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TITLE: STATUS OF ENDF/B-V FISSION YIELDS

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INTRODUCTION

Complete yield sets for fissioning nuclides at one or more fission-neutron energies are important in reactor physics calculations; safety, safeguard, and waste studies; and in some measurement applications. Depending on the quality of each set, a number of parameters can be calculated directly from the yield data such as aggregate delayed and prompt neutrons per fission and total and delayed energy release. Other quantities such as decay heating and absorption buildup require additional data.

The first extensive yield data incorporated in the Evaluated Nuclear Data Files (distributed and maintained by the Brookhaven National Laboratry) were in Version IV (ENDF/B-IV). This consisted of ten complete sets of yields for six fissioning nuclides at one or more fission-neutron energies. These sets were for independent (i.e., directly yielded) fission products only.

Version V of ENDF/B (ENDF/B-V) has been greatly expanded. It consists of independent and cumulative yields (by A and Z) for 11 fissioning nuclides at 1 or more fission-neutron energies (20 complete yield sets). Each set contains yields for ∿1100 nuclides; uncertainties are now incorporated in the files. Thus, ENDF/B-V contains ∿44 000 yields plus their uncertainties. These values are listed for each Z value along each mass chain. The independent yields apply before delayed-neutron emission (102 precursors), and the cumulative values apply after delayed neutrons are emitted. Between the two sets most, if not all, user requirements can be satisfied.

The quality of the yield sets is not uniform. Calculated integral quantities are currently used to compare the general quality. Thus, integral quantities such as $\bar{\nu}_d$, $\bar{\nu}_p$, prompt-energy release, etc., are reserved for yield testing rather than being incorporated directly into the yield evaluation process. Only the conservation of the fission-nuclide charge is incorporated into the evaluation, and the yields under each mass peak are normalized to 100% along with a final normalization to 200% for the total mass yields.

The nuclide yield sets included in ENDF/B-IV and -V are identified in Table I. Mass chain yields are not included in ENDF/B-V. In most but not all chains, these are the same as the cumulative yield of the stable or long-lived end nuclide of each decay chain. Figures 1-4 provide a graphical plot of selected mass chain yields and Table II lists the chain yields and uncertainties for 5 of the 20 yield sets important in light water reactors for the mass range 75-160 (ENDF/B uses the range 66-172). Mass chain yields for all sets are listed in Refs. 1 and 2 and are readily derived from Ref. 3.

TABLE I

ENDF/B YIELD SETS[a]

Fissionable	Yield Sets			
Nuclide	Thermal	Fast	(14 MeV)	Spontaneous
^{232}Th		XX	X	
^{237}Np		X		
^{233}U	XX	X	X	
^{235}U	XX	XX	XX	
^{236}U		X		
^{238}U		XX	XX	
^{239}Pu	XX	XX	X	
^{240}Pu		X		
^{241}Pu	XX	X		
^{242}Pu		X		
^{252}Cf				X

[a] X denotes sets in ENDF/B-V only.
XX denotes sets in ENDF/B-IV and V.

TABLE II

ENDF/B-VE MASS CHAIN YIELDS/100 FISSIONS (UNCERTAINTIES IN %)

MASS	TH232(F)	UNCERTAINTY	U238(F)	UNCERTAINTY	U233(T)	UNCERTAINTY	U235(T)	UNCERTAINTY	PU239(T)	UNCERTAINTY
75	2.969E-03	+/- 16.00	2.423E-04	+/- 23.00	8.278E-03	+/- 23.00	1.179E-03	+/- 23.00	1.243E-03	+/- 32.00
76	7.137E-03	+/- 16.00	8.049E-04	+/- 23.00	1.471E-02	+/- 22.99	3.857E-03	+/- 32.00	2.756E-03	+/- 31.99
77	1.229E-02	+/- 8.00	3.334E-03	+/- 11.00	2.615E-02	+/- 23.00	8.432E-03	+/- 11.00	7.336E-03	+/- 11.00
78	3.644E-02	+/- 16.00	1.128E-02	+/- 23.00	5.518E-02	+/- 23.00	2.183E-02	+/- 8.00	2.853E-02	+/- 11.00
79	8.465E-02	+/- 11.00	3.342E-02	+/- 16.00	1.512E-01	+/- 16.00	4.531E-02	+/- 4.00	4.704E-02	+/- 16.00
80	2.046E-01	+/- 16.00	6.950E-02	+/- 23.00	2.391E-01	+/- 23.00	1.308E-01	+/- 4.00	1.133E-01	+/- 16.00
81	4.290E-01	+/- 16.00	1.431E-01	+/- 23.00	2.910E-01	+/- 16.00	1.953E-01	+/- 2.80	1.716E-01	+/- 16.00
82	1.116E+00	+/- 16.00	2.383E-01	+/- 23.00	5.521E-01	+/- 22.97	3.278E-01	+/- 2.80	2.057E-01	+/- 22.63
83	2.223E+00	+/- 1.40	3.935E-01	+/- 1.00	1.018E+00	+/- .70	5.360E-01	+/- .50	2.951E-01	+/- .50
84	4.108E+00	+/- 2.00	8.149E-01	+/- 1.40	1.704E+00	+/- 1.00	9.951E-01	+/- .70	4.745E-01	+/- 1.00
85	4.242E+00	+/- 2.00	7.308E-01	+/- 1.40	2.196E+00	+/- [illegible]	1.310E+00	+/- .35	5.732E-01	+/- .50
86	6.723E+00	+/- 2.00	1.278E+00	+/- 1.40	2.859E+00	+/- 1.40	1.969E+00	+/- .50	7.591E-01	+/- 1.00
87	7.154E+00	+/- 2.80	1.587E+00	+/- 1.40	4.019E+00	+/- 1.00	2.557E+00	+/ .70	9.925E-01	+/- .70
88	7.480E+00	+/- 2.00	2.060E+00	+/- 2.00	5.504E+00	+/- 1.00	3.633E+00	+/- .70	1.364E+00	+/- 1.40
89	7.600E+00	+/- 4.00	2.846E+00	+/- 2.00	6.314E+00	+/- 2.80	4.877E+00	+/- 1.40	1.708E+00	+/- 2.80
90	7.685E+00	+/- 6.00	3.240E+00	+/- 2.00	6.906E+00	+/- 2.80	5.913E+00	+/- .70	2.109E+00	+/- 2.00
91	7.578E+00	+/- 2.80	4.069E+00	+/- 2.80	6.537E+00	+/- 1.00	5.933E+00	+/- .50	2.503E+00	+/- 1.40
92	6.833E+00	+/- 4.00	4.525E+00	+/- 4.00	6.595E+00	+/- 1.00	5.980E+00	+/- .70	3.009E+00	+/- 2.00
93	6.731E+00	+/- 4.00	4.975E+00	+/- 2.80	7.014E+00	+/- 1.00	6.383E+00	+/- .70	3.896E+00	+/- 1.40
94	5.682E+00	+/- 6.00	4.977E+00	+/- 6.00	6.815E+00	+/- 1.00	6.444E+00	+/- .70	4.429E+00	+/- 2.00
95	5.374E+00	+/- 4.00	5.105E+00	+/- 1.00	6.190E+00	+/- 4.00	6.495E+00	+/- .70	4.894E+00	+/- 2.00
96	4.409E+00	+/- 6.00	5.932E+00	+/- 6.00	5.665E+00	+/- 1.00	6.282E+00	+/- .70	5.080E+00	+/- 2.00
97	4.454E+00	+/- 2.00	5.525E+00	+/- 1.00	5.458E+00	+/- 1.00	5.941E+00	+/- .70	5.396E+00	+/- 2.80
98	3.700E+00	+/- 6.00	5.812E+00	+/- 1.40	5.158E+00	+/- 1.40	5.774E+00	+/- .70	5.832E+00	+/- 2.00
99	2.876E+00	+/- 4.00	6.248E+00	+/- 2.00	4.874E+00	+/- 2.80	6.119E+00	+/- 1.00	6.156E+00	+/- 2.00
100	1.379E+00	+/- 6.00	6.618E+00	+/- 1.40	4.408E+00	+/- 1.40	6.206E+00	+/- 1.40	6.810E+00	+/- 4.00
101	7.305E-01	+/- 11.00	6.084E+00	+/- 6.00	3.231E+00	+/- 1.00	5.074E+00	+/- 1.00	5.899E+00	+/- 1.40
102	3.732E-01	+/- 11.00	6.327E+00	+/- 6.00	2.451E+00	+/- 1.40	4.236E+00	+/- 1.00	5.969E+00	+/- 2.00
103	1.528E-01	+/- 6.00	6.229E+00	+/- 1.40	1.669E+00	+/- 4.00	3.042E+00	+/- 1.40	6.950E+00	+/- 2.00
104	9.059E-02	+/- 11.00	4.969E+00	+/- 6.00	1.029E+00	+/- 1.40	1.835E+00	+/- .70	5.914E+00	+/- 2.00
105	4.617E-02	+/- 4.00	3.975E+00	+/- 2.80	4.829E-01	+/- 16.00	9.674E-01	+/- 2.00	5.362E+00	+/- 6.00
106	4.414E-02	+/- 8.00	2.513E+00	+/- 4.00	2.587E-01	+/- 1.00	4.017E-01	+/- 1.00	4.282E+00	+/- 2.80
107	5.194E-02	+/- 11.00	1.303E+00	+/- 8.00	1.174E-01	+/- 16.00	1.405E-01	+/- 6.00	3.362E+00	+/- 11.00
108	6.262E-02	+/- 16.00	6.011E-01	+/- 16.00	6.318E-02	+/- 16.00	6.706E-02	+/- 6.00	2.173E+00	+/- 16.00
109	6.091E-02	+/- 11.00	2.671E-01	+/- 11.00	4.419E-02	+/- 11.00	3.443E-02	+/- 11.00	1.876E+00	+/- 8.00
110	7.219E-02	+/- 16.00	1.355E-01	+/- 16.00	2.612E-02	+/- 16.00	3.038E-02	+/- 11.00	5.989E-01	+/- 23.00
111	7.132E-02	+/- 8.00	8.065E-02	+/- 2.00	1.921E-02	+/- 8.00	2.005E-02	+/- 4.00	3.037E-01	+/- 2.80
112	8.621E-02	+/- 8.00	6.504E-02	+/- 6.00	1.440E-02	+/- 11.00	1.610E-02	+/- 4.00	1.333E-01	+/- 2.80
113	8.630E-02	+/- 11.00	5.267E-02	+/- 8.00	1.366E-02	+/- 16.00	1.634E-02	+/- 6.00	6.517E-02	+/- 4.00
114	7.578E-02	+/- 16.00	3.933E-02	+/- 16.00	1.306E-02	+/- 16.00	1.403E-02	+/- 6.00	6.061E-02	+/- 4.00
115	6.924E-02	+/- 6.00	3.385E-02	+/- 4.00	1.183E-02	+/- 16.00	1.079E-02	+/- 11.00	3.573E-02	+/- 4.00

TABLE II (cont)

MASS	TH232(F)	UNCERTAINTY	U236(F)	UNCERTAINTY	U233(T)	UNCERTAINTY	U235(T)	UNCERTAINTY	PU239(T)	UNCERTAINTY
116	7.542E-02	+/- 16.00	4.162E-02	+/- 11.00	1.442E-02	+/- 16.00	1.696E-02	+/- 6.00	4.950E-02	+/- 8.00
117	6.812E-02	+/- 8.00	3.678E-02	+/- 11.00	1.191E-02	+/- 11.00	1.085E-02	+/- 2.80	5.611E-02	+/- 8.00
118	6.490E-02	+/- 16.00	3.962E-02	+/- 11.00	1.224E-02	+/- 11.00	1.094E-02	+/- 11.00	3.602E-02	+/- 11.00
119	5.893E-02	+/- 16.00	3.576E-02	+/- 11.00	1.258E-02	+/- 11.00	1.216E-02	+/- 11.00	3.906E-02	+/- 16.00
120	5.593E-02	+/- 16.00	3.577E-02	+/- 16.00	1.384E-02	+/- 11.00	1.210E-02	+/- 11.00	3.457E-02	+/- 16.00
121	5.041E-02	+/- 8.00	4.352E-02	+/- 11.00	1.496E-02	+/- 23.00	1.299E-02	+/- 6.00	3.831E-02	+/- 8.00
122	3.765E-02	+/- 16.00	3.762E-02	+/- 16.00	1.475E-02	+/- 11.00	1.530E-02	+/- 11.00	5.017E-02	+/- 16.00
123	3.056E-02	+/- 16.00	4.046E-02	+/- 16.00	1.990E-02	+/- 23.00	1.585E-02	+/- 8.00	4.372E-02	+/- 23.00
124	2.737E-02	+/- 16.00	4.436E-02	+/- 16.00	2.434E-02	+/- 10.99	2.592E-02	+/- 10.99	8.781E-02	+/- 15.98
125	3.861E-02	+/- 11.00	5.271E-02	+/- 8.00	1.122E-01	+/- 11.00	2.939E-02	+/- 8.00	1.110E-01	+/- 8.00
126	5.013E-02	+/- 16.00	6.385E-02	+/- 11.00	2.464E-01	+/- 23.00	5.559E-02	+/- 8.00	2.708E-01	+/- 11.00
127	9.077E-02	+/- 8.00	1.300E-01	+/- 6.00	5.617E-01	+/- 11.00	1.256E-01	+/- 6.00	4.893E-01	+/- 11.00
128	1.861E-01	+/- 16.00	4.015E-01	+/- 11.00	7.573E-01	+/- 6.00	3.507E-01	+/- 2.80	7.478E-01	+/- 6.00
129	3.730E-01	+/- 11.00	9.975E-01	+/- 8.00	1.613E+00	+/- 16.00	7.435E-01	+/- 6.00	1.486E+00	+/- 11.00
130	8.399E-01	+/- 11.00	1.875E+00	+/- 8.00	2.101E+00	+/- 15.98	1.784E+00	+/- 2.00	2.329E+00	+/- 10.97
131	1.621E+00	+/- 2.00	3.233E+00	+/- 1.40	3.606E+00	+/- .70	2.883E+00	+/- .50	3.846E+00	+/- .70
132	2.861E+00	+/- 1.40	5.130E+00	+/- 1.40	4.939E+00	+/- 1.00	4.298E+00	+/- .50	5.393E+00	+/- .70
133	3.964E+00	+/- 4.00	6.620E+00	+/- 1.40	6.022E+00	+/- .70	6.702E+00	+/- .35	6.975E+00	+/- .70
134	5.290E+00	+/- 2.00	7.565E+00	+/- 2.80	6.310E+00	+/- .70	7.795E+00	+/- .70	7.623E+00	+/- .70
135	5.382E+00	+/- 2.00	6.863E+00	+/- 1.40	6.235E+00	+/- 1.40	6.541E+00	+/- 1.00	7.618E+00	+/- 1.40
136	5.655E+00	+/- 2.00	6.855E+00	+/- 4.00	7.122E+00	+/- 3.94	6.316E+00	+/- .50	6.710E+00	+/- 2.77
137	6.640E+00	+/- 4.00	6.000E+00	+/- 1.00	6.812E+00	+/- .70	6.221E+00	+/- .35	6.698E+00	+/- .50
138	7.140E+00	+/- 11.00	5.666E+00	+/- 2.00	5.914E+00	+/- 1.40	6.756E+00	+/- .70	6.057E+00	+/- 1.40
139	7.156E+00	+/- 2.80	5.967E+00	+/- 2.80	6.134E+00	+/- 4.00	6.377E+00	+/- 1.00	5.624E+00	+/- 4.00
140	7.704E+00	+/- 2.80	5.948E+00	+/- 1.00	6.493E+00	+/- 1.00	6.276E+00	+/- .50	5.552E+00	+/- 1.00
141	7.303E+00	+/- 4.00	5.456E+00	+/- 2.80	6.531E+00	+/- 2.80	5.796E+00	+/- 1.00	5.257E+00	+/- 2.80
142	6.318E+00	+/- 4.00	4.728E+00	+/- 1.40	6.656E+00	+/- 1.00	5.877E+00	+/- .50	4.984E+00	+/- 1.00
143	6.519E+00	+/- 2.80	4.558E+00	+/- 1.00	5.892E+00	+/- 1.00	5.937E+00	+/- .35	4.428E+00	+/- .70
144	7.817E+00	+/- 4.00	4.543E+00	+/- 1.00	4.639E+00	+/- .70	5.474E+00	+/- .50	3.738E+00	+/- .50
145	5.283E+00	+/- 2.80	3.755E+00	+/- 1.00	3.392E+00	+/- .70	3.917E+00	+/- .35	2.992E+00	+/- .50
146	4.514E+00	+/- 4.00	3.393E+00	+/- 1.00	2.536E+00	+/- 1.00	2.975E+00	+/- .35	2.462E+00	+/- .50
147	3.011E+00	+/- 4.00	2.531E+00	+/- 1.40	1.750E+00	+/- 2.80	2.253E+00	+/- 1.00	2.043E+00	+/- 1.40
148	1.979E+00	+/- 2.80	2.081E+00	+/- .70	1.272E+00	+/- .70	1.670E+00	+/- .35	1.635E+00	+/- .70
149	8.832E-01	+/- 16.00	1.610E+00	+/- 1.40	7.771E-01	+/- 2.80	1.067E+00	+/- 1.40	1.239E+00	+/- 1.40
150	3.466E-01	+/- 16.00	1.265E+00	+/- 1.40	5.023E-01	+/- .99	6.483E-01	+/- .50	9.663E-01	+/- .50
151	3.142E-01	+/- 6.00	8.011E-01	+/- 2.00	3.153E-01	+/- 2.00	4.184E-01	+/- 1.00	7.721E-01	+/- 1.40
152	7.591E-02	+/- 16.00	5.207E-01	+/- 1.40	2.136E-01	+/- 2.80	2.678E-01	+/- .70	5.852E-01	+/- 1.40
153	3.325E-02	+/- 16.00	4.109E-01	+/- 2.80	1.048E-01	+/- 6.00	1.613E-01	+/- 2.80	3.637E-01	+/- 6.00
154	7.287E-03	+/- 42.57	2.134E-01	+/- 3.82	4.669E-02	+/- 29.84	7.340E-02	+/- 16.66	2.717E-01	+/- 31.60
155	3.828E-03	+/- 23.00	1.328E-01	+/- 16.00	2.175E-02	+/- 23.00	3.205E-02	+/- 4.00	1.655E-01	+/- 11.00
156	2.561E-03	+/- 11.00	6.748E-02	+/- 2.80	1.131E-02	+/- 6.00	1.319E-02	+/- 4.00	1.184E-01	+/- 2.80
157	9.562E-04	+/- 23.00	3.872E-02	+/- 16.00	6.327E-03	+/- 8.00	6.154E-03	+/- 8.00	7.410E-02	+/- 6.00
158	5.041E-04	+/- 32.00	1.730E-02	+/- 16.00	2.315E-03	+/- 32.00	2.915E-03	+/- 23.00	4.074E-02	+/- 23.00
159	1.060E-04	+/- 32.00	8.091E-03	+/- 16.00	8.746E-04	+/- 6.00	1.004E-03	+/- 6.00	2.659E-02	+/- 6.00
160	7.512E-05	+/- 32.00	3.229E-03	+/- 23.00	3.544E-04	+/- 44.94	3.160E-04	+/- 32.00	9.723E-03	+/- 31.96

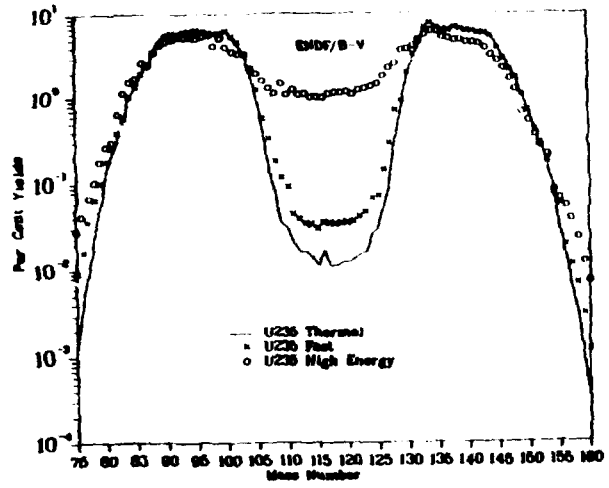

Fig 1
Chain yields vs mass number

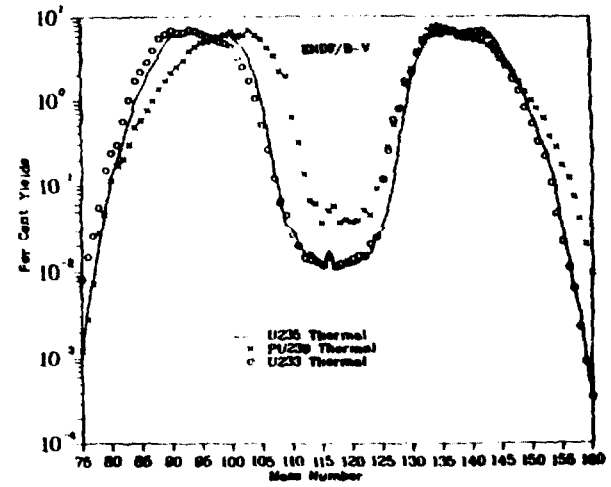

Fig 2
Chain yields vs mass number

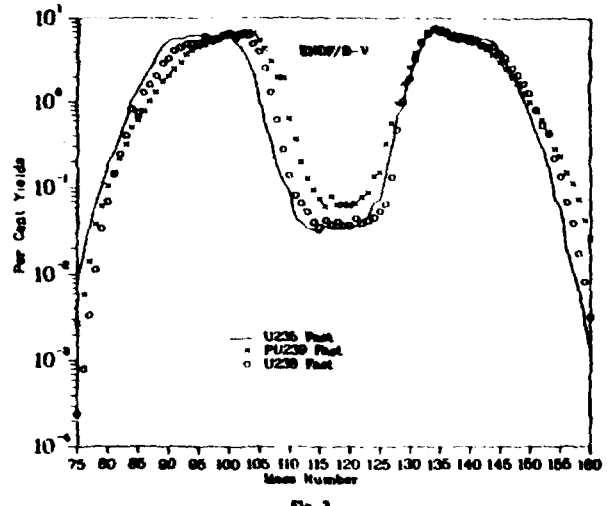

Fig 3
Chain yields vs mass number

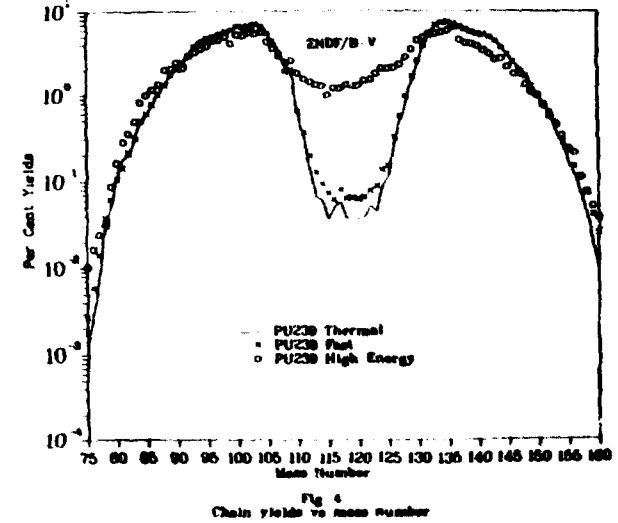

Fig 4
Chain yields vs mass number

Yield data included in the evaluation are based on all known measurements through mid-1978, including unpublished data (at the time of evaluation) by W. J. Maeck and B. W. Wehring, some being preliminary. The 102 delayed-neutron precursor branching fractions are also included in Refs. 1 and 2. Detailed listings of all data are provided in Ref. 3, currently available on microfiche; the ENDF/B-V yields will differ slightly from values in this report due to extensions of the decay chains to cover the range of data in the ENDF/B-V decay files and other minor adjustments. The extensive data-test results will be available in Ref. 2.

DATA INCLUDED IN THE EVALUATION

All recommended yields are the result of weighted averages of experimental values where they exist and modeled values otherwise. Most experimental values are for the mass-chain yields or cumulative values for the long-lived or stable products of each mass chain. The independent yields available during the ENDF/B-V evaluation are relatively sparse. For example, only 74 of the 1153 independent yields in ENDF/B-V for U-235 thermal fission are measured, and roughly half of this number were available for Pu-239 thermal fission. The U-235 values predominately determine parameters used in phenomenological yield distribution models.

Several models are in use. The distribution of yields along the nuclide charges Z of each mass chain A is first assumed to be a Gaussian about a most probable charge Zp(A) with a standard deviation of 0.560 ($\sim$1 1/2 charge units).[4] The Zp values are those in Ref. 5, where values are given, with adjustments in ENDF/B-V to achieve charge balance. The Gaussian model is further modified by a neutron fission-energy dependent even-odd proton and neutron effect given in Ref. 6. The nuclear pairing effects vary from 0 to $\sim$33%, being 23% for U-235 thermal fission. The modified independent yields, in turn, are further distributed among isomeric states as prescribed in Ref. 7. These models will undoubtedly change in the future, at least in their derived parameters, as more independent yield data become available. (An extensive effort at LASL to use the statistical model of fission to improve yield calculations was recently completed — R. E. Pepping, "A Statistical Model Investigation of Nulcear Fission," Ph. D. Thesis, U. of Wisconsin, August 1979. The results may help to predict variations of model parameters such as in energy dependence, but the statistical model is not likely to be applied directly in future versions of ENDF/B.)

The yields are combined using an inverse variance weighting in a General Electric computer code, iterating until the 100% criteria under the lower and upper mass peaks and reasonable charge balance is achieved. In this process, it is necessary to include

decay branching to isomeric states and branching between mass chains due to delayed neutron emission (Pn). (Of the 102 precursor Pn values, half are also model estimates.[1,2]) The Zp values are adjusted within their estimated uncertainty to achieve acceptable charge balance from the sum of binary and ternary fission yields. The ternary yields are listed in Ref. 8.

Large errors are assigned to the model-predicted yields (100% for yields < 1/2%, 64% for yields between 1/2 and 1%, and 32% for yields > 1%). The model values are normalized so that their sum equals the mass-chain yield. The chain-yield uncertaintes are generally very much smaller than model or measured values of independent yields, and a merging process is necessary to reflect the improved accuracy near the end of each decay chain. One set of cumulative yields is calculated by adding independent yields starting with the initial nuclide yield 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 sets are averaged using an inverse variance weighting. The result reflects the small uncertainty in chain yields and the larger uncertainty in the yields of the first few decay-chain nuclides. Other refinements handle delayed-neutron emission, isomer splits, and internal transitions in addition to beta-decay branching ratios.

In the measured data, mass spectrometric measurements are not permitted to have an uncertainty smaller than 0.5% relative because of possible errors in mass discrimination. A systematic uncertainty of 2% is combined with the reported random uncertainty of each absolute fission yield measurement. Radiochemical measurements, because of uncertainties in absolute accuracies of decay schemes and counting efficiences, have not been permitted to have uncertainties smaller than 20% for measurements in the years before 1955, 10% for data between 1955 and 1965, and 5% since 1965. Evaluated data by the Inter Laboratory Radiation Research Program (ILRR) have been treated as benchmark experimental data with their assigned uncertainty.

There are other special treatments and statistical tests to determine the validity of some apparently discrepant yields. These are discussed in Ref. 3.

YIELD DATA TESTS

A large number of tests have been applied to the final yield sets. All cumulative yields along each mass chain were recalculated from the independent yields using decay-branching fractions (the fractions are not listed in ENDF/B-V but are given in Ref. 3).

Approximately 700 plots were made for various yield-derived quantities. These include, for example, prompt and delayed neutron release, prompt and delayed energy release, and yield summations, all vs. Z and A. Some of these graphical data are of general interest and all are useful in finding inconsistencies in the yield data. In addition, integral (yield weighted) data have been compared to experimental data where possible. Reference 2 provides detailed numerical results; Table III indicates by an "X" some quantities in each set that appear to be inconsistent with conservation calculations or with experimental data. The values checked in this table represent, in many cases, a rather subjective judgment; in others the problem may be with auxiliary data, such as the Pn values, used in the yield weightings. The table is meant to briefly indicate the more significant quantities in need of improvement (most probably in some aspect of the yield evaluation) based on the extensive number of numerical tests and comparisons. However, the ENDF/B-V yield data are generally improved over that in ENDF/B-IV in addition to being greatly extended in yield sets and distribution models.

SUMMARY

ENDF/B-V incorporates several features not included in ENDF/B-IV.

- The number of yield sets have doubled.
- Independent and cumulative yields are now included, the former before and the latter after delayed neutron emission.
- Uncertainties are now included.
- Ternary fission effects on the charge balance are incorporated.
- Pairing effects for all sets are incorporated and isomeric state yields are now based on an improved model.
- Experimental yields have been cross checked with an independent evaluation by Crouch, and several transcription errors in both compilations eliminated.
- The few yield evaluations developed in the ILRR program are incorporated as benchmark data.
- More extensive yield testing has been completed.

There are still areas in need of continued improvement, particularly in the yield distribution models. Currently there is an effort to update some yield sets and to add an additional ten sets.

TABLE III

QUANTITIES REQUIRING IMPROVEMENT IN FUTURE VERSIONS OF ENDF/B YIELDS

Yield Set	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Fission System *	232 Th F	232 Th H	233 U T	233 U F	233 U H	235 U T	235 U F	235 U H	236 U F	238 U F	238 U H	237 Np F	239 Pu T	239 Pu F	239 Pu H	240 Pu F	241 Pu T	241 Pu F	242 Pu F	252 Cf S
Charge Balance						X					X			X			X			X
Number of β Decays	X		X	X							X				X					
Average Prompt Neutron	X			X	X		X			X				X						
Average Delayed Neutron	X		X	X						X		X								
Prompt Energy Release	X									X										
Total Energy Release	X		X		X						X						X	X	X	X
Average Mass for each Peak	X				X						X									X
Complementary of Isotopic Chain		X			X		X	X			X				X			X	X	X
Total Isomeric Yields				X				X				X						X		X

* Neutron Energy: T - Thermal, F - Fast, H - High Energy, S - Spontaneous

See text of report; the table is based on Ref. 2.

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