387h	0.555457k	0.101355h
128	0.348840g	0.504501j	2.456115j	0.286086i	1.947001j	0.734121k	0.879000i	0.379232m	0.836918j	0.182599l
129	0.543386d	0.835170h	3.375012j	1.011337i	2.077459i	1.371454h	1.451065i	0.819952m	1.591337l	0.252076h
130	1.810633f	1.794634h	3.599778j	1.913653i	3.149253l	2.361688j	2.454095i	1.818825k	2.091632k	0.945582k
131	2.890898b	3.219551c	4.103087g	3.290794d	3.992440e	3.856439b	3.878424b	3.100837e	3.604300c	1.620949f
132	4.313407a	4.671072b	4.886339g	5.147494e	4.838119d	5.406858b	5.329531c	4.564343e	4.953559c	2.968856e
133	6.699915a	6.724035b	5.529694i	6.762707b	6.017644e	7.016466b	6.971140b	6.729190c	5.950570d	4.046220f
134	7.872644b	7.666747b	5.715190g	7.609406g	6.453250f	7.676881b	7.382961b	7.917365e	6.306880c	5.351795f
135	6.539455a	6.601362c	5.729764i	6.967573c	5.841928f	7.621001c	7.554585b	7.170771d	6.265223e	5.528784f
136	6.318709a	6.227129b	5.302789h	6.979834f	5.645631f	7.143924d	7.063767d	7.105131e	6.905353d	5.621469f
137	6.188944b	6.221562a	4.948814g	6.052506c	5.146585f	6.613842b	6.590226b	6.650911c	6.757385c	5.839457h
138	6.768035b	6.680526c	4.593901i	5.762451e	4.883588g	6.124533d	6.126624c	6.605149d	5.907377f	6.449821i
139	6.413852c	6.343309b	4.810269h	5.670141d	5.049720f	5.637200g	5.611585e	6.217390f	6.305604g	7.096623f
140	6.220169b	5.977979c	4.528971g	5.815266c	4.611131e	5.364788d	5.333198c	5.766685e	6.424816e	7.877878f
141	5.847414d	5.949134e	4.486032h	5.336511f	4.381533f	5.246968f	5.147149g	4.905772e	6.480480g	7.463862g
142	5.849283b	5.542190d	4.205015i	4.585776d	4.061520g	4.928967b	4.754411c	4.746982d	6.670707e	6.540381g
143	5.956198a	5.731209b	3.815571g	4.622060c	3.908647f	4.413261b	4.342002a	4.577993c	5.965845c	6.647205f
144	5.499964a	5.268694c	3.172470g	4.547939c	3.722810g	3.739785a	3.672940c	4.227384c	4.726134c	7.916097g
145	3.933647a	3.775731b	2.709269i	3.808983c	3.003810h	2.986310a	3.004180b	3.262911d	3.444062d	5.338663f
146	2.997113a	2.921372b	2.198985k	3.445628c	2.436894i	2.458146a	2.460051b	2.766456c	2.585897c	4.554332g
147	2.246885c	2.138887c	1.623358g	2.592719c	2.091141f	2.002981d	1.990639c	2.284949e	1.738401g	2.978662g
148	1.673660a	1.683442b	1.197989k	2.112485c	1.730509l	1.642120b	1.661454a	1.932103c	1.301585d	2.005246g
149	1.081705d	1.036973c	0.813282l	1.625277d	1.458148i	1.216561c	1.241118b	1.474076e	0.778134g	1.083641h
150	0.653325b	0.685836b	0.511870k	1.273456d	1.080910l	0.967459b	0.996874b	1.209439d	0.505712e	0.561977m
151	0.418797d	0.411991b	0.357774j	0.799397d	0.801471h	0.738426c	0.784939c	0.913021e	0.315725f	0.363657i
152	0.266932d	0.270856e	0.257674k	0.530227d	0.578793l	0.576317d	0.626702e	0.717632e	0.213639g	0.075545l
153	0.158290g	0.167056g	0.203611k	0.414787f	0.391921i	0.361259i	0.425848h	0.540584h	0.103685i	0.031009k
154	0.074439d	0.072319d	0.126975m	0.216281d	0.252123l	0.259788e	0.267251e	0.379114f	0.046690g	0.006876m
155	0.032138h	0.039472k	0.078729k	0.141515k	0.155257l	0.165724k	0.208821k	0.241414j	0.021430l	0.003617m
156	0.014854g	0.020259f	0.057898g	0.076033f	0.114368g	0.124018h	0.154754h	0.172125g	0.012794i	0.002690j
157	0.006151j	0.010583m	0.037707k	0.041375l	0.080349k	0.074152i	0.106137j	0.135369h	0.006302j	0.000932m
158	0.003286k	0.006494l	0.023471k	0.018487l	0.042592l	0.041439l	0.065658l	0.092244m	0.002055m	0.000464n
159	0.001009i	0.003007k	0.012126j	0.008619l	0.026018k	0.020653i	0.038547k	0.048030h	0.000886i	9.77e-05n
160	0.000319n	0.001132l	0.007209k	0.003544m	0.015666l	0.009681l	0.016051n	0.020499m	0.000316n	6.92e-05n
161	8.53e-05h	0.000333h	0.005261j	0.001215g	0.008469h	0.004841i	0.008649h	0.008468h	0.000122i	1.45e-05m
162	1.59e-05n	5.77e-05m	0.002783k	0.000340n	0.005937l	0.002231l	0.006141l	1.27e-05n	1.27e-05o	7.98e-06n
163	6.11e-06n	9.62e-06m	0.001584k	0.000204n	0.003393l	0.000916m	0.003147m	5.90e-06n	5.93e-06o	4.64e-06n
164	1.88e-06n	5.77e-06m	0.000976k	0.000125n	0.001992l	0.000330m	0.001793m	1.97e-06n	1.95e-06o	2.04e-06n
165	9.52e-07n	2.31e-06m	0.000538k	7.66e-05m	0.001097l	0.000134m	0.000897n	6.15e-07m	6.32e-07n	3.53e-07m
166	3.63e-07n	9.62e-07m	0.000279j	5.67e-05n	0.000630j	6.66e-05l	0.000635n	4.14e-07n	3.68e-07o	1.38e-07n
167	2.47e-07n	3.85e-07m	0.000185k	4.35e-05l	0.000369l	1.52e-05n	0.000267n	1.04e-07n	5.09e-08o	9.77e-08n
168	5.71e-08n	9.62e-08m	0.000107k	2.84e-05n	0.000200l	4.29e-06n	7.66e-05n	9.50e-06n	1.29e-08o	5.30e-08n
169	2.38e-08n	5.77e-08m	7.80e-05j	1.70e-05n	0.000129j	1.47e-06n	2.58e-05n	4.02e-06n	4.40e-09o	2.69e-08n
170	5.01e-09n	1.92e-08m	3.25e-05k	1.02e-05n	5.95e-05l	3.18e-07n	7.66e-06n	1.64e-06m	1.62e-09n	1.07e-08n
171	2.35e-09n	6.73e-09m	1.76e-05k	5.72e-06n	3.30e-05l	1.57e-07n	2.58e-06n	2.19e-07n	4.47e-10o	4.64e-09n
172	7.69e-10n	1.92e-09m	1.66e-05j	1.07e-05n	2.13e-05l	4.94e-08n	7.66e-07n	7.31e-08n	1.51e-10o	2.39e-09n

Table 8

Set B Mass Chain Yields

mass	u233f	u233he	u236f	pu239h	pu240f	pu241f	pu242f	th232h	np237f	cf252s
66	3.99e-07n	0.000670k	8.30e-07n	6.23e-05l	8.88e-07n	1.88e-07n	2.90e-06n	0.000129i	1.87e-07l	5.26e-08n
67	1.60e-06n	0.001515l	2.08e-06n	9.82e-05l	1.33e-06n	1.31e-06n	5.79e-06n	0.000224j	3.73e-07l	1.44e-07n
68	4.88e-06n	0.001803n	4.15e-06n	0.000217l	3.11e-06n	2.82e-06n	8.69e-06n	0.000760j	1.88e-06l	3.84e-07n
69	1.33e-05n	0.002900n	9.34e-06n	0.000371l	4.88e-06n	1.03e-05n	1.16e-05n	0.001515j	6.89e-08l	9.91e-07n
70	5.32e-05n	0.004704n	2.08e-05n	0.000670l	1.19e-05n	3.28e-05n	2.90e-05n	0.002783j	2.44e-05l	2.39e-06m

71	0.000231n	0.007445n	5.19e-05n	0.001196l	3.41e-05n	8.45e-05n	5.79e-05n	0.005304j	6.19e-05l	6.02e-06n
72	0.000683n	0.013031j	0.000187n	0.002184l	0.000109j	0.000150n	0.000125n	0.007873j	0.000150l	1.41e-05n
73	0.001564m	0.018747l	0.000719m	0.003759k	0.000309m	0.000478m	0.000241n	0.016263j	0.000369k	3.21e-05n
74	0.003725n	0.028083l	0.003113n	0.005881l	0.000784n	0.001126n	0.000772n	0.030213j	0.000663l	7.06e-05n
75	0.011085n	0.043497l	0.008302n	0.010230l	0.001705n	0.002816n	0.001158n	0.053042j	0.001318l	0.000152n
76	0.019703n	0.066968l	0.022832n	0.016418l	0.004092n	0.005632n	0.002413n	0.090643j	0.006012l	0.000317n
77	0.037259m	0.101957l	0.045174m	0.023704k	0.010786m	0.009693l	0.006828m	0.130970j	0.010440k	0.000625m
78	0.062079n	0.154923l	0.058119n	0.041512l	0.022211m	0.018416l	0.013517n	0.249312j	0.024370k	0.002061k
79	0.097555n	0.230843l	0.114166n	0.086286k	0.041693m	0.035864l	0.033796n	0.413505j	0.056444k	0.003436n
80	0.211819l	0.337640l	0.186862n	0.157412l	0.071108m	0.064944l	0.055138m	0.691637j	0.111391k	0.004784n
81	0.369983i	0.541361m	0.269840n	0.272005l	0.117767m	0.092375k	0.091706m	1.055407j	0.235745j	0.008336l
82	0.592212j	0.837895m	0.384297n	0.349828l	0.173119m	0.142856j	0.125578n	1.371988j	0.357483k	0.015277l
83	0.992729d	1.305686i	0.564755m	0.473539k	0.225812f	0.203536e	0.178704f	1.730971h	0.482728f	0.041355i
84	1.646913d	2.055871i	1.041023m	0.797597l	0.387259f	0.356864e	0.344098f	2.405313h	0.764156f	0.065824l
85	2.120474d	2.128544j	1.404166h	0.965547h	0.433496g	0.446553f	0.323157f	4.504953h	0.943529f	0.109031i
86	2.791283d	2.682477l	1.769318m	1.135089k	0.626292f	0.599326e	0.541052f	5.387893j	1.312144g	0.127391l
87	3.839970d	3.384983i	2.300375h	1.311613h	0.855547g	0.801993f	0.633340h	4.972307g	1.748054g	0.214949l
88	5.074510d	3.972427j	2.903340h	1.905361j	0.974526h	0.988938e	0.834913f	5.344973h	2.160309g	0.316107j
89	5.752346g	4.624521i	3.866771i	2.068536h	1.409931i	1.282172i	1.098864j	5.935102g	2.540089h	0.363233g
90	6.386977d	4.758131j	4.726828l	2.102754k	1.798823f	1.550924f	1.360012f	6.084759g	3.341144f	0.522465l
91	6.449272d	5.178402i	5.500850g	2.237309j	2.190363f	1.928825f	1.801399g	5.991665g	3.926816f	0.597083g
92	6.541788d	5.475885i	5.611012h	2.914485k	2.680322f	2.394422f	2.151179g	5.515768g	4.385161f	0.683939g
93	6.938879d	5.377588i	5.530128h	3.228897k	3.510794f	2.980999f	2.805855g	5.583862g	5.116882f	0.922775h
94	6.754053d	5.028212l	5.022972i	3.488761k	3.931243f	3.305810f	3.126856g	5.355038j	5.135931f	1.082168i
95	6.282346d	5.053958h	6.357054i	3.928726i	4.438210f	3.791982f	3.624745f	4.938007i	5.669297e	1.242835f
96	5.724824d	4.815132l	6.048170l	4.374147k	4.733370f	4.293444f	4.281194g	3.774838j	5.488387f	1.595509k
97	5.428447d	4.833920h	5.450093g	4.564323h	5.165564f	4.458663f	4.455980f	3.359161h	6.137973e	1.667163f
98	5.138015d	3.947898l	6.034184k	4.864154k	5.501400f	4.799103f	4.833419f	2.709561j	6.106580f	2.297083k
99	4.698149g	3.781740h	5.815444g	4.749738h	5.930922g	5.528992h	5.437807i	2.048452f	6.118047g	2.632067f
100	4.357599d	3.086651l	5.776085k	5.121307k	6.811451f	5.960374f	6.084161f	1.638174i	6.436427g	3.448161j
101	3.893542f	2.743740l	5.229041i	4.997584k	6.479862h	6.490907e	5.990136i	1.357787i	6.124369f	3.933948g
102	2.935481f	2.507262l	5.196586l	5.476686k	6.667164h	6.865604e	6.420304i	1.023859i	5.769296g	4.038054h
103	1.664343i	2.532174i	4.156286i	5.207893h	6.613308i	6.508026h	6.544403j	0.886648h	5.558304f	5.447208f
104	1.279155e	1.978568l	3.540101l	5.443429k	6.839620h	7.306442e	6.485519i	0.962435i	4.131492h	5.656980h
105	0.855466i	1.804765i	2.465547h	4.274868h	5.584536i	6.583418i	6.966055h	1.081533h	3.103525g	6.211626f
106	0.325219h	1.387055k	1.012315j	3.577379j	5.093262h	6.244297e	5.758838i	1.194485h	2.334109i	6.311680f
107	0.145756j	1.422649m	0.616013m	2.862284k	3.927550k	4.906669k	5.027247l	1.177844i	1.712617j	6.618205g
108	0.097559n	1.431957m	0.384001n	2.398210k	2.795166k	3.541954k	4.397309l	1.279823i	1.296866l	6.109400g
109	0.085292m	1.503545k	0.154096m	2.476479i	1.746191i	2.352977k	3.194055k	1.413551h	0.637752j	5.940418g
110	0.079815n	1.321089m	0.114152n	1.744318k	0.941013l	1.399562j	2.077608l	1.382254i	0.300653k	5.903153k
111	0.073687j	1.412376i	0.067305j	1.547298i	0.487211i	0.644584l	1.222247l	1.303290g	0.095279h	5.187627f
112	0.064857l	1.690540i	0.052925n	1.392305i	0.227972i	0.317786l	0.653576m	1.471980h	0.073460j	4.135488g
113	0.062631l	1.702444i	0.041067m	1.295266k	0.149580k	0.213241l	0.318057m	1.418936h	0.051558j	4.782829h
114	0.055870n	1.228653m	0.036321n	1.256600k	0.091121m	0.117393k	0.133050m	1.331016i	0.052834l	3.328425k
115	0.054779k	1.447280j	0.038445m	1.271726i	0.061250i	0.109020k	0.109153l	1.312195g	0.048947i	2.897211f
116	0.065484m	1.381761l	0.037359n	1.157196k	0.064827m	0.096928l	0.097549m	1.272370i	0.047787k	2.127287k
117	0.065723j	1.320991l	0.037698l	1.151458k	0.063752l	0.088045k	0.098267l	1.429681h	0.043023k	1.500654i
118	0.070680j	1.285070m	0.036295m	1.265306j	0.058995m	0.083358l	0.087794m	1.113324i	0.052941k	0.993867k
119	0.074920j	1.220152l	0.035340m	1.251859k	0.058555m	0.082389l	0.087794m	1.060308i	0.053266k	0.384147k
120	0.070917j	1.159649l	0.038205m	1.248022k	0.067071m	0.086505l	0.082916m	0.975484i	0.053022k	0.238962k
121	0.080336l	1.710001j	0.037463n	1.444680j	0.068034m	0.091594l	0.082044n	0.949023i	0.052609i	0.117532f
122	0.072647j	1.235136m	0.050575n	1.460716k	0.075996m	0.094651l	0.083866n	0.848247i	0.060728k	0.088464l
123	0.075808n	1.351245l	0.071178n	1.729587k	0.086940m	0.101771l	0.088422n	0.805834i	0.075697k	0.040869j
124	0.103384k	1.514461m	0.094016n	1.882184k	0.109879m	0.113101l	0.100519n	0.796609j	0.072747k	0.025432l
125	0.146139g	1.516257i	0.164285m	1.954902j	0.089289i	0.151116k	0.128898k	0.720982i	0.131045h	0.017685j
126	0.284589i	2.312017l	0.243428m	2.547933l	0.271673k	0.223951k	0.168351l	0.878031i	0.165173k	0.027712k
127	0.739534k	2.226838h	0.353390m	2.204234i	0.417491i	0.332128l	0.277268l	1.078026h	0.355856j	0.105591i
128	1.183967i	2.542472l	0.544425m	2.719282k	0.693441k	0.658785k	0.517936l	1.166342i	1.499571j	0.193489k
129	1.737216i	2.833625l	0.930972j	3.387362k	1.149483l	1.167150j	1.230159j	1.252821h	1.759487i	0.588805h
130	2.792976l	3.200091l	1.742986l	4.472198k	2.031069k	1.863027j	2.005994k	2.445798j	2.726681j	0.847124l
131	3.742352d	4.066951h	2.949756f	4.365749g	3.520040g	3.362428f	3.106466f	2.815254h	3.600055d	1.599812h
132	5.037372e	3.983494h	4.376397f	5.231195g	5.041959j	4.709868f	4.483763e	3.428572g	4.853792d	2.152595g
133	6.038073d	4.560393i	6.893372h	4.865743j	6.919886e	6.459724e	6.649572d	4.663337i	6.468864f	3.152104g
134	6.314475d	4.985265i	7.740875f	6.009275h	7.486179g	7.544606e	7.430162d	6.642892h	7.072826e	3.899700h
135	6.423164d	5.133530i	6.079545f	6.376440k	7.442543e	7.069647e	6.997196f	5.246944g	7.259395f	4.190145g
136	7.039554e	5.708629l	6.592126g	6.243613g	6.681315f	6.687501f	6.877002f	6.579760k	6.712400e	4.191617j

137	6.749106d	5.076073h	6.004417h	4.545788i	6.559005g	6.386823f	6.315746f	5.598808g	6.252811e	5.022656g
138	6.575755e	6.396232k	6.638414k	4.131454k	6.449165f	6.147261i	6.195603f	5.760764g	6.135233f	5.561545g
139	5.887556f	5.866070h	6.062405i	4.128723j	5.982345i	6.307392g	6.015723f	5.796842g	5.634704f	5.853515f
140	6.005914e	5.030049j	5.635502f	3.843636i	5.505426f	5.306048f	5.449694g	5.989903g	5.493600e	5.959867e
141	6.247733g	4.464269h	5.379958h	3.560214i	5.015438h	5.075319h	5.016567i	6.114955g	5.341258g	5.966351f
142	6.122289e	4.397528l	5.423144h	3.108543j	4.889920f	4.634242f	4.600878f	5.408502i	4.795652f	6.025751g
143	5.524121d	3.218155h	5.762824h	2.807836i	4.436753f	4.671235d	4.545299e	5.119583g	4.649954f	6.253822f
144	4.379333d	2.478323i	5.111680h	2.704471h	3.962051g	4.171096f	4.262299f	4.217892i	4.139619f	5.899073f
145	3.199751d	2.025202j	4.152905i	2.158065j	3.075099f	3.326693d	3.369644e	2.630949h	3.450362f	5.051517h
146	2.381593d	1.629104m	3.462719j	1.743971k	2.553082e	2.805788d	2.908089e	2.453127j	2.799534f	4.433891h
147	1.685954d	1.241185i	2.295173f	1.709635i	2.202893f	2.224196f	2.370548f	1.864808h	2.227831f	4.280649f
148	1.197536d	0.884282m	1.729152m	1.295678k	1.774039f	1.956179d	2.001289e	1.068817j	1.719460f	3.945769j
149	0.710615d	0.616857k	1.338310j	1.055207k	1.335202e	1.458571e	1.573372e	0.813042i	1.302589f	2.719409g
150	0.469859e	0.446070m	0.739914n	0.993759l	1.085382f	1.230379d	1.319905e	0.410517j	0.993970f	2.444907k
151	0.308286d	0.342014j	0.414867k	0.737611k	0.850480e	0.911266f	0.987960f	0.232520h	0.727214f	1.948906g
152	0.192187e	0.216819l	0.315192m	0.539999l	0.651102f	0.731908e	0.790400f	0.129381j	0.459940f	1.721700k
153	0.103453i	0.142869j	0.252867n	0.457717k	0.514598i	0.550597h	0.623322g	0.089584i	0.365157h	1.292928g
154	0.043626g	0.097651l	0.131116n	0.326903l	0.309577h	0.381333f	0.435689f	0.055172j	0.187242f	1.067268k
155	0.022742o	0.065374l	0.093655n	0.233150k	0.235513i	0.335845l	0.328165n	0.031656j	0.141933k	0.792890h
156	0.017567k	0.043623i	0.033729i	0.213972i	0.173939i	0.244251l	0.237008n	0.018313j	0.100496i	0.676700g
157	0.010122l	0.027761k	0.023414n	0.113299k	0.130276j	0.162834l	0.164082n	0.010612j	0.032215l	0.537819h
158	0.003317n	0.017080l	0.011239n	0.073087l	0.077783m	0.111948l	0.109388n	0.006249j	0.012772l	0.469618k
159	0.001734l	0.010649k	0.004402n	0.052510k	0.035905i	0.065134l	0.065633n	0.004550j	0.006491l	0.340237i
160	0.000419n	0.007162l	0.001967n	0.035386l	0.019401n	0.039692l	0.041021n	0.001724j	0.002508l	0.285805k
161	9.48e-05n	0.004672i	0.000493i	0.018506i	0.011869j	0.023407l	0.023701n	0.001058i	0.000779l	0.193696h
162	2.27e-05n	0.002749n	0.000206n	0.009047l	0.006864m	0.011788m	0.012762n	0.000510j	0.000303l	0.119572l
163	1.04e-05n	0.001706n	0.000112n	0.003195l	0.002167m	0.005228m	0.005469n	0.000255j	0.000130l	0.075839l
164	3.51e-06n	0.001047n	4.50e-05n	0.001841l	0.001164n	0.003313n	0.001367n	0.000132j	5.62e-05l	0.047208l
165	1.16e-06m	0.000626n	1.72e-05m	0.000737l	0.000570m	0.001538m	0.000937m	7.28e-05j	1.92e-05k	0.028645l
166	6.73e-07n	0.000264k	1.03e-05n	0.000505l	0.000303n	0.000621n	0.000456n	2.97e-05i	1.12e-05l	0.018396k
167	9.38e-08n	0.000218n	4.87e-06n	0.000274l	0.000182n	0.000311n	0.000182n	1.59e-05j	1.55e-06l	0.009568l
168	2.46e-08n	0.000133n	1.22e-06n	0.000138l	9.10e-05n	0.000124n	7.29e-05n	8.01e-06j	3.98e-07l	0.005251l
169	8.24e-09n	8.29e-05k	3.00e-07n	6.42e-05l	9.27e-05l	5.90e-05n	4.38e-05n	3.88e-06j	1.30e-07l	0.001669m
170	2.46e-09n	4.37e-05n	9.08e-08n	4.80e-05l	2.02e-05n	1.66e-05n	2.10e-05n	1.74e-06j	4.08e-07l	0.001398o
171	7.58e-10n	2.37e-05n	3.00e-08n	3.67e-05l	1.11e-05n	5.80e-06n	1.19e-05n	8.19e-07j	1.21e-07l	0.000708o
172	2.84e-10n	2.28e-05m	8.05e-09n	1.84e-05l	6.06e-06n	1.66e-06n	6.38e-06n	3.81e-07j	4.68e-07l	0.000346o

Table 9
Set C Mass Chain Yields

mass	u234f	u237f	pu240h	u234he	u236he	pu238f	am241f	am243f	np238f	cm242f
66	3.92e-06n	4.46e-07n	6.18e-05m	0.000446k	0.000185k	1.22e-06n	9.34e-07n	4.99e-07n	1.29e-07n	9.98e-07n
67	9.29e-06n	1.39e-06n	0.000132m	0.001052k	0.000406k	2.04e-06n	1.87e-06n	8.98e-07n	5.47e-07n	2.99e-06n
68	2.68e-05n	1.98e-06n	0.000245n	0.001472n	0.000787n	6.12e-06n	5.71e-06n	2.20e-06n	2.29e-06n	3.99e-06n
69	6.19e-05n	5.95e-06n	0.000501n	0.002060n	0.001096n	2.04e-05n	9.34e-06n	4.99e-06n	6.97e-06n	5.99e-06n
70	0.000207n	1.19e-05n	0.001002n	0.003436n	0.001994m	7.14e-05n	2.08e-05n	1.60e-05n	1.59e-05n	1.50e-05n
71	0.000516n	2.78e-05n	0.002146n	0.005298n	0.003088n	0.000183n	3.32e-05n	2.50e-05n	4.38e-05n	2.59e-05n
72	0.000634m	4.96e-05n	0.004575k	0.010425j	0.004685j	0.000428n	0.000135n	4.99e-05n	0.000159n	6.39e-05n
73	0.001074m	0.000298m	0.008405i	0.014800m	0.008177m	0.000461m	0.000349m	0.000120m	0.000299l	0.000200m
74	0.004143m	0.000991n	0.016348n	0.022567n	0.013944n	0.001267m	0.000685n	0.000280n	0.000648m	0.000399n
75	0.011764m	0.003172n	0.032695n	0.034342n	0.019920n	0.002433m	0.001350n	0.000699n	0.002890m	0.000898n
76	0.026097m	0.007334n	0.052206n	0.055061n	0.028895n	0.007862m	0.003644n	0.001299n	0.005233m	0.001364m
77	0.056774m	0.017887m	0.076151m	0.083869m	0.059830m	0.021288m	0.008729m	0.002896m	0.014451m	0.004942m
78	0.088793n	0.046589n	0.110352n	0.135411n	0.109573n	0.036494m	0.018485m	0.004992n	0.030398m	0.012980m
79	0.144550n	0.075342n	0.159412n	0.206237m	0.169365n	0.067414m	0.034404m	0.018970n	0.057810m	0.027956m
80	0.216850n	0.128942n	0.221860n	0.260171n	0.239304n	0.111522m	0.061629m	0.038955n	0.098687m	0.047489m
81	0.361367n	0.208182n	0.299399n	0.472964n	0.348707n	0.182472m	0.095508m	0.064894n	0.169432m	0.085865m
82	0.653781n	0.307337n	0.402437n	0.828336n	0.540249m	0.275110m	0.157605n	0.100272n	0.239364m	0.124796m
83	1.207121m	0.477178m	0.507700m	1.174167m	0.638303m	0.378619l	0.236196m	0.169797m	0.388699m	0.191277l
84	1.963561l	0.926643n	0.660155n	1.493364m	1.072087m	0.613372n	0.354250n	0.252693n	0.682940n	0.289891n
85	2.173022j	0.964954m	0.832866m	2.318464l	1.347133m	0.709709m	0.509810m	0.359741m	0.708002m	0.409372m
86	3.494133m	1.552907l	1.046460m	2.269865m	1.744527m	1.043544m	0.654537m	0.503297m	1.151290m	0.566987n
87	2.989971j	1.791696m	1.246311j	3.184755l	2.579003m	1.185290l	0.854085l	0.674492m	1.440597m	0.790016m
88	3.966095j	2.744195l	1.490658j	3.767984l	2.655251m	1.601367m	1.265693m	0.875808n	1.801165m	0.960182m

89	5.389946l	3.389245l	1.747368i	4.300028l	3.659138j	2.074393m	1.357625m	1.124441m	2.300614l	1.219797m
90	6.038863l	3.915434l	1.952523i	4.707081l	3.820010l	2.434680l	1.715407m	1.369531m	2.667405l	1.517704m
91	6.425058j	4.386102l	2.450160h	5.002994l	4.254236k	2.948812l	2.126664i	1.748210m	3.223750l	1.887072m
92	6.110431j	4.810684l	2.872168h	5.183537l	4.818080l	3.477655l	2.939793j	2.106981m	3.677868l	2.269659l
93	6.155856i	5.299536k	2.896950i	5.042664k	5.069331j	4.112736l	2.818777l	2.578962l	4.380033l	2.661108l
94	6.418682l	5.464065l	3.493818l	5.165801l	5.361608l	4.740867l	3.688954m	3.143605m	4.846381l	3.358067l
95	6.334472j	5.610686l	3.697669i	5.032528j	5.261609j	4.424131l	3.751411i	3.739426l	5.044699l	4.015632l
96	6.224629l	5.804128l	4.135222l	5.292175l	5.307519l	5.337094l	4.740649l	4.453158l	5.421906l	4.633765l
97	6.038748i	5.879938l	4.276969i	5.042643j	5.445944j	5.656110l	4.636896i	4.677929l	5.650345l	4.844937l
98	5.766617l	5.938378k	4.759399l	4.857642l	5.225298l	5.622103l	5.445534l	5.087262l	5.697342k	5.205408l
99	5.075879i	6.197933k	4.868966i	4.254718j	5.126146j	6.112515k	5.398710i	5.398364k	6.164795k	5.427610k
100	4.136138l	5.941237k	5.207708l	3.508873l	4.790620l	6.108882l	5.909581k	5.445501l	6.095436l	5.649250l
101	3.394207l	5.804044l	5.397972l	3.167298m	4.201578l	6.048102l	6.104194l	5.924719l	6.055529l	5.953334l
102	2.669984m	5.685019l	5.438604l	2.970021m	3.553056l	6.139202l	6.063632l	5.994938l	6.145743l	5.973385l
103	2.417112i	4.948943l	5.291055i	2.298263l	3.213834l	5.896871l	6.451358i	5.905154l	5.816819l	5.943383l
104	1.321509l	4.639230l	5.218491l	2.084273m	2.820132l	5.706725l	6.024053l	5.990533l	5.707294l	5.945120l
105	1.237440i	2.688536l	4.754474g	2.132680k	2.504589j	4.762554k	5.335824i	5.866728k	4.240514l	5.785440k
106	0.429079k	2.060784l	4.021683i	1.529381m	1.814851m	4.240739l	4.813459i	5.624986l	3.840821l	5.483860l
107	0.268439n	1.122885m	3.147594m	1.233372m	1.585501m	3.010741m	5.125893l	5.245324l	2.444159l	5.134254l
108	0.185862n	0.495590n	2.638614l	1.420996m	1.376317m	2.140623l	4.117154l	4.936190l	1.656408l	4.485087l
109	0.122809m	0.178977m	2.297550i	1.258807l	1.197770m	1.216499m	2.335166i	3.778282k	0.897512m	3.406221l
110	0.103246n	0.128837n	1.949985m	1.420860m	1.296324m	0.608231m	2.054700m	2.816597m	0.477711n	2.412818m
111	0.058195m	0.069377n	1.671646i	1.318350j	1.106070j	0.305820n	1.001643i	1.747796m	0.229225m	1.427738m
112	0.072272n	0.059466n	1.568710i	1.471315j	1.160652j	0.163104n	0.743581i	0.928829m	0.129380n	0.738830m
113	0.059741m	0.043712m	1.717772i	1.304214m	1.085207m	0.082404m	0.285529m	0.421411m	0.069905m	0.351414m
114	0.058850n	0.036671n	1.248885m	1.324603n	1.047029m	0.081552n	0.134957n	0.219608n	0.073647n	0.179597n
115	0.068516k	0.041579l	1.193070g	1.328335k	1.044624k	0.083435m	0.159600i	0.101991m	0.071175m	0.110575m
116	0.056786n	0.034688n	1.066283m	1.180295m	1.266416m	0.075051m	0.102696m	0.099822n	0.060794m	0.099776n
117	0.054787m	0.034780m	0.861726g	1.193030l	1.143987l	0.075015m	0.092426m	0.099911l	0.060855l	0.099842m
118	0.054787m	0.035773m	0.984892m	1.190142m	1.101793m	0.074416n	0.092426m	0.094880m	0.059798m	0.089858m
119	0.059768m	0.034744m	1.004251m	1.170307m	1.022384m	0.072887m	0.087292m	0.089887m	0.058343m	0.089858m
120	0.064644n	0.034744m	1.065212m	1.150471m	1.052162m	0.074884m	0.087292m	0.084893m	0.059315m	0.084866m
121	0.069617n	0.036618n	1.166651m	1.338944m	1.161425m	0.077829n	0.093612n	0.084850n	0.061501n	0.082838n
122	0.081585n	0.044535n	1.248066m	1.220235m	1.101895m	0.082448n	0.099163n	0.094724n	0.064385n	0.092673n
123	0.099453n	0.056410n	1.369443m	1.299239m	1.171275m	0.092797n	0.114414n	0.099669n	0.072071n	0.107203n
124	0.119440n	0.071312n	1.536602m	1.430212n	1.293255m	0.109895n	0.125526n	0.119679n	0.083231n	0.118397n
125	0.156502l	0.119122m	1.613847m	1.610590l	1.469057m	0.149768m	0.193194k	0.129836j	0.126410m	0.155931n
126	0.259256l	0.177882m	2.066375l	2.136081l	1.596479m	0.230362l	0.261674l	0.230988l	0.184736m	0.268908l
127	0.388771j	0.248163m	2.002128i	2.197159l	1.955418m	0.369425m	0.380497m	0.349178m	0.272261m	0.373166m
128	0.647501m	0.574035n	2.919041l	2.510235m	2.234180m	0.659086m	0.613680n	0.568125n	0.586200n	0.604254n
129	1.616498j	1.012595m	2.859785l	3.191397l	2.809725k	1.118321m	1.018105m	0.947889m	1.011311m	1.011492m
130	2.540781m	2.029719l	4.309479l	3.478193m	3.350675l	2.227635m	1.867115m	1.736782m	2.090704m	1.906686m
131	3.735867j	3.213456l	4.460339i	3.708335l	3.809984l	3.915719l	4.168328i	3.194724l	3.476196j	3.455496l
132	4.364303j	4.755271l	4.590675k	5.261590k	4.873230k	5.304196l	4.321860j	4.722176l	5.147919k	4.887063l
133	6.464197i	5.472325k	5.553934i	5.010730l	5.390076k	5.873619l	5.817838h	5.620808l	5.769666k	5.647269l
134	5.749837j	6.819004l	5.473597k	5.542541k	5.844895l	6.604941l	7.828396k	6.237599k	8.045237j	6.296452l
135	5.581853k	6.624940k	5.341134h	5.459793l	5.573625l	6.745252l	6.506050h	6.772182l	6.429053j	6.764861l
136	6.492108l	6.718522k	5.776373l	6.500150l	6.109720l	7.420700l	7.796377l	7.457241l	7.278368k	8.302974l
137	5.862588i	6.466979k	4.541609i	5.031960i	5.139651i	6.510333l	5.838064i	7.152656l	6.555696l	6.981347l
138	6.587177l	6.287656l	5.445086k	5.261842l	5.071495l	6.296191l	6.655478k	6.605988l	6.192929l	6.441033l
139	6.004106l	6.068429l	4.583750i	5.279236l	5.203529l	5.724017l	6.751272i	5.950888l	5.730036l	5.775629l
140	5.787173h	6.640428l	3.853162i	3.930933j	4.118092j	5.614320l	4.941442g	5.481615l	5.786680l	5.370960l
141	6.505636j	5.575092l	3.587640i	3.680841j	4.054839j	4.785162l	4.719010i	4.952430l	4.933550l	4.768646l
142	5.990981j	5.456845l	3.899261j	4.325688l	4.262499l	5.875272l	5.448542l	5.246326l	5.771746l	5.381958l
143	6.142069j	4.816876l	3.102701i	3.285722j	3.939119j	4.535451l	3.888470i	5.202590l	4.379986l	4.966082l
144	5.443792j	4.852575l	2.671651i	2.695224j	3.486658j	3.925876l	3.414493i	4.153681l	4.140539l	3.949147l
145	3.989072l	3.632061l	2.687350k	2.340618m	2.551063m	3.236464l	3.447823l	3.414374l	3.265225l	3.297530l
146	3.071571l	3.123756l	2.130256m	1.914146m	1.995138m	2.766972l	2.917383l	2.895203l	2.853172l	2.794016l
147	2.017734j	2.616392l	1.785936i	1.282374h	1.732623h	2.236537m	2.149320i	2.336129l	2.392061m	2.180079m
148	1.434487m	1.856962m	1.511467m	1.047696n	1.270610m	1.757320m	1.902551m	1.865712m	1.770249m	1.806850m
149	1.035806k	1.442550l	1.367703h	0.622681n	0.880697n	1.597527m	1.570523i	1.556353m	1.750311m	1.492667m
150	0.637331n	1.042320m	1.069353n	0.483257n	0.684734n	0.982394n	1.239334m	1.233071m	0.903318n	1.241071n
151	0.318111l	0.771929n	0.811540j	0.336050n	0.484876n	0.908011n	0.946359i	0.966791n	0.894592m	0.932917m
152	0.248632n	0.524515n	0.653045n	0.237211n	0.356236n	0.678513n	0.811300n	0.797353n	0.643832n	0.750385n
153	0.148761l	0.346378n	0.580414i	0.181944k	0.279672k	0.468972n	0.629203i	0.588048n	0.432424n	0.545759n
154	0.080563n	0.188033n	0.400489n	0.089192n	0.141543n	0.319398n	0.426601n	0.418833n	0.288283n	0.407957n

155	0.050721n	0.118758n	0.279493i	0.064245n	0.092028n	0.239475n	0.398477i	0.308974n	0.201798n	0.292371n
156	0.020885n	0.057400n	0.226092i	0.047118j	0.070480j	0.159650n	0.262464i	0.219272n	0.124923n	0.204660n
157	0.010940n	0.042555n	0.160359i	0.032617n	0.049477n	0.099781n	0.145618n	0.149504n	0.077836n	0.136444n
158	0.006365n	0.014845n	0.110223n	0.019769n	0.027707n	0.079721p	0.096732n	0.095683n	0.043242n	0.088735n
159	0.002089n	0.006829n	0.070300l	0.011638k	0.016302k	0.035921n	0.079375i	0.057808n	0.025945n	0.053602n
160	0.001095n	0.002730m	0.052202n	0.007020n	0.009921n	0.019994n	0.063022n	0.034972n	0.013453n	0.034201n
161	0.000438m	0.001042m	0.034781i	0.004551k	0.006469j	0.010234m	0.037668i	0.019934n	0.007001m	0.018517n
162	0.000159n	0.000297n	0.023470n	0.002767n	0.003859n	0.003744m	0.008741m	0.008480m	0.002917m	0.007365m
163	4.97e-05n	5.15e-05n	0.016327n	0.001680n	0.002276n	0.001796n	0.002571m	0.003242m	0.000942n	0.002455m
164	2.88e-05n	2.77e-05n	0.010220n	0.000990n	0.001386n	0.000699n	0.001040n	0.001395n	0.000279n	0.001078n
165	9.46e-06m	9.93e-06m	0.006939n	0.000583n	0.000754m	0.000300m	0.000617m	0.000599m	8.17e-05m	0.000526n
166	2.49e-06n	5.94e-06n	0.004490n	0.000257n	0.000420j	0.000130n	0.000239n	0.000299n	2.69e-05n	0.000214n
167	5.97e-07n	2.38e-06n	0.002857n	0.000208n	0.000257n	4.49e-05n	0.000104n	9.97e-05n	1.15e-05n	7.80e-05n
168	2.69e-07n	1.09e-06n	0.001837n	0.000119n	0.000148n	6.98e-06n	4.16e-05n	5.58e-05n	4.13e-06n	2.44e-05n
169	9.45e-08n	4.16e-07n	0.001154i	7.91e-05n	0.000119m	3.99e-06n	1.46e-05n	2.39e-05n	1.25e-06n	1.46e-05n
170	2.49e-08n	8.41e-08n	0.000741n	3.91e-05n	4.46e-05n	1.70e-06n	8.33e-06n	1.30e-05n	3.08e-07n	1.01e-05n
171	7.96e-09n	2.28e-08n	0.000531n	2.08e-05n	2.47e-05n	6.98e-07n	4.89e-06n	3.49e-06n	6.73e-08n	4.48e-06n
172	1.19e-09n	6.93e-09n	0.000367n	1.68e-05n	1.38e-05n	3.79e-07n	1.98e-06n	1.79e-06n	5.77e-09n	2.73e-06n

Table 10
Set D Mass Chain Yields

mass	th227t	th229t	pa231f	am241t	am241h	a242mt	cm245t	cf249t	cf251t	es254t
66	8.53e-08n	3.02e-08l	9.85e-05n	1.36e-07n	0.000339n	9.57e-06n	1.04e-06n	3.00e-07n	9.35e-05n	9.39e-09n
67	2.16e-07n	7.18e-08l	0.000177n	2.52e-07n	0.000726n	1.91e-05n	2.09e-06n	5.01e-07n	0.000140n	1.88e-08n
68	8.23e-07n	2.71e-07l	0.000345n	5.81e-07n	0.001162n	2.87e-05n	4.18e-06n	3.00e-06n	0.000187n	3.75e-08n
69	2.35e-06n	1.15e-06l	0.000689n	1.26e-06n	0.001937n	5.74e-05n	1.04e-05n	5.71e-06n	0.000281n	7.51e-08n
70	5.19e-06n	3.64e-06l	0.001280n	4.55e-06n	0.003200n	9.57e-05n	2.61e-05n	3.06e-05n	0.000374n	1.41e-07n
71	1.27e-05n	1.56e-05l	0.002462n	6.78e-06n	0.004842n	0.000191n	5.75e-05n	5.36e-05n	0.000468n	2.35e-07n
72	5.68e-05n	7.18e-05l	0.004432n	9.93e-06n	0.008716n	0.000478n	0.000104n	0.000109n	0.000655n	1.45e-07l
73	9.37e-05m	0.000260l	0.008903m	3.98e-05m	0.013559n	0.000957n	0.000209n	0.000214m	0.000954m	9.69e-07l
74	0.000265n	0.001041l	0.016742n	8.94e-05n	0.021308n	0.001722n	0.000460n	0.000533m	0.001216n	1.88e-06n
75	0.000784n	0.003383l	0.031514n	0.000248n	0.027118n	0.002871n	0.000773n	0.000956m	0.001777n	3.29e-06n
76	0.002256n	0.011973l	0.059124n	0.000517n	0.038940n	0.005746n	0.002091n	0.001913m	0.002340n	6.58e-06n
77	0.010891l	0.042056j	0.098926m	0.003383m	0.058663m	0.009695m	0.005158m	0.004620m	0.003340m	1.36e-05l
78	0.037246n	0.255851k	0.196972n	0.007148n	0.077482n	0.019138n	0.010448n	0.008172l	0.004676n	2.42e-05l
79	0.643541l	0.422800j	0.396969l	0.011939m	0.106546n	0.029353l	0.020448l	0.018454l	0.005806l	4.85e-05l
80	1.883283m	1.636491i	0.689483n	0.021847n	0.181000m	0.047855n	0.036582n	0.030261l	0.008420n	9.39e-05n
81	3.485008l	2.298120i	0.989297m	0.043684n	0.249329m	0.066983n	0.062692n	0.048030l	0.011223n	0.000235n
82	4.883868m	3.456487j	1.691246m	0.064077n	0.354041m	0.115419n	0.104844n	0.075751l	0.015551l	0.000424n
83	5.653256l	5.199428g	2.301276j	0.177265j	0.464420m	0.247989j	0.190982k	0.129884i	0.021947m	0.000872l
84	6.149415l	9.351723f	4.230482j	0.277786j	0.593532m	0.390846j	0.269753m	0.189642l	0.028484n	0.001726n
85	6.722658k	9.209156f	4.484248i	0.318023j	0.782329m	0.450324k	0.294181i	0.250688l	0.042969m	0.003352m
86	7.084953k	8.306021f	5.149603l	0.443596l	0.948662m	0.571047m	0.474388n	0.336594l	0.056565n	0.007124n
87	7.038131l	7.237108g	5.963832l	0.697907m	1.076704i	0.674619n	0.508205j	0.422156l	0.075285n	0.014230n
88	7.083168l	8.189612g	6.633533l	0.768877l	1.214488k	0.920838m	0.614886i	0.521144l	0.104051n	0.028593n
89	7.588615h	9.054496f	6.985217i	0.988304i	1.537910m	1.192149j	0.857202i	0.455434i	0.151198n	0.051894k
90	7.682956i	8.373094h	6.849946l	1.366567j	1.741136m	1.379422j	1.080187k	0.588868i	0.296187m	0.113012n
91	6.167085k	6.593329f	6.448984j	1.847946h	2.044897h	1.749651k	0.880204h	0.828127g	0.519946i	0.275741j
92	4.740288l	5.965047g	6.773657l	2.010441h	2.217020j	2.101637i	1.290145j	0.891135h	0.581024n	0.357619n
93	4.373777l	4.844053g	6.715180l	2.687143i	2.424342l	2.579150j	1.816635i	1.078319h	0.701689k	0.470869m
94	3.664474l	4.111336j	6.359588l	3.192690l	2.598156i	2.721451m	1.639377i	1.197019h	0.749811n	0.565227n
95	3.382430j	2.675366f	6.356235i	3.977545g	3.124817i	3.294279j	2.351206h	1.506069f	0.978960j	0.708960j
96	2.613811m	1.380278j	4.966944l	4.260961l	3.284327l	3.624064l	2.824579l	1.680999i	1.432866m	0.751744n
97	2.382440l	0.731037g	4.353357h	5.267398g	3.545127j	4.280808j	2.896429h	2.085608f	1.649746i	0.975554j
98	1.366808l	0.271352j	3.178944l	5.875970l	3.939538l	4.611194l	3.679975l	2.318423i	2.203117m	1.343856m
99	1.432854j	0.152071h	2.534050h	6.624390g	4.336901i	5.349424i	4.169585f	2.800711g	3.288263h	2.297705i
100	0.936641m	0.036026l	1.978594m	6.254700k	4.566865l	5.479308l	4.938151l	3.236425i	3.386625l	2.423282l
101	0.749312m	0.013081l	1.384969m	5.998302l	4.783424l	5.870560l	5.761641j	3.686038i	3.870362l	2.487148m
102	0.581725m	0.006552l	0.643032m	6.177847l	4.891798l	6.653634l	5.956845k	4.214248i	4.257632l	2.714242l
103	0.570188l	0.005997j	0.370689i	6.229465h	5.040525i	7.072962j	6.328250h	4.927273f	4.354513l	3.128265j
104	0.314197n	0.010114l	0.197173n	6.219106l	4.727494i	6.951483l	6.754414j	5.092728h	4.553161l	3.398538l
105	0.276770k	0.008090h	0.146306k	6.644416g	4.729528i	6.953949j	6.402817g	5.434584f	4.843500i	4.248856i
106	0.173128m	0.012004j	0.103468k	5.958447l	4.123556i	6.164088l	5.742900i	5.618008g	4.934712l	4.023853j
107	0.094091n	0.010813l	0.095527n	5.270934l	3.784033i	5.381347l	5.579344j	5.698314i	5.224989l	3.877234l

108	0.053909n	0.011742l	0.078791n	4.254739l	3.513967l	4.109745l	5.743715l	5.725655i	5.322621l	3.684061l
109	0.033753m	0.012898k	0.079651j	2.494585i	3.222369i	3.749192j	4.658722j	5.579277h	5.225069i	3.721595j
110	0.035284n	0.016895k	0.068937n	1.492485m	2.876922l	2.423846m	4.723505l	5.414621i	5.225127l	3.877295l
111	0.040989l	0.021650i	0.095282j	0.951136h	2.332104i	1.534712j	4.010336i	5.500346h	5.017987h	4.192541h
112	0.028713l	0.020836i	0.058512j	0.559857i	2.423159i	0.642989j	3.006297k	4.925475h	5.334010i	4.342348j
113	0.036696l	0.017003j	0.080964j	0.196580k	2.467821i	0.251871m	2.039334k	4.165386i	4.456789j	3.890811j
114	0.030304n	0.021486l	0.061059n	0.148919n	1.838109m	0.105254n	1.093787m	3.624160i	4.508978l	4.943476l
115	0.030215m	0.019833i	0.083305j	0.051124h	1.720210i	0.073742j	0.559542h	2.986375g	4.559190g	5.572666h
116	0.032324n	0.019618l	0.064668m	0.039796m	1.544809m	0.038780m	0.216646m	2.199953i	3.627723m	5.480334k
117	0.038272m	0.022747i	0.065692m	0.031885l	1.496050l	0.029353l	0.143133l	1.830886j	2.902772l	5.087148k
118	0.047476n	0.016930i	0.066719m	0.036024l	1.447021m	0.027146m	0.084595m	1.021380i	1.908332m	4.458818l
119	0.063451m	0.015712k	0.068772m	0.027857m	1.447021m	0.023268m	0.052614m	0.609513i	1.240416m	3.913191k
120	0.083840n	0.014678l	0.072878m	0.025867m	1.540443m	0.023268m	0.037139m	0.385308l	0.763333m	3.392579l
121	0.113596m	0.013309k	0.079029k	0.026180n	1.601252m	0.019529j	0.031133k	0.206423i	0.497224i	2.695797i
122	0.109142n	0.013673k	0.087210n	0.029351n	1.788519m	0.032850n	0.053311n	0.180266l	0.280555n	2.295830m
123	0.221216n	0.012893l	0.098553n	0.039794n	1.905286m	0.043771n	0.063304m	0.168209i	0.196388n	1.938617l
124	0.313720n	0.011105l	0.116361n	0.050377n	2.296014m	0.054787n	0.071014n	0.137428l	0.187420n	1.339261m
125	0.500067k	0.005644m	0.145755m	0.081637m	2.352158l	0.103657l	0.093503k	0.207119k	0.380967k	0.903326k
126	0.569149l	0.019045j	0.193271l	0.170100l	3.578009k	0.169126l	0.161991l	0.446129l	0.506719m	0.845123l
127	0.673108l	0.038914k	0.291509m	0.585649h	2.321208i	0.266662m	0.486344j	0.588926j	0.608631j	0.944831j
128	0.926608m	0.051942m	0.529081n	0.930118m	2.908697l	0.413702l	0.651684i	0.783704i	0.709418m	1.286096l
129	1.428327k	0.118843i	1.034453h	1.361734h	3.604077l	1.471999m	1.270584j	1.630072j	0.929550i	1.960259j
130	1.864049m	0.417244k	2.084777m	2.233984m	4.595209l	2.004841m	1.850324j	1.974170i	1.216432m	2.461702m
131	2.626336l	0.604336g	2.667257i	3.563315f	4.472304i	3.483687h	2.915607g	3.168128g	1.841308i	3.794180i
132	3.388646i	1.204007f	3.584308i	4.775108f	3.772098k	4.813691h	4.184611f	4.159552h	3.217466j	4.798906j
133	4.839077k	2.966538f	5.092815i	5.507630e	4.630996h	5.982260i	5.467867g	5.249503g	3.911973j	5.058292k
134	5.729390l	5.968143f	6.375640k	7.239502g	5.281205k	7.003336i	7.100712h	5.390574g	4.854212l	5.354648l
135	6.776684l	5.806931f	6.672920i	7.012588g	4.741971j	6.654152k	6.800380g	5.420276h	4.432428j	5.476295j
136	7.666171l	5.974547f	7.476111l	7.930157g	6.216885l	6.553652k	5.041344j	5.662877k	5.665815l	5.135196l
137	6.966919k	7.169380g	7.018564i	6.415981h	4.390373i	6.137532j	6.219815i	5.700280h	5.707720l	4.699539l
138	7.248573l	7.888810g	7.452637l	6.934448i	4.404919l	5.975975l	6.173800h	5.399914h	5.777183l	4.474047l
139	7.548144l	8.487908g	7.345277l	6.668077g	4.079915i	5.766955j	5.843295i	6.109041g	5.655673l	4.157150l
140	7.749613k	7.940885f	6.715763h	5.936439g	3.532391j	5.409275j	5.516822f	5.324028f	4.509273h	3.995753h
141	7.640609j	7.461594f	6.838927i	4.791970g	3.243333i	5.244436j	5.159751h	5.431640h	4.918617j	4.583781i
142	7.448923l	7.300350g	6.208105l	4.720582k	3.038531i	4.490711j	4.731230h	4.393599g	5.464604l	4.592552l
143	6.989135j	8.307434g	5.325788h	3.671068g	2.704216i	4.637793j	4.417257g	4.704304g	5.080525i	4.827392i
144	5.966224j	9.758022h	4.694476i	3.488406h	2.525339i	4.425765j	4.298894j	4.317734h	5.050883l	3.889585j
145	3.105632l	5.016667j	3.208685j	3.313133i	2.249859m	3.350866l	3.036074j	3.537418k	4.947034l	3.561060l
146	1.037369m	3.379384h	2.607171m	2.645464m	2.026899m	2.879976m	2.754335j	3.351229h	4.239998l	3.264100l
147	0.183393m	2.114336h	2.027286h	2.032382h	1.815791i	2.466797j	2.438092h	2.856442h	3.513508k	2.967364l
148	0.031314n	1.021486h	1.560233m	1.829189m	1.590821m	2.133477m	2.316050l	2.255527l	3.345269m	2.659000m
149	0.010101n	0.588230h	0.921756i	1.432518i	1.305875i	1.719593j	1.950343j	2.053920h	3.020187k	2.264642m
150	0.002021n	0.178456i	0.550639n	1.148799m	1.235721m	1.602343m	1.818158m	1.755003l	2.424743l	1.979998l
151	0.000505n	0.037998k	0.316407n	0.839475j	0.897233i	1.218078j	1.142816h	1.604719h	2.019051l	1.700240k
152	0.000202n	0.009755l	0.179470n	0.722576n	0.815177n	1.023991m	1.222758m	1.255875l	1.520199m	1.624615m
153	0.000101n	0.002058l	0.076967j	0.602388i	0.671613i	0.829094j	1.295211m	1.210257g	1.216134m	1.591976l
154	4.04e-05n	0.000483l	0.041501n	0.377025n	0.530077n	0.547193n	0.892515m	0.892833l	0.912163m	1.280085m
155	1.01e-05n	9.84e-05l	0.020748n	0.307721k	0.341757i	0.361109n	0.696315n	0.616094i	0.713341n	0.984615m
156	5.05e-06n	2.60e-05l	0.010374n	0.191143i	0.273777i	0.327549j	0.432886k	0.676861h	0.566411k	0.796263l
157	1.52e-06n	7.16e-06l	0.005187n	0.164262j	0.179285j	0.155052k	0.447993n	0.421298i	0.407619n	0.754309k
158	5.76e-07n	1.79e-06l	0.003216n	0.085871n	0.153996n	0.087542n	0.328393n	0.381032l	0.305713n	0.684770n
159	2.02e-07n	5.28e-07l	0.001556n	0.073005j	0.133100i	0.054713n	0.229064n	0.364075i	0.203810n	0.489121n
160	1.01e-08n	1.34e-07l	0.000737n	0.034595n	0.087645n	0.038331n	0.179528n	0.232957l	0.152907n	0.391501n
161	6.06e-09n	3.58e-08l	0.000373n	0.022102j	0.060727i	0.020150k	0.119600n	0.193116j	0.101904n	0.293473n
162	3.03e-09n	8.86e-09l	0.000197n	0.010472n	0.034647n	0.013131n	0.079666n	0.110678n	0.081523n	0.195649n
163	1.01e-09n	2.68e-09l	0.000104n	0.002827n	0.024462n	0.006566n	0.054732n	0.066861n	0.061142n	0.097824n
164	6.06e-10n	8.95e-10l	4.15e-05n	0.000325n	0.017450n	0.002189n	0.024934n	0.043472n	0.040762n	0.047934n
165	3.02e-10m	2.68e-10l	2.05e-05m	0.000100m	0.010190n	0.001067m	0.010904m	0.028031m	0.030403m	0.019692m
166	1.01e-10n	7.16e-11l	9.34e-06n	6.81e-05n	0.007133n	0.000547n	0.004460n	0.016692n	0.020381n	0.008804n
167	6.06e-11n	1.79e-11l	3.63e-06n	3.04e-05n	0.004076n	0.000219n	0.002230n	0.007394n	0.015285n	0.003913n
168	3.03e-11n	6.27e-12l	1.56e-06n	1.36e-05n	0.002956n	0.000109n	0.001318n	0.004182n	0.010190n	0.001956n
169	1.01e-11n	1.79e-12l	6.22e-07n	5.86e-06n	0.001936n	8.75e-05n	0.000598n	0.001687n	0.008152n	0.000978n
170	6.06e-12n	1.61e-12l	3.11e-07n	1.68e-06n	0.001165n	4.38e-05n	0.000294n	0.000863n	0.006115n	0.000489n
171	3.02e-12l	1.34e-12l	1.56e-07n	3.25e-07n	0.000774n	2.19e-05n	0.000172n	0.000481n	0.004076n	0.000196n
172	1.11e-12l	1.16e-12l	1.04e-07n	1.05e-07n	0.000510n	1.09e-05n	8.01e-05n	0.000363n	0.003057n	9.78e-05n

Table 11
Set E Mass Chain Yields

mass	cf250s	cm244s	cm248s	es253s	fm254s	fm255t	fm256s	np237h	u232t	u238s
66	0.001965n	3.98e-05n	0.000439n	0.000267n	2.83e-05n	0.000158n	0.000101n	0.005000n	0.006995n	8.13e-11n
67	0.002457n	6.57e-05n	0.000549n	0.000359n	3.84e-05n	0.000205n	0.000162n	0.006999n	0.008994n	2.45e-10n
68	0.002948n	9.96e-05n	0.000769n	0.000513n	5.26e-05n	0.000252n	0.000222n	0.008999n	0.012991n	8.13e-10n
69	0.003734n	0.000149n	0.000988n	0.000677n	7.48e-05n	0.000326n	0.000303n	0.011999n	0.017988n	2.45e-09n
70	0.004917n	0.000249n	0.001390m	0.000946n	0.000102n	0.000438n	0.000405n	0.015001n	0.025001n	8.13e-09n
71	0.005896n	0.000398n	0.001867n	0.001334n	0.000152n	0.000578n	0.000525n	0.019998n	0.034977n	2.45e-08n
72	0.007861n	0.000657n	0.002416n	0.001847n	0.000202n	0.000746n	0.000707n	0.024998n	0.046967n	8.13e-08n
73	0.009877m	0.000997m	0.003208m	0.002342m	0.000282m	0.000952m	0.001007m	0.032997m	0.067962m	2.55e-07m
74	0.012775n	0.001494n	0.004392n	0.003386n	0.000384n	0.001305n	0.001313n	0.042996n	0.089940n	8.13e-07n
75	0.016705n	0.002569n	0.005930n	0.004617n	0.000505n	0.001585n	0.001818n	0.052995n	0.129911n	2.45e-06n
76	0.019719n	0.003989n	0.007689n	0.006199n	0.000722n	0.002149n	0.002540n	0.070053n	0.170962n	8.13e-06n
77	0.025549n	0.004749m	0.010694m	0.008147m	0.001011n	0.002796n	0.003424m	0.094992m	0.249875m	2.55e-05m
78	0.032428n	0.009958n	0.014276n	0.011286n	0.001516n	0.003729n	0.004645n	0.119994n	0.349760n	8.14e-05n
79	0.042256n	0.016928n	0.018670n	0.015390n	0.002325n	0.004661n	0.007069n	0.160003n	0.479754m	0.000337m
80	0.050130n	0.026890n	0.025268n	0.022588n	0.003546n	0.006340n	0.009095n	0.200064n	0.640217n	0.000818n
81	0.068788n	0.044810n	0.035143n	0.030780n	0.005054n	0.008017n	0.012118n	0.259996n	0.799466n	0.004026n
82	0.089646n	0.070740n	0.046282n	0.041960n	0.008566n	0.010364n	0.016540n	0.351876n	1.144032n	0.012247n
83	0.096572j	0.115805k	0.045639j	0.061642k	0.012090m	0.013328m	0.022152m	0.449979m	1.499281m	0.029141j
84	0.159726l	0.115547m	0.076734k	0.082559n	0.017225n	0.016826n	0.030423n	0.585247n	1.802569m	0.107053j
85	0.223454k	0.220776k	0.100485k	0.112051m	0.026280n	0.023803m	0.040284m	0.730191m	2.672660k	0.081399m
86	0.287095k	0.202581m	0.165606k	0.155366n	0.041024n	0.030049n	0.055094n	0.918798m	3.356207l	0.985261i
87	0.287376m	0.369410m	0.214938m	0.204494m	0.056549m	0.040079m	0.074709m	1.210520m	4.383922k	1.545151m
88	0.345654n	0.448949n	0.278483n	0.288819n	0.095617o	0.051433n	0.111469n	1.528665m	6.208151j	2.586694i
89	0.477084k	0.715469i	0.434625k	0.369393k	0.131508n	0.065332n	0.151701n	2.020057l	6.916297h	3.955079i
90	0.513752m	0.806883k	0.481615m	0.458447m	0.201544m	0.085695m	0.201430m	2.503496l	6.598398l	5.431288h
91	0.566510i	0.824986k	0.596273i	0.532615j	0.394977j	0.111863n	0.242146l	2.669318k	7.157881h	5.820960h
92	0.772840n	1.096325n	0.859116m	0.616334n	0.444972n	0.139962n	0.303310n	4.024789l	6.849382i	5.860970i
93	0.952141m	1.298633m	1.195295m	0.680820k	0.482813j	0.190588m	0.404111m	4.915119k	7.292711h	6.215516h
94	1.137351m	1.496442m	1.502795m	0.968637m	0.495389n	0.233152n	0.525419n	5.038630l	6.227445i	6.500918i
95	1.481512i	1.627707k	1.627802i	1.145034l	0.521892i	0.307643n	0.666565n	5.544108l	6.199644h	6.606563i
96	1.532493m	2.495774m	2.101514l	1.531561m	1.015462m	0.410507n	0.747381m	5.507429l	5.834200l	6.679377i
97	1.583535i	3.064710j	2.617648i	1.874113i	1.261351h	0.687185k	0.767752m	5.379936k	5.431860h	6.540650i
98	2.483212l	3.495306l	3.221834m	2.231597l	1.511893m	0.699482n	1.010356n	5.310420l	4.699501l	6.497335i
99	3.278954h	3.896997h	4.120521h	3.104331i	1.754805j	0.856908m	1.208492m	4.861882j	4.207946g	6.071174g
100	3.568951l	4.989660l	4.510950l	3.445266l	2.218967m	0.952051m	1.510748m	5.200182l	3.000601m	6.130801i
101	4.008989l	5.787726l	5.245274l	3.849302l	2.714429l	1.142432m	1.812454m	4.999801l	1.999071m	6.537861h
102	4.956870l	6.885586l	5.455486l	4.558574l	3.016096l	1.237658m	2.009848l	4.599987l	1.499276m	6.160764h
103	5.303707i	6.929656k	5.514035i	5.856763i	3.168797i	1.332866m	2.210852l	4.329988l	1.060987h	4.557441h
104	6.473899k	7.685087l	6.313833l	6.282349l	4.022437l	1.523693m	2.719992m	4.001153l	0.349759n	3.744879h
105	6.593749h	9.293313i	6.397579h	6.241100k	4.931077j	2.388842j	3.108347j	3.444595k	0.243278k	0.786172k
106	6.825548i	7.397748k	6.169435i	6.531296j	5.564657j	2.415192l	3.617618l	2.999881l	0.099931n	0.269772m
107	7.270417k	6.985186l	6.294329l	6.280450l	5.428867l	2.608408l	4.522027l	2.499859m	0.025982n	0.139032n
108	6.939567l	5.987469l	6.086124l	5.875518l	5.630144l	2.705282l	5.225943l	1.900148m	0.008194n	0.081323n
109	6.331166k	5.012555k	6.056896j	5.520885k	5.701464j	2.898647l	5.419375k	1.456841l	0.008996m	0.011855m
110	5.950842l	3.991859l	5.769829l	5.274117l	6.456305l	3.284716l	5.621100k	1.299910m	0.008295n	0.009792n
111	4.931662k	2.876289i	5.417081j	4.728588i	5.529359i	3.188053l	5.433589j	1.213998l	0.009140j	0.008565m
112	4.095200i	2.045340k	4.683308i	3.977335k	6.228977i	3.625350l	5.627411l	1.211692l	0.010992n	0.005859n
113	3.510651j	0.881390k	2.662815j	3.646713l	5.730471l	4.253715k	6.029369l	1.229910m	0.013991n	0.005103m
114	2.469580m	0.398307n	2.098110l	3.242006l	5.032474l	4.830385l	6.029607l	1.229892n	0.015989n	0.004110n
115	2.049625h	0.257776h	1.387753h	2.828023h	5.078004i	5.591322j	6.131334j	1.229247h	0.018780j	0.003827m
116	1.191441n	0.069704n	0.076868n	2.571044m	4.244323l	5.662013k	5.657000k	1.229966m	0.015477m	0.003554m
117	0.493871m	0.029910m	0.021387m	2.228547l	3.518710l	5.856075k	4.716267k	1.229951l	0.014499m	0.003280m
118	0.196533n	0.009970m	0.007486m	1.222017m	2.619656m	5.893067l	4.019579l	1.229323m	0.011433n	0.003189m
119	0.117920n	0.004985m	0.003208m	0.661928m	1.813613m	5.953676k	3.222151m	1.229358m	0.008699m	0.003793m
120	0.058960n	0.001992n	0.002139m	0.315689m	1.111835n	5.796459l	2.618003m	1.229289m	0.008119m	0.003793m
121	0.027037j	0.001318k	0.001818m	0.152455j	0.796747j	5.699855l	2.719902j	1.259340m	0.008636k	0.003890n
122	0.019653n	0.002440n	0.001647n	0.065661n	0.409269n	5.329909l	1.569186m	1.299445m	0.014436n	0.004189n
123	0.018671n	0.004866n	0.001867n	0.031804n	0.252673n	4.926991l	0.908811n	1.349286m	0.019055n	0.004489n
124	0.018796n	0.008776n	0.002061n	0.020023n	0.160207n	3.879258m	0.467613n	1.408380m	0.031557n	0.004988n
125	0.021288k	0.015498l	0.006506k	0.018983k	0.126788l	3.016298k	0.443043m	1.499181m	0.158293i	0.005989m
126	0.043971n	0.068132n	0.013257n	0.029947n	0.163834n	2.404707l	0.418656n	1.899685l	0.228646n	0.006985n

127	0.113078k	0.198664j	0.031151j	0.063365j	0.238890k	2.321930j	0.429335l	2.501147k	0.382894j	0.013975m
128	0.214964n	0.486668n	0.101962n	0.154564n	0.455129n	2.168970l	0.570901n	2.899035m	1.063250m	0.019952n
129	0.396905k	0.660480j	0.322215k	0.310467j	0.871424j	2.264065j	0.858857l	3.298829l	1.765107j	0.026590k
130	0.880002n	1.991361i	2.027769m	0.580676n	1.507504m	2.482584m	1.546477m	3.615708m	3.012895m	0.139653n
131	1.704686h	3.004012g	2.620447h	1.136256k	2.440037i	3.214969k	2.537032l	4.090617h	3.748439h	0.448890h
132	2.459597h	4.194229h	4.335317h	2.528404k	3.520872l	4.808938j	4.024000k	4.397509h	5.170557i	3.326248f
133	3.904174h	5.660986g	5.264997i	2.669811k	4.341222i	5.422682j	3.827673l	4.498360l	5.803819h	5.601202f
134	4.159653h	6.812967h	4.993017k	2.952382l	5.188870l	5.855151l	4.102546l	5.447073h	5.235405k	4.837292e
135	4.642911k	7.483203g	5.741358i	4.702590k	4.478733i	6.163349j	6.211316k	4.999421l	5.319465h	5.213117f
136	4.982011h	7.629288h	4.851178j	4.363838l	5.806152l	6.369712l	4.911367l	5.008906h	7.198364m	5.714467f
137	5.453609l	7.923238i	6.076900i	4.530537l	5.542704l	6.285112l	5.089951l	5.113161l	7.804503i	5.809433h
138	5.736640l	7.663838i	6.534107l	4.820372l	5.732576l	6.057570l	5.275900l	5.003579l	5.639774j	6.440974i
139	6.191587i	6.997414i	6.221661i	5.870703k	4.987087k	5.659810l	6.098468k	4.764126k	7.120304h	6.840348i
140	5.249179i	6.101880h	5.820549i	5.660598i	5.543736h	4.828491k	5.960553j	4.826781k	7.304308h	6.798937f
141	5.849432i	5.619863h	5.607301i	5.740320k	5.478458i	4.621492l	5.757499l	4.798816l	6.913198h	6.890223i
142	6.544320k	4.876956i	6.303152i	5.802861l	5.032920k	4.343200l	5.273306l	4.502399l	6.350994i	6.300047i
143	5.565486i	3.995777h	5.484139k	6.442620i	5.454272i	3.138478k	4.880066l	3.542717l	5.085506g	7.160881h
144	4.743435i	3.675941i	5.828263i	5.107928k	4.846000j	3.206951l	4.489211l	2.999562l	4.329340i	6.212791i
145	4.942833l	3.085355i	4.443857l	5.799818l	4.106912l	2.829023l	3.903043l	2.498738m	3.115456i	5.997633i
146	4.448470l	2.587718i	3.736030l	5.406569l	3.724867l	2.482331m	3.415123l	1.998957m	2.504767k	5.243420l
147	3.814493i	1.981320i	3.130742i	4.816761l	3.447090k	2.022638m	3.122393l	1.701924l	1.205412h	4.399052j
148	3.460255l	1.691969i	2.626143l	3.833932l	2.865348l	1.747026m	2.704178m	1.199355m	0.952662n	3.043279l
149	3.257319i	1.451882i	2.027575m	3.131921k	2.856980l	1.468327k	2.653692k	0.899318n	0.666917n	2.201026i
150	2.367200m	0.997406i	1.521120m	2.465120m	2.201135m	1.287714m	2.238920m	0.702004n	0.511157n	0.998215m
151	2.071794i	0.696698i	1.184067i	1.907814k	1.685685m	1.285991k	2.050003l	0.529598n	0.342982n	0.199498n
152	1.574084m	0.597165i	0.968502n	1.561535m	1.498378m	1.103257m	1.641670m	0.399692n	0.266765n	0.049874n
153	1.215109i	0.500561i	0.792720i	1.482217k	1.385176i	0.998079k	1.352259m	0.314825l	0.190543n	0.019950n
154	0.836687m	0.389370n	0.407796n	1.075242m	1.034244m	0.708804n	1.064752m	0.249927n	0.134020n	0.007980n
155	0.683967n	0.291983n	0.254869n	0.927166m	0.800964n	0.531592n	0.837312n	0.179863n	0.104799n	0.002992n
156	0.508090n	0.203949j	0.203895n	0.772813n	0.664436n	0.442994n	0.721898m	0.139891n	0.076217n	0.000997n
157	0.410380n	0.155725n	0.132532n	0.744247k	0.618913j	0.364707k	0.520306l	0.092571n	0.052400n	0.000399n
158	0.341985n	0.097328n	0.101948n	0.579632n	0.473402n	0.265796n	0.399648n	0.079938n	0.033348n	9.97e-05n
159	0.254045n	0.068130n	0.071363n	0.564124k	0.433259j	0.194917n	0.304477n	0.067885n	0.020960n	1.99e-05n
160	0.215609n	0.043847n	0.050979n	0.439806n	0.218077n	0.150646n	0.231067n	0.050143n	0.014547n	4.99e-06n
161	0.166106n	0.029198n	0.035682n	0.289805n	0.118324n	0.115178n	0.161753n	0.034973n	0.008574n	1.50e-06n
162	0.127022n	0.019466n	0.030584n	0.212523n	0.072815n	0.088599n	0.114179n	0.026979n	0.005716n	5.98e-07n
163	0.107481n	0.011679n	0.023448n	0.144905n	0.054617n	0.070879n	0.079926n	0.019984n	0.003525n	9.97e-08n
164	0.078176n	0.007786n	0.018351n	0.106390n	0.038394n	0.053159n	0.057130n	0.015990n	0.002384n	2.99e-08n
165	0.062963m	0.004906m	0.013179m	0.077282n	0.024575n	0.045969m	0.043456m	0.011993m	0.001715n	9.98e-09m
166	0.050809n	0.003406n	0.010195n	0.057961n	0.018204n	0.035439n	0.033302n	0.009493n	0.001143n	3.99e-09n
167	0.040061n	0.002433n	0.008156n	0.040573n	0.011833n	0.026580n	0.024739n	0.006995n	0.000762n	9.97e-10n
168	0.032244n	0.001460n	0.006117n	0.028981n	0.005462n	0.017720n	0.019030n	0.005496n	0.000476n	3.99e-10n
169	0.024427n	0.000973n	0.004588n	0.022218n	0.003641n	0.015062n	0.013321n	0.004197n	0.000305n	1.99e-10n
170	0.020541n	0.000584n	0.003568n	0.016584n	0.002809n	0.012404n	0.009563n	0.003202n	0.000212n	9.98e-11n
171	0.015634n	0.000389n	0.002549n	0.010626n	0.001820n	0.008860n	0.007041n	0.002388n	0.000143n	2.99e-11n
172	0.012702n	0.000292n	0.002039n	0.007728n	0.000910n	0.007088n	0.004757n	0.001899n	9.53e-05n	9.98e-12n

Table 12

Set F Mass Chain Yields

mass	cm243t	cm246s	cm243f	cm244f	cm246f	cm248f	pu242h	np237t	pu240t	pu242t
66	3.42e-06n	2.16e-05o	9.50e-06n	7.30e-06n	4.11e-06n	2.08e-06n	2.08e-07n	4.88e-08n	1.60e-07n	4.97e-08n
67	8.56e-06n	0.000441o	1.80e-05n	1.30e-05n	7.53e-06n	3.66e-06n	4.17e-07n	8.78e-08n	3.10e-07n	9.95e-08n
68	2.12e-05n	0.000421o	3.40e-05n	2.50e-05n	1.40e-05n	6.83e-06n	7.33e-07n	4.88e-07n	9.39e-07n	2.29e-07n
69	4.70e-05n	0.000815o	6.70e-05n	4.80e-05n	2.91e-05n	1.29e-05n	1.56e-06n	1.95e-06n	2.98e-06n	4.97e-07n
70	8.56e-05n	0.000801o	0.000140n	9.61e-05n	5.72e-05n	2.58e-05m	3.12e-06m	5.85e-06n	9.99e-06n	1.79e-06n
71	0.000170n	0.001107o	0.000270n	0.000190n	0.000110n	5.25e-05n	5.22e-06n	1.46e-05n	1.80e-05n	2.69e-06n
72	0.000376n	0.001499o	0.000530n	0.000380n	0.000231n	0.000109n	1.14e-05n	2.93e-05n	5.99e-05n	9.95e-06n
73	0.000670m	0.002097o	0.001000m	0.000730m	0.000451m	0.000208m	1.86e-05m	8.85e-05m	0.000150m	2.99e-05m
74	0.001712n	0.002871o	0.002000n	0.001401n	0.000863n	0.000396n	5.22e-05n	0.000263n	0.000300n	7.96e-05n
75	0.004238n	0.004155o	0.003700n	0.002601n	0.001605n	0.000762n	5.22e-05n	0.000439n	0.000899n	0.000199n
76	0.008582n	0.005707o	0.006647n	0.004818n	0.003012n	0.001386n	0.000209n	0.001854n	0.001798n	0.000418n
77	0.017785m	0.007492n	0.012000n	0.008503m	0.005313m	0.002581m	0.005183m	0.004325m	0.005894m	0.002690m
78	0.029914n	0.011857o	0.020001n	0.015008n	0.009432n	0.004652n	0.014569n	0.012687n	0.016977n	0.006467n

79	0.051272n	0.017150o	0.034002n	0.025013n	0.016057n	0.008020n	0.029249n	0.026350n	0.015980n	0.007464n
80	0.085619n	0.025595o	0.055038n	0.041035n	0.027108n	0.013878n	0.055415n	0.035167n	0.038968n	0.019920n
81	0.158714n	0.039200o	0.087004n	0.066034n	0.043153n	0.022777n	0.091987n	0.117108n	0.109853n	0.040801n
82	0.246251n	0.057134o	0.133216n	0.101318n	0.068418n	0.036653n	0.134639n	0.175875n	0.120049n	0.060722n
83	0.355703m	0.083109n	0.199998m	0.160054m	0.100249m	0.057603m	0.218992m	0.341803l	0.249766m	0.139571m
84	0.421916n	0.099802o	0.300797n	0.231209n	0.163345n	0.092479n	0.353737n	0.504681n	0.421773n	0.286289n
85	0.406853m	0.159790n	0.420051m	0.330181m	0.230783m	0.129404m	0.674781h	1.004938j	0.469720m	0.329257m
86	0.550524m	0.184031n	0.585856m	0.464337m	0.324214n	0.190041n	0.830466n	1.141117m	0.684139n	0.501334n
87	0.717813n	0.292597n	0.782941n	0.634178n	0.456513n	0.281081n	0.999695j	1.857655j	0.837637n	0.684730n
88	0.776808n	0.364701n	1.003472m	0.844165n	0.620735n	0.385740n	1.180816j	2.253053j	1.201259m	0.868460n
89	1.058497m	0.569279n	1.301320m	1.103167m	0.808538n	0.526878n	1.345949k	2.819611l	1.324100m	0.924308n
90	1.136520m	0.635261n	1.600331m	1.401007m	1.004433m	0.677513m	1.533371m	3.442702l	1.840562l	1.238810m
91	1.155202i	0.701050n	1.900159m	1.700750m	1.303979m	0.876133m	2.124179j	3.661816j	2.208392m	1.685824m
92	1.377563l	0.969182n	2.303857m	2.006985m	1.610599m	1.096403m	2.397422j	4.175698i	2.683834l	2.047368m
93	1.794693k	1.243862n	2.608430l	2.417954l	1.947100l	1.441356m	2.647926k	4.824462j	3.460291l	2.683496l
94	2.207092k	1.463276n	3.001639m	2.804011m	2.213912l	1.717995m	2.826936k	5.019365k	3.896098l	3.156832l
95	2.893548h	1.976309l	3.228403k	3.016501j	2.327108k	2.052410j	3.393017j	5.681872j	4.689112l	3.780645l
96	3.346583l	2.278779m	3.622052l	3.609472l	2.909138l	2.296173l	3.857548l	5.675136l	4.730495l	4.255794l
97	3.960518h	2.363460k	4.000712l	4.102079l	3.307764l	2.689426l	4.250292i	5.853327i	5.168953l	4.513259l
98	4.739465l	3.334578l	4.402346l	4.605646l	3.819868k	3.094768m	4.563730k	5.910276l	5.948129l	5.621140k
99	5.021762h	4.225438j	4.900341k	5.101816l	4.308126k	3.594600k	5.127936i	6.612058i	5.968915k	5.995629k
100	5.429661l	4.716195l	5.503917k	5.702185k	4.908335l	4.085070k	5.064528l	5.344593l	6.695368l	6.148659k
101	5.946531j	5.470746l	6.100085l	6.201489l	5.409126l	4.675793l	5.085941k	6.640116j	5.925860l	6.094089l
102	8.702216k	6.139192k	6.600228l	6.501772l	6.010530l	5.372696l	5.368715l	5.088098l	6.156005l	6.134488l
103	6.421727h	6.835643j	6.900187l	6.701817l	6.411477l	5.970477l	5.676476j	5.778366j	5.966247l	6.234774l
104	6.714521j	6.954057l	6.901156l	6.703418l	6.723471l	6.499667l	5.509407k	3.881990j	6.111221l	6.254705l
105	6.383824h	6.795922j	6.600092k	6.401184k	6.808940k	6.879708k	5.550813i	2.647381k	5.656419l	6.006371l
106	5.910693k	6.731699l	6.000084l	5.901417l	6.611154l	6.963948l	5.064454l	3.299610l	5.266321l	5.934506l
107	5.666908k	6.606551k	5.200072l	5.201249l	6.210478l	6.764978l	3.834644k	2.410494l	4.197068l	5.485678l
108	4.306337l	6.007434l	4.200135l	4.301147l	5.510196l	6.369620l	3.039441l	1.778680l	3.267952l	4.449664l
109	4.105321k	5.512780k	3.200066l	3.401232m	4.706985k	5.786775k	2.546623j	1.101409m	2.148744l	3.505540k
110	2.625986m	4.845288l	2.203500m	2.602558m	3.806493l	4.974249l	2.329649l	0.536698n	1.458981l	2.603203l
111	1.849240l	4.309427l	1.500030m	1.900456l	2.904901l	4.078884l	2.234185j	0.136614n	0.399442n	1.105912m
112	2.355469k	4.029611k	0.960019m	1.300442m	2.105019m	3.183519l	1.932375j	0.058549n	0.199721n	0.397917n
113	0.466983n	1.752167m	0.590016n	0.850289m	1.503585m	2.387639l	1.780168i	0.039033n	0.109891m	0.259042m
114	0.177819n	1.242047n	0.350010n	0.540259n	1.002390m	1.687618m	1.425522m	0.034154n	0.099860n	0.149219n
115	0.162740m	0.813718m	0.210004m	0.340115m	0.651098l	1.094334l	1.237393k	0.016257k	0.069931m	0.119558m
116	0.069466n	0.070974n	0.130004n	0.210071m	0.400956m	0.734610m	0.916407m	0.019658m	0.049930n	0.079705m
117	0.045783m	0.025342m	0.088002m	0.140048m	0.250423l	0.457631l	0.810312l	0.017782l	0.042970l	0.049870l
118	0.032313m	0.008606n	0.068001m	0.095032m	0.150359m	0.277961m	0.712761m	0.016709m	0.041959m	0.049816m
119	0.027294m	0.004022n	0.060001m	0.074025m	0.098234m	0.168762m	0.610938m	0.016200m	0.041959m	0.049816m
120	0.035218m	0.002031n	0.057001m	0.065022m	0.070167m	0.109199m	0.610938m	0.014294m	0.030865m	0.035867m
121	0.037392n	0.001548o	0.059002n	0.064031n	0.057194n	0.072473m	0.647598m	0.015868n	0.030810n	0.024745n
122	0.054121n	0.001951o	0.065438n	0.070339n	0.056194n	0.057405n	0.775774n	0.017737n	0.033796n	0.024744n
123	0.061131n	0.002919o	0.079378n	0.086214n	0.064226n	0.055423n	0.880621m	0.019602n	0.041742n	0.031672n
124	0.072503n	0.004366p	0.110015n	0.119452n	0.086003n	0.066334n	1.076351m	0.026143n	0.060663n	0.040639n
125	0.102306m	0.010165n	0.211210k	0.179425k	0.117374k	0.087341k	1.329445l	0.029540m	0.060735m	0.055594m
126	0.166261n	0.034641o	0.297670n	0.287386n	0.207515n	0.148175n	1.565842m	0.070951n	0.139148n	0.118791n
127	0.655311h	0.105346n	0.497249m	0.466997m	0.347046m	0.237888m	1.986371j	0.183390l	0.358431m	0.208474m
128	0.745795k	0.250849o	0.825492m	0.745302m	0.553344n	0.395077n	2.462089l	0.522738n	0.696985m	0.415731n
129	1.206708k	0.566578n	1.292862m	1.092992m	0.872706m	0.634411m	2.659214l	0.971301k	1.354207m	0.843891m
130	2.133605l	1.792972n	2.000642m	1.692700m	1.289321m	0.991321m	2.937754m	1.839257m	2.160803m	1.631795l
131	3.193492g	3.325675j	2.888722l	2.389162l	1.888696l	1.486900m	3.781217i	3.156840h	3.339711l	2.616641l
132	4.773685h	4.654923j	3.884835l	3.185548l	2.677256m	2.081571m	5.269045g	4.567736i	4.815151l	3.969568l
133	5.742512h	5.705270j	4.880948l	3.981943l	3.479293l	2.882821l	5.559636i	6.476310i	6.715520k	5.860116k
134	7.528245k	5.833108l	5.795511k	4.881466l	4.378895l	3.798307l	5.931830j	7.351504h	7.631007l	7.469011l
135	5.908389k	6.626351k	6.475204l	5.675232l	5.273826l	4.696607k	6.177574i	7.676000i	7.234269l	7.494485k
136	4.868946l	7.000599k	7.469068l	6.598412l	6.215476k	5.756134l	5.556258k	7.179158i	7.026604k	7.390275k
137	6.317239l	6.759442k	6.813590j	6.687470j	6.515968j	6.363644j	5.160803l	6.175714l	6.556774l	6.721415l
138	5.813323l	6.655420l	6.683342k	6.772442l	6.779051l	6.746141l	5.230965j	6.224770i	6.408550l	6.616675l
139	6.800054k	6.292854l	6.175956l	6.570461l	6.761938l	6.973103l	4.893587j	6.131347l	5.962652l	6.354039l
140	5.540412h	6.368095k	5.678098l	6.272075l	6.562240l	6.864362l	4.879387i	6.015882j	5.703479l	6.022604l
141	5.149223k	5.323566k	4.850189k	5.925597k	5.929272k	6.617429j	4.823173j	6.018260j	5.493817l	5.295156l
142	3.773883l	5.531054l	4.582862l	5.278035l	5.578393l	6.094366l	4.310172j	4.972978j	4.791217l	4.677512l
143	4.285902i	5.314201k	4.084231l	4.778842l	4.974197l	5.587022l	3.632369j	5.036064j	4.487740l	4.547277l
144	3.721052l	5.051618k	3.699217k	4.023911k	4.673161k	5.054390j	3.166505j	4.845564l	3.928864l	4.195433l

145	3.273451k	3.511538l	3.386780l	3.782849l	3.976388l	4.275163l	2.560566l	3.605956l	3.070610l	3.435676m
146	2.457357l	2.905219m	3.087944l	3.285096l	3.479152l	3.776420l	2.156618k	2.809937k	2.568782m	2.805559l
147	2.092211i	2.570281j	2.689500l	2.881477m	3.081535l	3.279523l	1.956934m	2.500001j	2.123452l	2.387710l
148	2.353141m	1.977976m	2.390693l	2.484103m	2.677745m	2.785428l	1.761575m	1.658467m	1.772483m	1.990738l
149	1.984747m	1.543240n	1.989001m	2.090518l	2.280648m	2.379099m	1.592938k	1.547169l	1.393918m	1.598404m
150	1.852588m	1.119150n	1.729205m	1.803632m	1.989916l	2.081676m	1.274227m	0.737521n	1.063766n	1.260829m
151	1.244853i	0.857558n	1.392300m	1.490419m	1.685679m	1.685082m	0.905197k	0.741838l	0.854712n	1.022541m
152	1.237907m	0.571297o	1.093945m	1.192334m	1.388207m	1.387714m	0.872593n	0.364031n	0.655942n	0.801704n
153	1.309522m	0.589571n	0.843389n	0.904188m	1.090734m	1.189469m	0.659293n	0.196017n	0.457172n	0.623548n
154	0.904141m	0.335650o	0.637940n	0.686427m	0.849812n	0.941665m	0.455775n	0.104821m	0.327975n	0.435494n
155	0.708376n	0.228519o	0.456422n	0.526842l	0.693182l	0.737896l	0.368428n	0.078616m	0.258401n	0.316723n
156	0.445058n	0.181208o	0.327433n	0.366658n	0.484163n	0.562926n	0.271473n	0.061457m	0.139139n	0.237542n
157	0.455385n	0.120508o	0.228212n	0.257652n	0.355711n	0.414788n	0.178397n	0.024299m	0.099385n	0.168259n
158	0.344903n	0.083017o	0.148850n	0.178378n	0.247022n	0.306153n	0.119255n	0.012864m	0.072551n	0.118771n
159	0.233372n	0.058022o	0.099222n	0.118916n	0.177856n	0.217270n	0.073589n	0.001027n	0.044723n	0.079181n
160	0.184298n	0.039288o	0.063879n	0.074870n	0.118643n	0.148142n	0.045812n	0.000373n	0.021868n	0.051468n
161	0.121849n	0.026780o	0.038697n	0.046575n	0.076083n	0.098759n	0.026856n	0.000233n	0.008945n	0.024744n
162	0.081061n	0.020531o	0.023813n	0.028738n	0.048416n	0.065181n	0.013961n	0.000140n	0.001193n	0.008908n
163	0.055762n	0.014282o	0.013891n	0.016847n	0.030631n	0.041479n	0.006118n	5.60e-05n	0.000914n	0.003959n
164	0.025414n	0.010712o	0.007849n	0.009913n	0.018774n	0.025677n	0.003054n	2.33e-05n	0.000318n	0.001485n
165	0.011049m	0.007393n	0.004366n	0.005664m	0.010907m	0.015860m	0.002035m	1.05e-05m	0.000110m	0.000298m
166	0.004544n	0.005356o	0.002381n	0.003072n	0.006225n	0.009481n	0.001028n	2.52e-06n	6.46e-05n	0.000139n
167	0.002272n	0.004463o	0.001290n	0.001685n	0.003557n	0.005432n	0.000398n	9.33e-07n	2.39e-05n	3.96e-05n
168	0.001342n	0.002678o	0.000645n	0.000882n	0.001877n	0.003062n	0.000173n	1.87e-07n	9.24e-06n	1.29e-05n
169	0.000609n	0.001785o	0.000327n	0.000456n	0.000988n	0.001679n	9.68e-05n	7.00e-08n	3.68e-06n	3.46e-06n
170	0.000301n	0.001696o	0.000170n	0.000229n	0.000544n	0.000918n	4.59e-05n	9.33e-09n	9.94e-07n	1.98e-06n
171	0.000176n	0.001160o	8.24e-05n	0.000119n	0.000277n	0.000484n	1.97e-05n	4.67e-09n	2.39e-07n	9.90e-07n
172	9.57e-05n	0.000982o	4.17e-05n	5.85e-05n	0.000138n	0.000247n	1.53e-05n	9.33e-10n	7.65e-08n	4.95e-07n

Future Work

Because of continuing work on fission yield data, no compilation can be regarded as a final work. By applying computer techniques, it is possible to produce future revisions faster. It is not possible to examine the data well enough or gain enough knowledge of the work by each contributor to eliminate all possible mistakes or omissions. However, it is now easier to correct errors and to ensure random new typographical errors will not occur. If all errors found are reported to the authors, it will be possible to minimize errors in later issues of this document.

Energy Definitions

A fission neutron spectrum is one giving a Cd-115 ground state R-value of 2.8 for 235U fission using Mo-99 as reference nuclide. As an expedient, yields measured in the core of a fast reactor have been pooled with fission neutron spectrum yields. Selected yields measured in monoenergetic neutron energies between 0.5 and 2.0 meV have also been pooled with fission neutron spectrum yields. The definitions of thermal and high energy neutrons are consistent with general usage. Thermal neutrons are obtained from a reactor and are assumed to have been moderated to thermal equilibrium. The high energy neutrons are obtained from the H3(d, n)He4 reaction. The actual energies quoted vary from 14 to 15 meV with 14.7 meV being the most often listed mean value. Detailed descriptions of the neutron sources are given in the reference section.

Special Treatment Numbers

- 1. The data were multiplied by the ratio of the Mo-99 yield in U-235 thermal fission to the Mo-99 yield in U-233 thermal fission (6.06:4.80) to remove the original normalization; then they were treated as R-values.
- 2. Reported data (66ARA1) for Sb-126 are the sum of the independent yields of both isomers. The ratio 1.0 to 1.72 corrects for the estimated isomer yield ratio. No renormalization was made.
- 3. The preceding comment applies except the ratio equals 0.5555.
- 4. The measurements were relative to Mo-99, Ba-139, and Ba-140 equal to 6.25, 6.42, and 6.25, respectively. We assumed they were averaged and corrected for the ratio (Mo-99 + Ba-139 + Ba-140) to (6.25 + 6.42 + 6.25). No other renormalization was made.
- 5. The value is measured relative to the total number of fissions determined from the B-10-to-B-11 ratio, and is multiplied by 100 to obtain percent.
- 6. The data were renormalized by using the formula: Yield(mz,ma,mf) = (Yield(mz,ma,norf) * 6.14) / (Yield(norz,nora,norf)) where mz, ma, and mf are the atomic number (Z), mass atomic weight (A), and fissionable material (F), respectively, of the measured nuclide and norz, nora, and norf are the atomic number (Z), atomic weight (A), and fissionable material (F), listed for the normalizing nuclide.
- 7. Values listed are R-values.
- 8. The data were multiplied by 6.14:6.32 to remove the original Mo-99 normalizing values; then they were treated as R-values.
- 9. Values were relative to both Mo-99 and Ba-140 renormalized by the (Mo-99+Ba-140) to (6.1+5.4) ratio.
- 10. Average of 10 values relative to Mo-99 and 4 values relative to Ba-140. Renormalized by (4*Mo-99 + 10*Ba-140)/(4*6.1 + 10*5.4).
- 11. The data were multiplied by the yield of Mo-99 in U-235 thermal fission to the Mo-99 yield in U-235 fission with fission spectrum neutrons (6.14:6.1) to remove the original normalizing values; then they were treated as R-values.
- 12. The data were multiplied by the yield ratio of Mo-99 in U-235 thermal fission to the Mo-99 yield in fission with 8 meV neutrons (6.14:5.4) to remove the original normalizing values; then they were treated as R-values.
- 13. The data were multiplied by the ratio of the Mo-99 yield in U-235 thermal fission to the Mo-99 yield in U-238 fission spectrum fission (6.14:6.2) to remove the original normalizing values; then they were treated as R-values.
- 14. The data were measured relative to the independent yield and were multiplied by the independent yield in the file.

- 15. The data were measured relative to the sum of the yields of both isomers and were renormalized to the sum of isomer yields in the file.
- 16. The data were corrected to a Sr-90 half-life of 28.9 years.
- 17. The data were measured relative to Sn-121 and Sn-125 yields and were renormalized through the ratio (Sn-121 + Sn-125):(0.0122 + 0.0116).
- 18. The listed absolute independent yield values (IN) were calculated from the author's total isotopic yield and the isomer yield ratio (M/M+G) predicted by 76MAD2 (77DEN1 if measured). For relative or fractional independent yields, see special treatment 40 that normalizes to the reference nuclide or multiplies by chain yield, as appropriate.
- 19. The values were measured relative to 6 Sr-89 determinations and 2 Mo-99 values. The Sr-90 half-life was corrected from 19.9 to 28.9 years. The correction ratio was: (6 * Sr-89 + 2 * Mo-99) / (6 * 4.08 + 2 * 5.98) * (28.9 / 19.9).
- 20. The value was multiplied by 100 to give percent.
- 21. The Sr-90 half-life was corrected from 19.9 to 28.9 years. The values were also renormalized to the latest value of the reference nuclide.
- 22. The data were multiplied by the ratio of the Sr-89 yield in U-235 thermal fission to the Sr-89 yield in Th-232 pile neutron fission (4.6:6.7) to remove the original normalization; then they were treated as R-values.
- 23. The Sr-90 half-life was corrected from 25 to 28.9 years. The value was also renormalized to the latest value of the reference nuclide in the file.
- 24. The data were multiplied by the ratio of the Mo-99 yield in U-235 thermal fission to the Mo-99 yield in U-233 thermal fission (6.06:4.8) to remove the original normalization. Then they were treated as R-values.
- 25. The data were multiplied by the ratio of the Cs-137 yield in the Pu-239 thermal fission to the Cs-137 yield in the Pu-241 thermal fission (6.60:6.62) to remove the original normalization; then they were treated as R-values.
- 26. The data were multiplied by the ratio of the Mo-99 yield in U-235 thermal fission to the Mo-99 yield in U-233 thermal fission (6.06:4.75) to remove the original normalization; then they were treated as R-values.
- 27. The reported value was measured relative to the sum of the Sm-151 and Sm-152 yields; then we renormalized it to the sum of the yields of Sm-151 and Sm-152 in the file.
- 28. The data were multiplied by the ratio of the Mo-99 yield in U-235 thermal fission to the Mo-99 yield in Th-229 thermal fission (6.06:0.16) to remove the original normalization; then they were treated as R-values.
- 29. The listed normalizing values were obtained by adjusting the heavy mass peak yields to 100%.
- 30. The data were multiplied by 6.4, the assumed mass 136 yield.

- 31. The data were multiplied by the ratio of the Mo-99 yield in U-235 thermal fission to the Mo-99 yield in Pu-239 thermal fission (6.16:6.79) to remove the original normalization; then they were treated as R-values.
- 32. The data were multiplied by the ratio of the Mo-99 yield in U-235 thermal fission to the Mo-99 yield in U-232 thermal fission (6.25:4.15) to remove the original normalization; then they were treated as R-values.
- 33. The standard error is stated. The standard deviation is obtained by multiplying the standard error by 1.47.
- 34. The Kr-85 half-life was corrected from 9.2 to 10.76 years.
- 35. The Cs-137 half-life was corrected from 33 to 30 years.
- 36. The error was reassigned for this work.
- 37. The value reported is the sum of the metastable and ground states. One-half of the total yield is arbitrarily assigned to each state.
- 38. Measured relative to the sum of the independent yields of both isomers. This treatment is not yet functioning because the sum of independent yields is not stored or available to the computer.
- 39. The listed total relative or fractional isomer yield is the sum of the metastable and ground states. The fraction of this total assigned by computer to the metastable state is 0.71 for Xe-133, Xe-135, Te-133, Te-131 thermal fission as predicted by 76MAD2. For general cases (other than M/M+G = 0.71) see special treatment number 40. For total yields expressed as absolute independent yields (IN), rather than relative or fractional independent (FI) see special treatment number 18 that bypasses normalization to reference nuclide or multiplication by chain yield as appropriate.
- 40. The listed relative or fractional independent yields (IN or FI) were calculated from the author's total isotopic yield and the isomer yield ratio (M/M+G) predicted by 76MAD2 (77DEN1 if measured). For absolute independent yields, see special treatment 18 that bypasses normalization to reference nuclide or multiplication by the chain yield.

R-Values

For yields that were originally measured by the R-method, the original R-values were mathematically reconstructed. An updated yield value was then obtained from the usual R-value method equation. A discussion of the R-method is found in (56FOR1). This is a ratio method used to cancel counter geometry. Radioactivities of specific fission products in, say Pu239, to the corresponding radioactivity produced in U235 in the same irradiation are ratioed. The relative fissions in each foil are normalized by the relative fissions as determined from a nuclide, like Mo-99. If the yields of U235 are assumed to be well-known, the corresponding yield in Pu239 can be calculated from the ratios (designated R-values).

Symbols

Fissile material and inducing species in the order of appearance in this compilation

1	U235T	Uranium	235	Thermal neutrons
2	U235F	Uranium	235	Fission spectrum neutrons
3	U235HE	Uranium	235	High energy neutrons (14.7 MeV)
4	U238F	Uranium	238	Fission spectrum neutrons
5	U238HE	Uranium	238	High energy neutron (14.7 MeV)
6	PU239T	Plutonium	239	Thermal neutrons
7	PU239F	Plutonium	239	Fission spectrum neutrons
8	PU241T	Plutonium	241	Thermal neutrons
9	U233T	Uranium	233	Thermal neutrons
10	TH232F	Thorium	232	Fission spectrum neutrons
11	U233F	Uranium	233	Fission spectrum neutrons
12	U233HE	Uranium	233	High energy neutrons (14.7 MeV)
13	U236F	Uranium	236	Fission spectrum neutrons
14	PU239H	Plutonium	239	High energy neutrons (14.7 MeV)
15	PU240F	Plutonium	240	Fission spectrum neutrons
16	PU241F	Plutonium	241	Fission spectrum neutrons
17	PU242F	Plutonium	242	Fission spectrum neutrons
18	TH232H	Thorium	232	High energy neutrons (14.7 MeV)
19	NP237F	Neptunium	237	Fission spectrum neutrons
20	CF252S	Californium	252	Spontaneous fission
21	U234F	Uranium	234	Fission spectrum neutrons
22	U237F	Uranium	237	Fission spectrum neutrons
23	PU240H	Plutonium	240	High energy neutrons (14.7 MeV)
24	U234HE	Uranium	234	High energy neutrons (14.7 MeV)
25	U236HE	Uranium	236	High energy neutrons (14.7 MeV)
26	PU238F	Plutonium	238	Fission spectrum neutrons
27	AM241F	Americium	241	Fission spectrum neutrons
28	AM243F	Americium	243	Fission spectrum neutrons
29	NP238F	Neptunium	238	Fission spectrum neutrons
30	CM242F	Curium	242	Fission spectrum neutrons
31	TH227T	Thorium	227	Thermal neutrons
32	TH229T	Thorium	229	Thermal neutrons
33	PA231F	Protactinium	231	Fission spectrum neutrons
34	AM241F	Americium	241	Thermal neutrons
35	Am241H	Americium	241	High energy neutrons (14.7 MeV)
36	A242MT	Americium	242M	Thermal neutrons
37	CM245T	Curium	245	Thermal neutrons
38	CF249T	Californium	249	Thermal neutrons
39	CF251T	Californium	251	Thermal neutrons
40	ES254T	Einsteinium	254	Thermal neutrons
41	CF250S	Californium	250	Spontaneous fission

42	CM244S	Curium	244	Spontaneous fission
43	CM248S	Curium	248	Spontaneous fission
44	ES253S	Einsteinium	253	Spontaneous fission
45	FM254S	Fermium	254	Spontaneous fission
46	FM255T	Fermium	255	Thermal neutron fission
47	FM256S	Fermium	256	Spontaneous fission
48	NP237H	Neptunium	237	High energy neutrons (14.7 MeV)
49	U232T	Uranium	232	Thermal neutron fission
50	U238S	Uranium	238	Spontaneous fission
51	CM243T	Curium	243	Thermal neutron fission
52	CM246S	Curium	246	Spontaneous fission
53	CM243F	Curium	243	Fission spectrum neutrons
54	CM244F	Curium	244	Fission spectrum neutrons
55	CM246F	Curium	246	Fission spectrum neutrons
56	CM248F	Curium	248	Fission spectrum neutrons
57	PU242H	Plutonium	242	High energy neutrons (14.7 MeV)
58	NP237T	Neptunium	237	Thermal neutrons
59	PU240T	Plutonium	240	Thermal neutrons
60	PU242T	Plutonium	242	Thermal neutrons

Symbols Used in Tabular Section Pages

Z	Atomic Number
G	Ground State
M	Isomeric State
D	Metastable state resulting from delayed neutron emission
Zp	Most probable atomic number for Gaussian calculation
SIG	Gaussian width parameter (sigma)
XI	Experimental independent yields
RI	Recommended independent yields
XC	Experimental cumulative yields
CC	Calculated cumulative yields
RC	Recommended cumulative yields

Symbols To Indicate Accuracy of Weighted Average Numbers

Letter	Range,%	Error Stored in File,%
A	<0.35	0.35
B	0.35-0.50	0.50
C	0.50-0.70	0.70
D	0.70-1.00	1.00
E	1.00-1.40	1.40

F	1.40-2.00	2.00
G	2.00-2.80	2.80
H	2.80-4.00	4.00
I	4-6	6
J	6-8	8
K	8-11	11
L	11-16	16
M	16-23	23
N	23-32	32
O	32-45	45
P	45 and up	>64

The reader should note that the letter P stands for all errors greater than 45%. The letter P should suggest "*poorly*" known. The modeled independent yields greater than 1%, are assumed to have 32% error. Those between 0.5 and 1.0 are assumed to have 64% error and those <0.5% are assumed to have 100% error. The latter two cases, (although weighted as indicated) both translate as P in every output table. *It is recognized that even smaller independent yields have even larger than 100% error. Indeed, independent yields in the range of 1.0e-9 to 1.0e-12 may be difficult to predict to better than a factor of 100. For this reason, all yields less than 1.0e-12 are blanked out.*

Half-Lives

S	Seconds
M	Minutes
H	Hours
D	Days
Y	Years
L	Common log of years

The half-life also may be listed as short, long, or stable where appropriate.

Symbols To Indicate Measurement Techniques

BM	ENDF/B-V bench mark value
MS	Mass spectrometric
RC	Radiochemical
GC	Gas counter
SP	Special
ES	Estimate
CM	Compiler (not included in average)

Measurement Type

CU	Cumulative
IN	Independent
FC	Fractional Cumulative
FI	Fractional Independent
RE	Relative (arbitrary units)

Note Symbols

SM	Sum of both isomers
AE	Adjusted by T. R. England.
AW	Adjusted by W.H.Walker (73WAL1, 78WAL1, 78WAL2) for changed T 1/2, I-135 gamma abundance and Xe-135 direct yield effects.
AJ	adjusted by others for flux depression or other errors as described in the bibliography section.
SU	Superseded by later publication
LT	Less Than
GT	Greater Than
CM	Data were taken from a compilation of many original sources already cited in this work.
NR	Not Reciprocally treated
GE	Greater than or Equal to
LE	Less than or Equal to
CA	Circa (approximately)
RP	Reciprocal (standard to which yields are relative is also reciprocally relative to that yield).
ES	Estimate
UL	Upper Limit that cannot be averaged with actual measured values
X1	Explanation 1. Not used because it is inconsistent with charge distribution model.
X2	Explanation 2. Not used because of questionable method.
X3	Explanation 3. Not used because it is a compiler value so the primary data is already included herein.
X4	Explanation 4. Outlier by traditional Dixon test (57DIX1)
X5	Explanation 5. This R-value is reduced to an absolute value in the next entry because U235T yields are not stored for use.
X6	Nuclide not treated in this work
X7	See next entry for absolute value hand-reduced for this work

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Lammer, Secretary) formed in 1991. The fission yields recommended in this work appear in the Evaluated Nuclear Data File (ENDF/B-VI) at the Brookhaven National Laboratory. To improve the evaluation for use in calculation of decay heat, revisions were recommended by the ENDF/B-VI Fission Yield Subcommittee. These revisions included modeled direct yield metastable vs. ground state splits (76MAD2), odd-even proton and neutron pairing effects (76MAD1), and the delayed neutron yields treated so that all independent yields are before delayed neutron emission and all cumulative yields are after delayed neutron emission (77ENG3). The authors are grateful for the cooperation of Mike James, David Weaver and Robert Mills of the UK with whom they have exchanged computer data banks and for the encouragement received from the IAEA Fission Product Nuclear Data Panels at Bologna, Italy, 26-30 November 1973, and Petten, Netherlands, 5-9 September 1977.

We especially appreciate the generosity of the General Electric Company in making early versions of codes and data compiled through 1981 available to Los Alamos for continued use in evaluations. Since 1981, the effort has been supported at Los Alamos by the U. S. DoE. Some brief review articles on fission yields appear in the literature. However, the authors believe that the user should have access to both the evaluated yields and the data on which they are based. This belief arose because no abstracting journal has a category "fission yield" so data remain widely scattered in letters, papers, reports, articles, books, and proceedings. Thus, the data have been collected only with difficulty and are not readily available to the user. Large bulk and consequent publication cost rule out journal publication. However, since 1977, it has been available from the authors on microfiche of the highest quality that are easily read, inexpensive, and conveniently stored. As noted in the text the data are now being made available on the internet.

The authors are grateful for the guidance and recommendations of the Fission Yield Subcommittee of CSEWG that is the functional body responsible for the preparation of the Evaluated Nuclear Data File for the USA National Nuclear Data Center at Brookhaven National Laboratory. Members of that Yield Subcommittee have included: T. R. England, chairman; D. G. Madland, J. R. Liaw, B. I. Spinrad, R. E. Schenter, D. M. Gilliam, J. P. Unik, V. Mc Lane, Y. Harker, P. L. Reeder, B. W. Wehring, W. J. Maeck, B. F. Rider, W. B. Wilson, A. C. Wahl, W. H. Walker, and K. Wolfsberg. This Fission Yield and Decay Data Subcommittee is a Sub-group of the Cross Section Evaluation Group (CSEWG) of the Evaluated Nuclear Data File (ENDF) maintained at Brookhaven National Laboratory.

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72KRY1 Kryger, B., **"On a Discrepancy Between the Theoretical and Experimental Fast Neutron Fission Yields of Rare Gases. Demonstration in the Fuel of the Rapsodie Reactor,"** Panel on The Behavior and Chemical State of Fission Products in Irradiated Fuel, Vienna, 7-11 August 1972. CEA Fontenay-Aux-Roses, Nuclear Research Center, France. Paper 4B. Transl. from French by STS Inc. (Oct. 1972) see ANL-TRANS-918. Total Xe+Kr (83, 84, 85, 86Kr + 131, 132, 134, 136Xe) cumulative fast fission yield = $(29\pm1)\%$ in Fortissimo 11-11-002 Assembly, Pin 22 with mean neutron energy of 700 keV. Because 70LIS1 finds this total = 25% for both 235U and 239Pu fast fission after 4 years storage acknowledging possible gas loss, 70LIS1 gas loss appears to be 16% (29/25=1.16) well above our 3% error. Kr, Xe yields taken as 1.16x 70LIS1 values which are still relative to Nd-148 = 1.75%. NSA 27: 14251 (1973). CA 79:12549e (1973). 70LIS1 Xe loss is real (75MAE1).

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& 2 [one finds that fractional direct fission yields for 135I and 133I of 0.481 + 0.023 = 0.504] then (.056/(1.36+.056))*.504= 0.020±0.014 FI for I-133 U235T and (1.36/(1.36+.056))*0.504= 0.484±0.024 FI for I-135 U235T. CA 81:56776 (1974). NSA 30: 15012 (1974). For thesis see NSA 30: 15009 (1974). CSISRS-90561.

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74MEE3 Meek, M. E., Rider, B. F., Estimated independent yield from Wahl model where conflicts in data infer large independent yields in obvious disagreement with charge distribution. (e. g., where a chain yield is measured to be 6.5% yield and its precursor is measured to have a cumulative yield of 6.1%, an independent yield of 6.5 minus 6.1 = 0.4% is inferred but the Wahl model may predict 1.0e-9% for this stable Z. In this case we believe the model prediction that the two final chain members cumulative yields should differ by only 1.0e-9%).

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74MEE5 Meek, M. E., Rider, B. F., Estimated fractional fission yield from charge distribution model (normally computed in previous iteration).

74MEE6 Meek, M. E., Rider, B. F., More valley yields are unmeasured than in any other region. We have estimated valley yields assuming no fine structure in the valley. This should result in a smooth shaped valley. To keep from influencing the absolute peak-to-valley ratio, these smooth estimates are usually made relative to the most accurately measured valley nuclide.

74MEE7 Meek, M. E., Rider, B. F., It is assumed that where the independent yield of the final chain members is negligible, the branching fraction for radioactive decay is independent of the fissioning nuclide. In the case of Kr-85, the independent yield of Kr85 is not negligible. In U235T fission, the total cumulative yield for Kr85g is 0.28519%, of which the cumulative yield for Kr85g from its independent yield is 0.02747%, leaving the cumulative yield of Kr85g from radioactive decay from Kr85m = 0.25772%. The total cumulative yield of Kr85m = 1.28996%. Hence, the true radioactive branching fraction of Kr85m to Kr85g is (0.25772/1.28996) = 0.19979. By adding back the independent yield of Kr85g to the Kr85g from radioactive decay of Kr85m, as it appears in actual fission product samples, one obtains an observable ratio of cumulative yield of Kr85g -to- cumulative yield of Rb85 of 0.2164, 0.2237, and 0.2312 for U235T, PU239T, and U233T, respectively. This computed U235T ratio of 0.2164 is in reasonable agreement with the value of 0.2160 ± 0.0019 measured by (80JAF1). The Kr85 independent yields used in these computations are an average of the mass 85 independent yields computed from the Zp model and the A'p model for charge distribution in fission by (86WAH1) split between Kr85m and Kr85 isomers according to the angular momentum model described by (76MAD2).

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