Evaluation: **^{93}Nb Incident Neutron Sublibrary, Release 1 (MAT 4125)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5, 8, 10, 12, 13, 14, 15, 33, 40
Evaluators: A. B. Smith, D. L. Smith, L. P. Gerardo (ANL); R. J. Howerton (LLNL)

ENDF/B-VI MOD 2 REVISION 1 (NNDC August 1991)
The section MOD numbers have been corrected in the directory.

ENDF/B-VI MOD 1 NEW EVALUATION (A. Smith, D. Smith, L. Gerardo, ANL, R. Howerton, LLNL, March 1990)
For complete summary of ENDF/B-V evaluation, see Summary Documentation, 4th Edition, Supplement 1 (1991), page 216.

Evaluation: **^{101}Ru Incident Neutron Sublibrary, Release 2 (MAT 4440)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN)

ENDF/B-VI, REVISION 1 (R. Q. Wright, ORNL, October 1991))

RESONANCE PARAMETERS (File 2)

The resolved resonance range is revised and extended to 1 keV using the MLBW formalism. The highest energy resonance included is 1035 eV. The resolved resonance parameters are taken from Mughabghab, et al. [1]. For resonances for which the value of Γ_γ is not specified in [1], the value 0.180 eV is used. The thermal capture cross section is 3.41 barns and is 10% higher than the ENDF/B-V value. The thermal capture is computed from the positive resonances; a bound level is not included. The capture resonance integral of 111.68 barns is about 11 barns higher than the ENDF/B-V value, and is in good agreement with the value given by Anufriev, et al. [2] of 108±15 barns and with the Mughabghab, et al., value of 100±20 barns.

Unresolved resonance parameters have been added for the range 1 to 100 keV. The unresolved range fit is based on the average capture cross sections from Macklin, et al. [3], see Table 1, following page. The parameters are based on:

$D_0 = 20.42$ eV, $S_0 = 0.59\times10^{-4}$, $S_1 = 6.0\times10^{-4}$, $S_2 = 2.0\times10^{-4}$

$D_1 = 8.75$ eV, $S_{\gamma0} = 8.815\times10^{-4}$, $S_{\gamma1} = 20.57\times10^{-4}$

2200 m/sec capture cross section (barns)
(from resonance parameters) = 3.41

Computed capture resonance integral (barns)
(0.5 eV - 1 keV) = 102.63
(above 1 keV) = 9.05
Total = 111.68

SMOOTH CROSS SECTIONS (File 3)

Total, elastic, and capture are set to zero in the resolved and unresolved resonance ranges (10^{-5} eV to 100 keV). The capture cross section is also revised for energies above 100 keV. The total cross section is unchanged from ENDF/B-V and elastic is revised to reflect the change in the capture cross section. The revised capture cross section follows the data of Macklin [3] between 3 and 700 keV. The capture cross section at 30 keV is about 1007 mb. The revised capture is also compared to the data of Macklin and with ENDF/B-V in Table 1. Macklin's data have been multiplied by a factor of 0.985 to correct for a processing code error. Shown in Table 1 is the change for the new evaluation relative to ENDF/B-V (%DIFF.).

TABLE 1. ^{101}Ru Capture (barns)

E (keV)	Macklin	MAT 4440	ENDF/B-V	% DIFF.
3 - 4	2.612	2.427	2.462	-1.42
4 - 6	2.043	2.110	2.217	-4.83
6 - 8	1.852	1.861	1.993	-6.62
8 - 10	1.720	1.699	1.840	-7.66
10 - 15	1.498	1.506	1.624	-7.27
15 - 20	1.280	1.308	1.404	-6.84
20 - 30	1.111	1.109	1.196	-7.27
30 - 40	0.919	0.926	1.003	-7.68
40 - 60	0.751	0.755	0.820	-7.92
60 - 80	0.601	0.613	0.670	-8.51
80 -100	0.518	0.525	0.574	-8.54
100 -150	0.434	0.441	0.467	-5.57
150 -200	0.337	0.352	0.370	-4.86
200 -300	0.273	0.275	0.296	-7.09
300 -400	0.1940	0.1982	0.2164	-8.41
400 -500	0.1469	0.1523	0.1507	+1.06
500 -600	0.1215	0.1229	0.1119	+9.83
600 -700	0.1001	0.1009	0.0877	+15.05

REFERENCES

1. S. F. Mughabghab, M. Divadeenum, and N. E. Holden, **Neutron Cross Sections, Volume I, Neutron Resonance Parameters and Thermal Cross Sections**, Part A, (Academic Press, NY, 1981)
2. V. A. Anufriev, et al., ***Sov. Atomic Energy* 58**, 326 (1985); translated from ***At. En.* 58**, 279 (1985)
3. R. L. Macklin, R. R. Winters, and J. Halperin, **RIT/LDN(80)1** (NEANDC(E)209) , p. 103 (1980) C.N.E.A. Bologna, Italy

ENDF/B-VI MOD 0 (NNDC, January 1990)
Converted from ENDF/B-V MAT 9330, Fission Product Special Purpose Library.

ENDF/B-V EVALUATION (R. Schenter, F. Schmittroth, F. Mann, et al., HEDL, RCN, February 1980)

SMOOTH CROSS SECTIONS (File 3) (for energy region above resonance region)
Total cross section calculated using Moldauer potential [3] .
Elastic cross section calculated as σ_{tot} - $\sigma_{n,\gamma}$ - σ_{inl}.
Inelastic cross section calculated using COMNUC-3 [4].

Neutron capture evaluated using methods (NCAP code) of Schmittroth [1,2], updated by combining available integral and differential data using the generalized least squares adjustment code FERRET [5].

ANGULAR DISTRIBUTIONS (File 4)

Elastic angular distributions were calculated from Moldauer potential. Nonelastic angular distribution assumed to be isotropic.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)

The evaporation spectrum (LF=9) parameters were obtained using NCAP code [2].

REFERENCES

1. F. Schmittroth and R. E. Schenter, **HEDL TME 73-63** (1973) Hanford Engineering Development Laboratory
2. F. Schmittroth, **HEDL TME 73-79** (1973) Hanford Engineering Development Laboratory
3. P. A. Moldauer, ***Nucl. Phys.*** **47**, 65 (1963)
4. C. L. Dunford, **AI-AEC-12931** (1970) Atomics International, and private communication.
5. F. Schmittroth, **HEDL-TME 77-51** (1978) Hanford Engineering Development Laboratory

Evaluation:	**^{102}Ru Incident Neutron Sublibrary, Release 2 (MAT 4443)**
Energy Range:	10^{-5} eV to 20 MeV
Files:	1, 2, 3, 4, 5
Evaluators:	R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN)

ENDF/B-VI MOD 2 Revision 1 (R. Q. Wright, ORNL, October 1991)

RESONANCE PARAMETERS (File 2)

Resolved resonance range is revised and extended to 13.4 keV using the MLBW formalism; the highest resonance included is 13.446 keV. The resolved resonance parameters are taken from Mughabghab, et al. [1] and from Table V of Macklin and Halperin [2]. 42 s-wave and 107 p-wave resonances are assigned. The bound level at -146 eV has Γ_n^0 of 55 meV and Γ_γ of 112 meV and accounts for about 92% of the thermal capture cross section. The following data has been used:

0 - 1700 eV	14 levels from Anufriev [3]
1700-2660 eV	Parameters are fictitious
2.66-13.4 keV	Based on data of Macklin and Halperin [2], Tables V and VI.

The unresolved resonance region (13.4 to 100 keV) fit is based on the average capture cross sections and strength functions from Macklin and Halperin. The parameters are based on:

$D_0 = 360$ eV, $S_0 = 0.45\times10^{-4}$, $S_1 = 5.0\times10^{-4}$, $S_2 = 0.94\times10^{-4}$

$D_1 = 116$ eV, $S_{\gamma0} = 2.917\times10^{-4}$, $S_{\gamma1} = 9.91\times10^{-4}$

2200 m/sec cross sections (barns)

Total	= 6.793
Elastic	= 5.565
Capture	= 1.228

Computed capture resonance integral= 4.316 barns

SMOOTH CROSS SECTION (File 3)

Total, elastic, and capture are set to zero in the resolved and unresolved resonance regions (10^{-5} eV to 100 keV). The cross sections above 100 keV are unchanged from the previous evaluation.

The average capture cross sections from the revised evaluation are compared with the previous evaluation and with the data of Macklin and Halperin in Table I.

Table I. Ru-102 Average Capture (mb)

E (keV)	Macklin [2]	ENDF/B-VI MOD 0	ENDF/B-VI MOD 2	% change Macklin	% change MOD 0
3- 4	683.5	561.6	829.2	21.3	47.6
4- 6	501.3	522.8	501.7	0.08	-4.04
6- 8	445.6	443.2	432.7	-2.89	-2.37
8-10	464.9	418.6	457.3	-1.63	9.25
10-15	349.9	347.3	379.0	8.32	9.13
15-20	265.8	278.2	276.5	4.03	-0.61
20-30	218.8	219.2	218.0	-0.37	-0.55
30-40	157.6	172.5	171.4	8.76	-0.64
40-50	131.9	144.5	143.3	8.64	-0.83
50-60	122.0	127.0	125.1	2.54	-1.50
60-80		111.5	109.2		-2.06
80-100		98.9	96.7		-2.22

% change Macklin = % difference for revised evaluation relative to Macklin values.
% Change MOD 0 = % difference for revised evaluation relative to previous evaluation.

REFERENCES

1. S. F. Mughabghab, M. Divadeenum, and N. E. Holden, **Neutron Cross Sections, Volume I, Neutron Resonance Parameters and Thermal Cross Sections**, Part A (Academic Press, NY, 1981).
2. R. L. Macklin and Halperin, ***Nucl. Sci. Eng.*** **73**, 174 (1980).
3. V. A. Anufriev, et al., ***Sov. Atomic Energy*** **58**, 326 (1985); translated from ***At. En.*** **58**, 279 (1985).

ENDF/B-VI MOD 0 (NNDC, January 1990)

Converted from ENDF/B-V t 9331 Fission Product Special Purpose Library.

ENDF/B-V EVALUATION (R. Schenter, F. Schmittroth, F. Mann, et al., HEDL, RCN, February 1980)

SMOOTH CROSS SECTIONS (File 3) (for energy region above resonance region)

Total cross sections were calculated using Moldauer potential [3] .

Elastic cross sections were calculated as σ_{tot} - $\sigma_{n,\gamma}$ - σ_{inl}.

Inelastic cross sections were calculated using COMNUC-3 [4].

Neutron capture was evaluated using methods (NCAP code) of Schmittroth [1,2], updated by combining available integral and differential data using the generalized least squares adjustment code FERRET [5].

ANGULAR DISTRIBUTIONS (File 4)

Elastic angular distribution were calculated from Moldauer potential. The nonelastic angular distributions were assumed to be isotropic.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)

Evaporation spectrum (LF=9) parameters were obtained using NCAP code [2].

REFERENCES

1. F. Schmittroth and R. E. Schenter, **HEDL TME 73-63** (1973) Hanford Engineering Development Laboratory
2. F. Schmittroth, **HEDL TME 73-79** (1973) Hanford Engineering Development Laboratory
3. P. A. Moldauer, ***Nucl. Phys.*** **47**, 65 (1963)
4. C. L. Dunford, **AI-AEC-12931** (1970) Atomics International, and private communication.
5. F. Schmittroth, **HEDL-TME 77-51** (1978) Hanford Engineering Development Laboratory

Evaluation: **Cadmium Isotopes Incident Neutron Library, Release 2, 3, 4**
MAT 4825 (^{106}Cd) , 4831 (^{108}Cd), 4837 (^{110}Cd), 4840 (^{111}Cd), 4843 (^{112}Cd), 4846 (^{113}Cd), 4849 (^{114}Cd), 4855 (^{116}Cd)
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: J. McCabe, A. B. Smith,[1] J. W. Meadows (ANL); R. Q. Wright (ORNL)

ENDF/B-VI MOD 4, Revision 2 (R. Q. Wright, ORNL, and V. McLane, NNDC)

The File 1 comments for the even isotopes were updated.

^{112}Cd An obsolete code was deleted in File 3, MT=4.

^{114}Cd The unresolved resonance range scattering width was changed to 6.19 fm in order to eliminate a discontinuity in the total cross section at 100 keV.

^{116}Cd The unresolved resonance parameters were revised in order to eliminate a discontinuity in the total cross section at 100 keV. The s- and p-wave strength functions were increased to 0.2E-4 and 3.4E-4, respectively, for both the resolved and unresolved resonance regions. The calculated resolved resonance thermal scattering cross section is 5.806 barns. The revised evaluation has higher total and elastic cross sections between 9 and 100 keV, but the capture is almost identical (within +1.2 to -2.0%) to the previous evaluation.

ENDF/B-VI MOD 3 Evaluation (J. McCabe, A. B. Smith, J. W. Meadows, ANL, August 1994)

Comprehensive neutronic evaluated data files for the naturally-occurring isotopes of cadmium are deduced from the experimental data and nuclear models. Particular attention is given to those processes relevant to fuel-cycle and fission-product applications. Comparisons are made with prior evaluations of the cadmium isotopes, and discrepancies and consistencies cited. Some discrepancies are very large (*e.g.*, as much as 100%), and the differences have the potential for a pronounced impact on applications usage. The present files are comprehensive, including many important processes that are not represented in the previous ENDF/B-VI evaluation.

The resonance region evaluation was carried over from the MOD 2 update to the ENDF/B-V evaluations, R. Q. Wright [2]. See McCabe, et al. [1] for complete documentation.

REFERENCES

1. J. McCabe, A. B. Smith, and J. W. Meadows, Report **ANL/NDM-129** (1993) Argonne National Laboratory.
2. R. Q. Wright, ***Trans. Am. Nucl. Soc.* 68**, Part A, 468 (1993).

ENDF/B-VI MOD 2 NEW EVALUATION, R. Q. Wright (December 1991)

This evaluation is a modification of the ENDF/B-V evaluation.

RESOLVED RESONANCE RANGE

The MLBW formalism is used for this evaluation. The resolved resonance parameters are taken from Mughabghab [1] and Musgrove, et al. [2].

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[1] Also at the University of Arizona, Tempe, AZ.

^{106}Cd The upper limit of the resolved resonance range is 6.0 keV; the highest energy resonance included is 5881 eV. In Mughabghab [1] there is a gap between about 700 and 2500 eV where no resolved resonance data is available. 14 fictitious s-wave resonances were inserted in this region. Above 2500 eV, 25 resonances were assigned as s-wave and 27 were assigned as p-wave. Also 4 fictitious s-wave resonances were inserted above 6 keV. For s-wave resonances the average gamma width is 0.1612 eV; the average level spacing is 142.6 eV; the s-wave strength function is 0.834×10^{-4}. The p-wave capture width is set to 0.175 eV for all 27 resonances.

^{108}Cd The upper limit of the resolved resonance range is 6.1 keV; the highest energy resonance included is 5970 eV. In Mughabghab [1] there is a gap between about 500 and 2500 eV where no resolved resonance data is available. 18 fictitious s-wave resonances were inserted in this region. Above 2500 eV, 31 resonances were assigned as s-wave and 29 were assigned as p-wave. For s-wave resonances the average gamma width is 0.1055 eV; the average level spacing is 119.6 eV; the s-wave strength function is 1.446×10^{-4}. The p-wave capture width is set to 0.125 eV for all 29 resonances.

^{110}Cd The upper limit of the resolved resonance range is 7.1758 keV; the highest energy resonance included is 9860 eV. 55 resonances were assigned as s-wave (including 11 s-wave resonances above 7175.8 eV) and 48 were assigned as p-wave. The bound level at -110 eV has a Γ_n^0 of 304.44 meV[2] and accounts for about 92% of the thermal capture cross section. The total cross section at thermal is 29.24 barns.

^{112}Cd The upper limit of the resolved resonance range is increased to 7.35 keV; the highest energy resonance included is 11455 eV. 64 s-wave and 54 p-wave resonances were assigned including 24 s-wave resonances above 7350 eV. The bound level at -125 eV has a Γ_n^0 of 93.91 meV and Γ_γ of 83 meV (Mughabghab [1]), and accounts for about 95% of the thermal capture cross section. The elastic cross section at thermal is 6.31 barns.

^{114}Cd The upper limit of the resolved resonance range is increased to 8.0 keV; the highest energy resonance included is 10088 eV. 40 s-wave and 45 p-wave resonances were assigned including 5 s-wave resonances above 8000 eV. The bound level at -225 eV has a Γ_n^0 of 34.53 meV and Γ_γ of 53.0 meV, and accounts for about 43% of the thermal capture cross section. The elastic cross section at thermal is 4.461 barns.[3]

^{116}Cd The upper limit of the resolved resonance range is increased to 9.0 keV; the highest energy resonance included is 8825 eV. 27 s-wave and 21 p-wave resonances are assigned. The bound level at -550 eV has Γ_n^0 of 101 meV and Γ_γ of 48 meV, and accounts for about 90% of the thermal capture cross section. The elastic cross section at thermal is 5.39 barns.

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[2] Note that the Mughabghab [1] reduced neutron width of the bound level should be half the quoted value (302.5 meV), see page D-2 of Mughabghab [4]. Also the calculated capture resonance integral is 42 barns. In addition, one of the double entries of the 89.5 eV resonance should be deleted.

[3] Note that the value of the capture resonance integral given on page 48-22 of Mughabghab [1] should read 13±2 barns (see Mughabghab [4]).

UNRESOLVED RESONANCE RANGE

The unresolved resonance range fit is based on the average capture cross sections from page 449 of Musgrove, et al. [3]. The unresolved resonance parameters are based on:

	D_0 (eV)	S_0 (10^{-4})	S_1 (10^{-4})	S_2 (10^{-4})	D_1 (eV)	$S_{\gamma 0}$ (10^{-4})	$S_{\gamma 1}$ (10^{-4})
106Cd	110.	1.0	5.0	0.5	42.	14.09	41.67
108Cd	100.	1.44	4.4	0.5	46.67.	10.5	25.71
110Cd	155.	0.5	3.0	1.0	53.33.	4.58	15.0
112Cd	190.	0.5,	4.4	1.5	75.	4.05	12.0
114Cd	235.	0.64	3.5	1.0	90.	2.26	7.78
116Cd	390.	0.16	2.8	1.0	150.	1.205	4.67

FILE 3 CHANGES:

Total, elastic, and capture are set to zero in the resolved and unresolved resonance ranges (1.0×10^{-5} eV to 100 keV). For ^{106,108,110,112}Cd, the cross sections are unchanged from the previous evaluation for energies above 100 keV. The capture cross section is reduced by about 40% for ^{114}Cd and 20% for ^{116}Cd between 100 keV and 5 MeV. The elastic cross section is increased by a small amount in this range such that the total cross section is unchanged.

	^{106}Cd	^{108}Cd	^{110}Cd	^{112}Cd	^{114}Cd	^{116}Cd
2200 m/s Capture cross section (barns) (from resonance parameters)	1.12	1.10	11.01	2.195	0.336	0.075
Computed resonance integral (barns)	14.20	16.98	41.36	13.50	13.15	1.735

REFERENCES

1. S.F. Mughabghab, M. Divadeenam, and N.E. Holden, **Neutron Cross Sections, Volume I, Neutron Resonance Parameters and Thermal Cross Sections**, Part A (Academic Press, NY, 1981)
2. A. Musgrove et al., ***J. of Physics*, G 4**, 771 (1978)
3. A. Musgrove et al., **Neutron Physics and Nuclear Data**, Conference, Harwell, UK (1978) Table V, page 449. (1978). Values are multiplied by a factor of 0.985 (see ***Nucl. Sci. Eng.* 82**, p. 230)
4. S.F. Mughabghab, **Neutron Cross Sections, Volume I, Neutron Resonance Parameters and Thermal Cross Sections**, Part B (Academic Press, NY, 1981)

ENDF/B-VI MOD 0 EVALUATION (NNDC, January, 1990)

Converted to ENDF-6 format from ENDF/B-V: ^{106}Cd (MAT 9440), ^{108}Cd (MAT 9442), ^{110}Cd (MAT 9444), ^{112}Cd (MAT 9447), ^{114}Cd (MAT 9450), ^{116}Cd (MAT 9453).

Evaluation: **^{112,114}Sn Incident Neutron Library, Release 1**
MAT 5025 (^{112}Sn), MAT 5031 (^{112}Sn)
Energy Range: 10^{-5} eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: F. M. Mann (HEDL)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, August 1991)

The low energy interpolation code changed to log-log for the total and capture cross section (MF=3, MT=1,102).

ENDF/B-VI MOD 0 (NNDC, January 1990)

ENDF/B-V MAT 9513 (^{112}Sn) and MAT 9516 (^{114}Sn) converted to ENDF-6 format.

ENDF/B-V EVALUATION (F. Mann, HEDL, February 1980)

File 2 resonance parameters taken from Mughabghab [1].

File 3 cross sections are from Hauser-Feshbach calculations using the Moldauer potential. Low energy data determined from thermal cross section using a 1/v tail.

File 4 angular distributions assumed isotropic.

File 5 evaporation temperatures from $3.2*\sqrt{E/AWR}$.

REFERENCE

1. S. F. Mughabghab and D. L. Garber, **BNL-325**, Third Ed., Vol. 1, Resonance Parameters (1973) Brookhaven National Laboratory

Evaluation: **^{127}I Incident Neutron Sublibrary, Release 2 (5325)**
Energy Range: 10^{-5} eV to 30 MeV
Files: 1, 2, 3, 4, 6, 8, 9, 12, 14, 15
Evaluators: P. G. Young, R. E. Macfarlane (LANL)

ENDF/B-VI MOD 1 NEW EVALUATION (P. Young, R. MacFarlane, LANL, March 1991)

GENERAL COMMENTS

Resolved resonance parameters from an analysis of Mughabghab [Mu81] were used with a multi-level Breit-Wigner representation to represent the total, elastic, and capture data up to an incident neutron energy of 1 keV.

The evaluation above the resonance region (E>1 keV) is based on a theoretical analysis using the SCAT2 optical model code [Be81] the COMNUC [Du70] and GNASH [Yo77, Ar88] Hauser-Feshbach statistical theory codes, the DWUCK [Ku70] distorted-wave Born approximation code, and the ECIS [Ra70] coupled-channel deformed optical model code.

OPTICAL MODEL POTENTIAL

The spherical optical model potential of Yamamuro [Ya90] which utilizes Walter's [Wa85] potential above 20 MeV, was utilized with slight modification at low energies, similar to Yamamuro [Ya88]. For protons, the potential of Perey [Pe63] was modified to include an energy-dependent term in the surface imaginary potential. The alpha potential used by Arthur and Young in Fe calculations [Ar80] was adopted for alpha particles. The above potentials were used to supply transmission coefficients for neutrons, protons, and alpha particles in the Hauser-Feshbach statistical calculations. Of course, all the neutron cross sections depend on the potentials through the transmission coefficients. It was necessary only to adjust the neutron total and capture cross sections to improve agreement with experimental data. The neutron potential was used to obtain all the shape elastic components of the neutron elastic scattering angular distributions, as well as the compound elastic and inelastic scattering angular distribution components.

DIRECT REACTION ANALYSIS

The coupled-channel calculations of Matoba [Ma75] for ^{126}Te were repeated with ECIS in order to verify the importance of vibrational states and to confirm the validity of using simple DWBA calculations. The deformation parameters beta(l=2,J=2+) and beta(l=3,J=3-) from Matoba, together with B(E2) and B(E3) values for ^{127}I in Nuclear Data Sheets [Ha82], were used to infer deformation parameters for ^{127}I levels. The E2 strength was distributed among known levels in ^{127}I; the E3 strength was distributed among 5 arbitrarily assumed negative parity levels between E_x=1.3 and 2.1 MeV in ^{127}I. The deformation parameters from the above analysis were used in DWBA calculations with DWUCK to provide cross section and angular distributions for the discrete ^{127}I(n,n′) reactions to relevant levels in ^{127}I. The compound nucleus reaction cross section was decreased appropriately for the direct reaction components.

HAUSER-FESHBACH STATISTICAL CALCULATIONS

The GNASH code was used for all Hauser-Feshbach statistical theory calculations between 0.001 and 30 MeV. Width fluctuation corrections were obtained from the COMNUC code [Du70], which utilizes the model of Moldauer [Mo76]. Preequilibrium corrections are carried out in GNASH with the exciton model of Kalbach [Ka77,Ka85]. Discrete level data were obtained from Nuclear Data Sheets [Ha82]; continuum level densities were represented with the Gilbert-Cameron [Gi65] model using the Cook parameters [Co67]. Particle transmission coefficients were obtained from the optical model calculations described above. Transmission coefficients for γ rays were calculated using the Brink-Axel model [Br55,Ax62]. Normalization of the γ-ray strength function was carried out using the compilation of Mughabghab [Mu81]. Calculations were carried out for all reactions that produce neutrons, protons, α particles, or γ rays for incident neutron energies between 1 keV and 30 MeV. The RECOIL code by MacFarlane [Ma84] was used to analyze and unfold the GNASH output for representation in ENDF/B MF=6 format. Angular distribution systematics by Kalbach [Ka88] were used to describe angular distributions for continuum particles, as well as discrete reactions where direct reaction data were lacking.

RESONANCE PARAMETERS (File 2)

Resolved Resonance Parameters: Zero to 1 keV, MLBW representation used with the resonance parameters of Mughabghab [Mu81]. Smooth cross section background included for the capture cross section to improve agreement with experimental data in range 20 to 1000 eV.

<u>2200 m/sec cross sections (barns)</u>

Total	= 10.9821
Capture	= 6.23164
Elastic	= 4.75044

SMOOTH CROSS SECTIONS (File 3)

<u>Total Cross Section</u>: From 1 keV to 14 MeV, the optical model calculation was adjusted to agree with bulk of experimental data. Below 100 keV, the cross section was smoothly joined with resonance range. From 0.1 to 3 MeV, the data of Tabony, et al., [Ta68], Miller, et al. [Mi52], Bockelman, et al. [Bo49] was emphasized. From 3 to 14 MeV, mainly Foster and Glasgow [Fo71] was used. Near 30 MeV, experimental data of Deconninck [De61] was used to adjust optical model calculations.

<u>Elastic Scattering Cross Section</u>: The cross section was obtained by subtracting all nonelastic cross sections from total. It is essentially equal to combination of shape elastic cross section from SCAT2 and compound elastic cross section from COMNUC calculation. Optical model potential and other parameters were taken from the analysis described above.

<u>Inelastic Scattering Cross Section</u>: Sum of MT=51-91 Cross Sections.

<u>MT=16,17,22,28,37,649,849</u>: Based on GNASH calculations.

<u>(n,n′) Discrete Inelastic Cross Sections</u>: Based on compound nucleus calculations using GNASH code, with DWBA direct reaction components added for E2 vibrational contributions in MT= 51-58,60,63-65 and E3 contributions in MT=67-71. Note that MT=67-71 are assumed levels for the purpose of including the E3 strength, which must be present.

<u>(n,n′) Cross Section to Continuum States</u>: Based on GNASH calculations.

Capture Cross Section: From 1 to 100 keV, essentially GNASH calculation, with small adjustment for data, especially [Gi61]. From 100 keV to 3.5 MeV, calculated values adjusted significantly to match data, especially [St61]. From 3.5 to 30 MeV, based on GNASH calculations, in agreement with experimental data.

(n,p) and (n,α) Cross Section Sum of MT=600-649 and MT=800-849, respectively.

(n,p) and (n,α) to Discrete States: Based on GNASH calculations. Note that, for (n,α), data for first 29 levels lumped into a single level (MT=801) due to small cross sections. Decay scheme of thirteenth excited state assumed.

(n,alpha) Cross Section to Continuum States: Based on GNASH calculations.

ANGULAR DISTRIBUTIONS (File 4)

Elastic angular distributions were obtained by combining shape elastic calculations using the SCAT2 code [Be81] with compound elastic contributions calculated with COMNUC [Du70]. Optical model and other parameters were taken from the analysis described above. Legendre polynomial representation used.

CORRELATED ENERGY-ANGLE DISTRIBUTIONS (File 6)

Continuum energy distributions for MT=16, 17, 22, 28, 37, 91, 649, and 849 were calculated with the GNASH reaction theory code (see above). Energy-angle correlations are given using the updated angular distribution systematics of Kalbach [Ka88]. Recoil angular distributions are given as P1 Legendre expansions. Multiplicities angular (and implicit energy) distributions are also provided for discrete reactions in MT=51-71, 600-622, and 800-829. Data are given for outgoing particles, gamma rays, and recoil nuclei.

MT=16,17,22,28,37,649,849: GNASH Hauser-Feshbach statistical/preequilibrium calculations. Energy-angle distributions are given for secondary neutrons and recoil nuclei.

(n,n′) Discrete Inelastic Cross Sections: Discrete data taken from compound nucleus and pre-equilibrium calculations with GNASH, and from DWBA calculations with DWUCK. MT=51-54,56-58,60,63-65 include direct components with compound nucleus and preequilibrium, MT=55,59,61,62,66 include compound nucleus and preequilibrium, and MT=67-71 are pure direct reaction data. Angular distributions are given as Legendre expansions.

(n,n′) Cross Section to Continuum States: GNASH Hauser-Feshbach statistical/preequilibrium calculations. Energy-angle distributions are given for secondary neutrons and recoil nuclei.

(n,p) and (n,α) to Discrete States: Discrete data taken from compound nucleus and preequilibrium calculations with GNASH. Angular distributions assumed isotropic because of very small cross sections. Note that, for (n,α), data for first 29 levels lumped into a single level (MT=801) due to small cross sections. Decay scheme of thirteenth excited state assumed. Energy-angle distributions are given for secondary alphas and recoil nuclei.

RADIOACTIVE NUCLIDE DATA

(n,p) Information on ground and 88-keV isomeric states.

(n,α) Information on ground, 11-, and 37-keV isomeric states.

MULTIPLICITIES FOR RADIOACTIVE NUCLIDES (File 9)

Branching ratios obtained from GNASH calculations. NOTE: Isomeric transition contributions are not included in γ cascades so that multiplicities add to unity.

PHOTON PRODUCTION (Files 12, 13, and 15)

Photon multiplicities from radiative capture. Note that γ rays from (n,γn′) reactions are included so that multiplicities become nonphysically large above neutron energies of a few hundred keV.

Photon angular distributions are from radiative capture; assumed isotropic.

Photon gamma-ray energy distributions are obtained from GNASH calculations.

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Evaluation: **^{138}Ba Incident Neutron Library, Release 3 (MAT 5649)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5, 12, 13, 14, 15
Evaluators: R. Q. Wright (ORNL), R. Howerton (LLNL)

ENDF/B-VI MOD 1 NEW EVALUATION (R. Q. Wright, ORNL, December 1994)

RESONANCE REGION

Resolved resonance parameters were added in the range from 0.4 to 198 keV using the MLBW formalism; the highest resonance included is 194.78 keV. The principal source for the resolved resonance parameters in this evaluation is the data of Brusegan, et al. [1] which has 11 s-wave and 29 p-wave resonances. An additional 20 p-wave resonances have been included from Musgrove, et al. [2].

The average Γ_γ for s-wave is 0.089 eV, D_0 = 18.7 keV, and $S_0 = 0.73\times10^{-4}$.
The average Γ_γ for p-wave is 0.066 eV, D_1 = 3.95 keV, and $S_1 = 1.07\times10^{-4}$.
The scattering radius, R = 5.083 fm.

2200 m/sec cross sections (barns)

Total	=	3.342
Elastic	=	2.982
Capture	=	0.360

Capture Resonance Integral = 0.267 barns

FILE 3 CHANGES

File 3 Cross Sections are revised below 400 eV. The low energy total cross section is based on the measured data of Koester, et al. [3]. The low energy capture is 1/v up to 400 eV with a thermal value of 0.36 barns taken from Mughabghab, et al. [4]. The elastic cross section has been set to zero in the resolved resonance range but for capture a small 1/v background has been used.

(n,p) and (n,α) were revised to be the same as the JENDL3.2 evaluation.

AVERAGE CAPTURE CROSS SECTIONS

The average capture cross sections, flat weighting, calculated with NJOY, using this evaluation are compared with the measured values from Musgrove, et al. [2] for the energy range 0.1 to 100 keV in Table 1, below.

Table 1. ^{138}Ba Average Capture (mb)

Energy (keV)	Measured	Calculated
0.1-0.4		3.82
0.4-1.0		51.38
1 - 3		34.74
3 - 4		0.97
4 - 5	13.9 ±1.8	15.63
5 - 6		0.79
6 - 8	13.0 ± 2.0	13.66
8 - 10	5.5 ± 0.8	9.21
10 - 15	2.7 ± 0.4	3.00
15 - 20	5.6 ± 0.7	5.86
20 - 30	3.0 ± 0.6	2.69
30 - 40	3.3 ± 0.7	3.77
40 - 50	2.1 ± 0.7	2.54
50 - 60	6.4 ± 1.3	6.39
60 - 80	3.3 ± 1.0	2.99
80 - 100	2.5 ± 1.0	2.50

REFERENCES

1. A. Brusegan, E. Macavero, and C. Van der Vorst, **Nuclear Data for Science and Technology**, International Conference, Gatlinburg, TN, May 9-13, 1994.
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4. S. F. Mughabghab, M. Divadeenam, and N. E. Holden, **Neutron Cross Sections, Volume I, Neutron Resonance Parameters and Thermal Cross Sections**, Part A, (Academic Press, NY, 1981)

ENDF/B-VI MOD 0 (NNDC, January 1990)

Originally evaluated by R. Howerton [1] for ENDL. Converted to ENDF/B-V then to ENDF/B-VI format by NNDC.

REFERENCE

1. R. W. Howerton, **UCRL-50400**, Vol. 15, Part D, Rev. 1, p. 234 (1978) Lawrence Livermore National Laboratory

Evaluation: **^{140}Ba Incident Neutron Library, Release 3 (MAT 5655)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. E. Schenter, F. Schmittroth (HEDL)

ENDF/B-VI MOD RELEASE 3 (NNDC, May 1995)
Minor correction to File 1 comments.

ENDF/B-VI MOD 0 (NNDC, January 1990)
ENDF/B-V material converted to ENDF-6 format by NNDC.

ENDF/B-V EVALUATION (R. Schenter, F. Schmittroth, HEDL, April 1974)

RESONANCE PARAMETERS (File 2)
No resonance parameters given except AP.

2200m/s capture cross section (barns)		
(from resonance parameters)	=	0.000
(from 1/v component)	=	1.600
total	=	1.600
Computed resonance integral	=	12.740

SMOOTH CROSS SECTIONS (File 3)
Total cross section calculated using Moldauer potential [4] for energies above the resonance region.
Elastic cross section above resonance region calculated from σ_{tot}- $\sigma_{n,\gamma}$- σ_{inel}.
Inelastic cross sections calculated using COMNUC-3 [5].
Neutron capture evaluated using methods (NCAP code) [1,2] for energies above the resonance region. A 1/v component was added to give the 2200 m/s cross section of Mughabghab [3] for lower energies. The calculated resonance integral agrees (to within 1 σ) with the value given in Mughabghab.

ANGULAR DISTRIBUTIONS (File 4)
Angular distribution assumed isotropic.

SECONDARY ENERGY DISTRIBUTIONS (File 5)
Evaporation spectrum (LF=9) parameters obtained using NCAP code [2].

REFERENCES

1. F. Schmittroth, R. E. Schenter, **HEDL TME 73-63** (1973) Hanford Engineering Development Laboratory
2. F. Schmittroth, **HEDL TME 73-79** (1973) Hanford Engineering Development Laboratory
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5. C. L. Dunford, **AI-AEC-12931** (1970) Atomics International, and private communication

Evaluation: **^{139}La Incident Neutron Library, Release 1 (MAT 5728)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5, 8, 9
Evaluators: R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, July 1991)
Converted MAT 9707 from ENDF/B-V to ENDF-6 format and added to evaluation.

ENDF/B-VI MOD 0 (NNDC, July 1991)
Converted from ENDF/B-V MAT 7579 to ENDF-6 format.

ENDF/B-V EVALUATION (R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN), February 1980)

RESONANCE PARAMETERS (File2)
Taken from Mughabghab [3].

SMOOTH CROSS SECTIONS (File 3)
Calculated using potential of Moldauer [4] above resonance region.
Elastic cross section above resonance region calculated from σ_{tot}- $\sigma_{n,\gamma}$- σ_{inel}.
Inelastic cross sections calculated using COMNUC-3 [5].
Neutron capture evaluated above the resonance region using methods (NCAP code) [1,2]. A 1/v component was added to give the 2200 m/s cross section of Mughabghab. Energy region above the resonance region was updated by combining available integral and differential data using the generalized least squares adjustment code FERRET [6].
Average logarithmic energy decrement for elastic scattering of neutrons calculated from $\bar{\mu}$ (MT 251).

ANGULAR DISTRIBUTIONS (File 4)
Angular distribution assumed to be isotropic.

SECONDARY ENERGY DISTRIBUTIONS (File 5)
Evaporation spectrum (LF=9) parameters obtained using NCAP code[2].

REFERENCES

1. F. Schmittroth and R. E. Schenter, **HEDL TME 73-63** (1973) Hanford Engineering Development Laboratory
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5. C. L. Dunford, **AI-AEC-12931** (1970) Atomics International, and private communication
6. F. Schmittroth, **HEDL-TME 77-51** (1978) Hanford Engineering Development Laboratory

Evaluation: **^{143}Nd Incident Neutron Sublibrary, Release 2 (MAT 6028)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, January 1992)

RESONANCE PARAMETERS (File 2)

The resolved resonance region is revised and extended 5285 eV using the MLBW formalism; the highest energy resonance included is 5503 eV. The resolved resonance parameters are taken from Mughabghab, et al. [1]. For resonances for which a value of Γ_γ is not specified, the value 0.080 eV is used. The s-wave strength function, as determined by PSYCHE, is 3.36×10^{-04} compared to $(3.2\pm0.3)\times10^{-04}$ in [1].

The thermal capture cross section is slightly lower than ENDF/B-V. The capture resonance integral is in good agreement with the value given in [1], 128±30 barns, which is calculated from the resonance parameters, and agrees with the ENDF/B-V value of about 129.5 barns. Negative scattering cross sections encountered in the ENDF/B-V evaluation are eliminated.

Unresolved resonance parameters have been added in the unresolved range of 5.285 to 100 keV. The unresolved range fit is based on the average capture cross sections from Nakajima, et al. [2] and Musgrove, et al. [3].

The unresolved parameters are based on (in eV):

$$D_0 = 32.48,\ S_0 = 3.5,\ S_1 = 0.8,\ S_2 = 1.0$$
$$D_1 = 18.41,\ S_{\gamma0} = 24.63,\ S_{\gamma1} = 43.45$$

2200 m/sec cross sections (barns)

Total	= 402.90
Elastic	= 79.83
Capture	= 323.07

Computed capture resonance integral (barns) = 129.56

SMOOTH CROSS SECTIONS (File 3)

Elastic, and capture are set to zero in the resolved resonance range (1.0×10^{-5} eV to 5285 eV). The capture is also revised by small amounts at 130 and 160 keV and above 1 MeV. The energy mesh for the capture above 1 MeV is revised to be the same as for the total cross section. The total is small but non-zero due to small cross sections for (n,α) and (n,nα).

The inelastic cross section is also revised.

TABLE 1. ^{143}Nd Capture Cross Section (mb)

E (keV)	Nakajima [2]	Musgrove [3]	MAT 6028
4 - 6	870	936	869
6 - 8	770	818	738
8 - 10	645	665	619
10 - 15	514	504	500
15 - 20	364	380	400
20 - 30	345	309	257
40 - 60	212	174	206
60 - 80	164	114	168
80 -100	168	86	146

REFERENCES

1. S. F. Mughabghab, M. Divadeenum, and N. E. Holden, **Neutron Cross Sections, Volume I, Neutron Resonance Parameters and Thermal Cross Sections**, Part A (Academic Press, NY, 1981)
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3. Musgrove, et al., **Neutron Physics and Nuclear Data for Reactors and Other Applied Purposes**, Conference, AERE Harwell, 25-29 Sept. 1978 (O.E.C.D., 1978) p. 449

ENDF/B-VI MOD 0 (NNDC, January 1990)

The ENDF/B-V MAT 9764 evaluation was translated to ENDF-6 format.

ENDF/B-V EVALUATION (R. Schenter, F. Schmittroth, F. Mann, et al. (HEDL); H. Gruppelaar (RCN), A. Prince (BNL), February 1980)

SMOOTH CROSS SECTIONS (File 3) (for energy region above resonance region)

Total cross sections calculated using Moldauer potential [3].

Elastic cross sections from σ_{tot} - $\sigma_{n,\gamma}$ - σ_{inl}.

Inelastic cross sections calculated using COMNUC-3 [4]. Level scheme data taken from Nuclear Data Tables and Igarasi [5].

(n,2n), (n,3n), (n,nd), (N,np), (n,p), (n,d), (n,t), (n,^{3}He), (n,α) calculated using the THRESH code [6]

Neutron capture evaluated using COMNUC-3 and (NCAP code) of Schmittroth [1,2]; updated by combining available integral and differential data using the generalized least squares adjustment code FERRET [7].

ANGULAR DISTRIBUTIONS (File 4)

Elastic angular distribution calculated from Moldauer potential. Nonelastic angular distribution assumed isotropic.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)

Energy distributions of secondary neutrons given as histogram using calculations of nuclear temperature from Gilbert and Cameron [8].

REFERENCES

1. T. Tamura, **ORNL-4152** (1967) Oak Ridge National Laboratory
2. F. Schmittroth, **HEDL TME 73-79** (1973) Hanford Engineering Development Laboratory
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Evaluation:	**^{145}Nd Incident Neutron Sublibrary, Release 2 (MAT 6034)**
Energy Range:	10^{-5} eV to 20 MeV
Files:	1, 2, 3, 4, 5
Evaluators:	R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, January 1992))

RESONANCE PARAMETERS (File 2)

The resolved resonance region is revised and extended from 1457 to 4140 eV using the MLBW formalism; the highest energy resonance included is 4637 eV. The resolved resonance parameters are taken from Mughabghab, et al. [1]. For resonances for which a value of Γ_γ is not specified, the value 0.075 eV is used. The s-wave strength function, as determined by PSYCHE, is 4.27×10^{-04} compared to $(4.4\pm0.4)\times10^{-04}$ in Mughabghab.

The thermal capture cross section is slightly lower than ENDF/B-V. The revised capture resonance integral is about 1.1% lower than the ENDF/B-V value of 232.3 barns, and is in good agreement with the value given in Mughabghab of 1240±35 barns. The negative scattering cross sections encountered in the ENDF/B-V evaluation were eliminated.

Unresolved resonance parameters have been added in the unresolved range of 4.140 to 50 keV. The unresolved range fit is based on the average capture cross sections from Nakajima, et al. [2] and Musgrove, et al. [3]. Average capture cross sections computed from the evaluation are compared with the average values from these references in Table I.

For the energy range 3 to 30 keV, the revised capture is fairly close to the Musgrove values; for 30 to 100 keV, the evaluation is higher than Musgrove but lower than the Nakajima data, and is also fairly close to the ENDF/B-V evaluation for the energy range 4.140 to 100 keV.

The unresolved parameters are based on (in eV):

$$D_0 = 17.32,\ S_0 = 4.0,\ S_1 = 0.8,\ S_2 = 1.0$$

$$D_1 = 8.66,\ S_{\gamma 0} = 43.29,\ S_{\gamma 1} = 86.58$$

<u>2200 m/s cross sections (barns)</u>

Total	= 59.08
Elastic	= 17.19
Capture	= 41.89

<u>Computed resonance integral (barns)</u>

0.5 - 4140 eV	= 227.07
Above 4140 eV	= 2.59
Total	= 229.66

SMOOTH CROSS SECTIONS (File 3)

Elastic, and capture are set to zero in the resolved resonance range (1.0×10^{-5} eV to 50 keV). The total is small but non-zero due to small cross sections for (n,α) and (n,nα).

The revised total and elastic cross sections are slightly lower than ENDF/B-V between 50 and 100 keV. All other cross sections are unchanged above 50 keV.

TABLE I. ^{143}Nd Capture Cross Section (mb)

E (keV)	Nakajima [2]	Musgrove [3]	MAT 6034
3 - 4		1.901	2.032
4 - 5	1.360	1.436	1.506
5 - 6	1.420	1.360	1.367
6 - 8	1.335	1.236	1.143
8 - 10	1.010	0.970	0.952
10 - 15	1.052	0.799	0.765
15 - 20	0.774	0.642	0.614
20 - 30	0.655	0.475	0.494
30 - 40	0.525	0.361	0.402
40 - 50	0.440	0.295	0.345
50 - 60	0.390	0.280	0.298
60 - 80	0.380	0.162	0.256
80 -100	0.405	0.124	0.218

REFERENCES

1. S. F. Mughabghab, M. Divadeenum, and N. E. Holden, **Neutron Cross Sections, Volume I, Neutron Resonance Parameters and Thermal Cross Sections**, Part A (Academic Press, NY, 1981)
2. Nakajima, et al., **Neutron Physics and Nuclear Data for Reactors and Other Applied Purposes**, Conference, AERE Harwell, 25-29 Sept. 1978 (O.E.C.D., 1978) p. 438
3. Musgrove, et al., **Neutron Physics and Nuclear Data for Reactors and Other Applied Purposes**, Conference, AERE Harwell, 25-29 Sept. 1978 (O.E.C.D., 1978) p. 449

ENDF/B-VI MOD 0 (NNDC, January 1990)

Converted from ENDF/B-V MAT 9766 to ENDF-6 format.

ENDF/B-V EVALUATION (R. Schenter, F. Schmittroth, F. Mann, et al., HEDL; H. Gruppelaar, RCN, February 1980)

SMOOTH CROSS SECTIONS (File 3) (for energy region above resonance region)

Total cross sections calculated using the Moldauer potential [3].

Elastic cross sections from σ_{tot} - $\sigma_{n,\gamma}$ - σ_{inl}.

Inelastic cross sections calculated using COMNUC-3 [4]. Level scheme data taken from Nuclear Data Tables and Igarasi [5].

(n,2n), (n,3n), (n,nd), (N,np), (n,p), (n,d), (n,t), (n,^{3}He), (n,α) calculated using the THRESH code [6]

Neutron capture evaluated using COMNUC-3 and (NCAP code) of Schmittroth [1,2]; updated by combining available integral and differential data using the generalized least squares adjustment code FERRET [7].

ANGULAR DISTRIBUTIONS (File 4)

Elastic angular distribution calculated from Moldauer potential. Nonelastic angular distribution assumed isotropic.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)

Energy distributions of secondary neutrons given as histogram using calculations of nuclear temperature from Gilbert and Cameron [8].

REFERENCES

1. T. Tamura, **ORNL-4152** (1967) Oak Ridge National Laboratory
2. F. Schmittroth, **HEDL TME 73-79** (1973) Hanford Engineering Development Laboratory
3. P. A. Moldauer, ***Nucl. Phys.*** **47**, 65 (1963)
4. C. L. Dunford, **AI-AEC-12931** (1970) Atomics International, and private communication
5. S. Igarasi, private communication.
6. S. Pearlstein, ***J. Nucl. En.*** **27**, 81 (1973)
7. A. Gilbert and A. G. W. Cameron, ***Can. J. Phys.*** **43**, 1446 (1965)
8. F. Schmittroth, **HEDL-TME 77-51** (1978) Hanford Engineering Development Laboratory

Evaluation: **^{147}Nd Incident Neutron Library, Release 1 (MAT 6040)**
Energy Range: 10^{-5} eV to 20 MeV
Files (MF): 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. Schenter, F. Schmittroth (HEDL)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, August 1991)
Illegal J-values in file 2 corrected.

ENDF/B-VI MOD 1 NEW EVALUATION (R. Q. Wright, ORNL, December 1988)
This evaluation is an update of the ENDF/B-V evaluation of Schenter and Mann.

Resolved resonance parameters have been added to define the total, elastic, and capture cross sections below 35 eV; above 35 eV, the evaluation is unchanged from ENDF/B-V. The resolved resonance parameters are taken from Mughabghab [1]. The MLBW representation was used with the smooth background set to zero in the resonance region.

The largest contribution to the thermal capture cross section (about 98%) is from the bound level at -5 eV. The thermal capture cross section is higher than the ENDF/B-V value by about a factor of 9; the capture resonance integral is slightly lower.

<u>2200 m/s capture cross section (barns)</u>
(from resonance parameters) = 439.9

<u>Computed resonance integral (barns)</u>
(from resonance parameters) = 429.5
(above 35 eV) = 144.0
total = 573.5

REFERENCES

1. S. F. Mughabghab, M. Divadeenam, and N. E. Holden, **Neutron Cross Sections, Volume I, Neutron Resonance Parameters and Thermal Cross Sections**, Part A (Academic Press, NY, 1981)

ENDF/B-V EVALUATION (R. Schenter, F. Mann, HEDL, January 1980)

SMOOTH CROSS SECTIONS File 3)
<u>Total cross section</u> calculated using Moldauer potential [4] above the resonance region.
<u>Elastic cross section</u> from $\sigma_{tot} - \sigma_{n,\gamma} - \sigma_{inl}$ above the resonance region, from $4\pi\times AP^2$ at lower energies.
<u>Inelastic cross section</u> calculated using COMNUC-3 [5].
<u>Neutron capture</u> evaluated using methods (NCAP code) [1,2] above the resonance region. A 1/v component was added to give the 2200 m/s cross section of Mughabghab. Low energy capture also adjusted to give resonance integral (to within 1 σ) of Ribon and Krebs [6].

ANGULAR DISTRIBUTIONS (File 4)
Angular distribution assumed isotropic.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)
Evaporation spectrum (LF=9) parameters obtained using NCAP code [2].

REFERENCES

1. F. Schmittroth and R. E. Schenter, **HEDL TME 73-63** (1973) Hanford Engineering Development Laboratory
2. F. Schmittroth, **HEDL TME 73-79** (1973) Hanford Engineering Development Laboratory
3. E. Clayton, **AAEC/TM619** (1972) Australian Atomic Energy Commission
4. P. A. Moldauer, ***Nucl. Phys.*** **47**, 65 (1963)
5. C. L. Dunford, **AI-AEC-12931** (1970) Atomics International, and private communication
6. P. Ribon and J. Krebs, **IAEA-169**, Vol. I, p.235 (1974) International Atomic Energy Agency

Evaluation: **^{147}Pm Incident Neutron Library, Release 1 (MAT 6149)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, August 1991)
Illegal J-values in File 2 were corrected.

ENDF/B-VI MOD 1 NEW EVALUATION (R. Q. Wright, ORNL, April 1989)
See ENDF-201 Summary Documentation, 4th Edition (1991), page 260, for documentation of ENDF/B-VI evaluation.

Evaluation: **^{144}Sm Incident Neutron Library, Release 3 (MAT 6225)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL), F. M. Mann (HEDL)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, October 1994)

RESONANCE PARAMETERS (File 2)

Resonance parameters have been added for the resolved resonance range from 0.4 to 12 keV using the MLBW formalism; the highest resonance included is 39.117 keV. The principal source for the resolved resonance parameters is the data of Macklin, et al. [1]; 18 s-wave and 56 p-wave resonances are included from Table II of this reference. An additional 26 s-wave resonances and 2 p-wave resonances are included from Table III. These additional resonances are above the cutoff and are only used to calculate the cross sections below 12 keV.

Unresolved resonance parameters have been added in the range is 12 to 80 keV. The fit is based on average Γ_γ of 0.074 eV for s-wave, and 0.089 eV for both p-wave and d-wave, scattering radius (R) = 5.617 fm, D_0 = 670 eV, $S_0 = 3.6\times10^{-4}$. $S_1 = 1.0\times10^{-4}$, $S_2 = 2.4\times10^{-4}$.

The revised values represent a change of 134% for the thermal capture and -93.8% for the capture resonance integral. The measured values of Alexander [2] are 1.64±0.10 barns for the thermal capture and 2.38±0.17 barns for the capture resonance integral.

<u>2200 m/sec Cross Sections</u>

Total	= 2.813 barns
Elastic	= 1.173 barns
Capture	= 1.640 barns

<u>Capture Resonance Integral</u> = 1.861 barns

SMOOTH CROSS SECTIONS (File 3)

Cross sections are revised below 400 eV. The low energy elastic cross section is calculated from the resolved resonance parameters. The low energy capture is 1/v up to 400 eV with a thermal value of 1.64 barns [2]. The elastic cross section has been set to zero in the resolved resonance range but for the capture a small 1/v background has been used.

<u>Changes above 80 keV</u>

<u>Total cross section</u> above 1 MeV is based on the ^{148}Sm total of Shamu, et al. [3,4].

The <u>elastic</u> is calculated by subtracting the nonelastic from the total.

The <u>(n,2n) cross section</u> is based on measured data as shown in McLane, et al. [4]. (n,2n) was not included in the previous evaluation but was included in the inelastic.

The <u>inelastic</u> above 11 MeV is revised to remove the (n,2n) contribution. In the continuum, it is also revised to be the same as the total inelastic scattering.

The <u>capture</u> is based on Macklin, et al. [1], Table IV, for the energy range 80-500 keV. The extension to 20 MeV is based on shape of ^{154}Sm capture. The average capture cross sections, calculated with NJOY, flat weighting, for this evaluation are compared with the measured values of Macklin, et al. [1] for the energy range 6 to 500 keV in Table I.

Table I. Sm-144 Average Capture (mb)

Energy (keV)	Measured	Calculated
6 - 8	130	113.7
8 -10	143	134.9
10 -12	176	163.5
12 -15	185	124.2
15 -20	120	108.7
20 -30	84	91.8
30 -40	77	79.8
40 -60	73	70.3
60 -80	65	62.7
80-100	57	56.4
100-150	49.1	49.2
150-200	48.2	48.2
200-300	45.0	45.0
300-400	40.9	41.0
400-500	41.7	41.5

ANGULAR DISTRIBUTIONS (File 4)

The elastic angular distributions used data from ^{152}Sm, MAT 6249.
The (n,2n) was assumed to be isotropic.

SECONDARY ENERGY DISTRIBUTIONS (File 5)

The (n,2n) used data from ^{152}Sm, MAT 6249.

REFERENCES

1. R. L. Macklin, N. W. Hill, J. A. Harvey, and G. L. Tweed, ***Phys. Rev. C* 48**, 1120 (1993)
2. C. W. Alexander, J. Halperin, J. B. Knauer, R. L. Walker, ***Nucl. Sci. Eng.* 95**, 194 (1987)
3. R. E. Shamu et al., ***Phys. Rev. C* 22**, 1857 (1980)
4. V. McLane, C. L. Dunford, and P. F. Rose, **Neutron Cross Sections, Vol. 2, Neutron Cross Sections** (Academic Press, NY, 1988)

ENDF/B-VI MOD 0 (NNDC, February 1990)

ENDF/B-V MAT 9083 converted to ENDF6 format by NNDC.

Evaluation: **^{150}Sm Incident Neutron Sublibrary, Release 2 (MAT 6243)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth (HEDL)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, October 1991)

RESONANCE PARAMETERS (File 2)

The resolved resonance region is revised and extended from 581.7 to 1600 eV using the MLBW formalism; the highest energy resonance included is 1563 eV.

The resolved resonance parameters are taken from Mughabghab, et al. [1]; the bound level at -3.2 eV is not included. Including both the -10.2 and -3.2 eV bound levels gives a value for the thermal capture cross section which is much too high. Including only the -10.2 eV level gives a thermal capture cross section of 103.4 barns and a total cross section of 122.2 barns; this would appear to indicate an error in [1]. For resonances for which a value of Γ_γ is not specified in [1], the value 0.060 eV is used.

The s-wave strength function is 3.79×10^{-4} compared to $(3.6\pm1.1)\times10^{-4}$ in [1]. The thermal capture cross section is only about 1.4% higher than ENDF/B-V. The capture resonance integral is in good agreement with the value given in [1], 358±50 barns, but somewhat higher than the value of 310±15 barns given by Eiland, et al. [2]. The revised capture resonance integral is 5.6% higher than the ENDF/B-V value of about 320 barns. Negative scattering cross sections were encountered in the ENDF/B-V evaluation; since the revised evaluation uses MLBW, rather than SLBW parameters, this problem is eliminated.

Unresolved resonance parameters have been added in the unresolved range of 1.6 to 100 keV. The unresolved resonance parameters are based on (in eV):

$D_0 = 48,\ S_0 = 3.6,\ S_1 = 0.6,\ S_2 = 2.9$

$D_1 = 15,\ S_{\gamma0} = 12.5,\ S_{\gamma1} = 40$

<u>2200 m/s cross sections (barns)</u>
From resonance parameters = 103.42

<u>Computed resonance integral (barns)</u>

0.5 - 1600 eV	= 334.00
Above 1600 eV	= 3.78
Total	= 337.78

SMOOTH CROSS SECTIONS (File 3)

Elastic, and capture are set to zero in the resolved and unresolved resonance range (1.0×10^{-5} eV to 100 keV). Total, elastic, and capture cross sections are revised above 100 keV. The revised total cross section is based on the measurements of Shamu, et al. [3]. ^{150}Sm σ_{tot} = ^{148}Sm $\sigma_{tot}\times$ R, where R is defined as: R = 1.0 + (^{150}Sm σ_{tot} - ^{148}Sm σ_{tot})/^{148}Sm σ_{tot}.

The data for total inelastic scattering and scattering to the 5th excited state are revised. The revised data below 3 MeV is based on the work of Efrosinin, et al. [4]. The inelastic continuum data was revised above 7 MeV.

The (n,2n) cross section was added to the file and is based on the data of Frehaut, et al. [5].

SECONDARY PARTICLE DISTRIBUTIONS (File 4 and File 5)

Angular distributions (File 4) and secondary energy distributions (File 5) were added for the (n,2n) reaction.

REFERENCES

1. S. F. Mughabghab, **Neutron Cross Sections, Vol 1, Neutron Resonance Parameters and Thermal Cross Sections**, Part B (Academic Press, NY, 1984).
2. H. M. Eiland, S. Weinstein, and K. W. Seemann, ***Nucl. Sci. Eng.*** **54**, 286 (1979)
3. R. E. Shamu, et al., ***Phys.Rev. C*** **22**, 1857 (1980).
4. V. P. Efrosinin, et al., **Nuclear Spectroscopy and Nuclear Structure**, 19th Conference, Riga, 27-30 March, 1979 (Leningrad, 1979) p. 274
5. J. Frehaut, et al., **BNL-NCS-50681**, Vol. I, p. 399 (1980) Brookhaven National Laboratory

ENDF/B-VI MOD 0 (NNDC, February 1990)

ENDF/B-V MAT 9809 converted to ENDF-6 format.

ENDF/B-V EVALUATION (R. E. Schenter and F. Schmittroth, HEDL, April 1974)

SMOOTH CROSS SECTIONS (File 3) (for energy region above resonance region)

Total cross sections calculated using Moldauer potential [3].
Elastic cross sections from σ_{tot} - $\sigma_{n,\gamma}$ - σ_{inl}.
Inelastic cross sections calculated using COMNUC-3 [4].
Neutron capture evaluated using NCAP code of Schmittroth [1,2].

ANGULAR DISTRIBUTIONS (File 4)

Elastic and nonelastic angular distributions assumed isotropic.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)

Evaporation spectrum (LF=9) parameters obtained using NCAP code [2].

REFERENCES

1. T. Tamura, **ORNL-4152** (1967) Oak Ridge National Laboratory
2. F. Schmittroth, **HEDL TME 73-79** (1973) Hanford Engineering and Development Laboratory
3. P. A. Moldauer, ***Nucl. Phys.*** **47**, 65 (1963)
4. C. L. Dunford, **AI-AEC-12931** (1970) Atomics International, and private communication

Evaluation: **^{151}Sm Incident Neutron Sublibrary, Release 1 (MAT 6246)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, August 1991)
Illegal J-values in File 2 were corrected.

ENDF/B-VI MOD 1 NEW EVALUATION (R. Q. Wright, ORNL, March 1980)
See ENDF-201 Summary Documentation, 4th Edition (1991), page 268, for documentation of ENDF/B-VI evaluation.

Evaluation: **^{152}Sm Incident Neutron Sublibrary, Release 2 (MAT 6249)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); R. E. Schenter, F. Schmittroth, F. Mann, D. Johnson, G. Neely (HEDL); H. Gruppelaar (RCN); A. Prince (BNL)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, July 1992))

RESONANCE PARAMETERS (File 2)

The resolved resonance region is revised and extended from to 5025 eV using the MLBW formalism; the highest energy resonance included is 5100 eV.

The resolved resonance parameters are taken from Mughabghab, et al. [1]. 92 s-wave resonances are assigned. The bound level at -136 eV has Γ_n^0 of 161.6 meV and Γ_γ of 61 meV, and accounts for only about 1.1% of the thermal capture cross section. For resonances for which the value of Γ_γ is not given in [1], the value 0.061 eV is used.

The capture resonance integral is in good agreement with the value of 2970±100 barns in Mughabghab. The thermal capture cross section is equivalent to the Mughabghab value of 206±6 barns.

Unresolved resonance parameters have been added in the unresolved range of 5.025 to 100 keV and are based on the average capture cross sections of Kononov [2]. These parameters (at 30 keV) result in the following values:

D_0 = 28 eV, $S_0 = 2.5\times10^{-4}$, $S_1 = 0.6\times10^{-4}$, $S_2 = 3.0\times10^{-4}$

D_1 = 9.33 eV, $S_{\gamma0} = 21.79\times10^{-4}$, $S_{\gamma1} = 65.36\times10^{-4}$

The scattering radius is = 7.665 fm.

<u>2200 m/s cross sections (barns)</u>

Total	= 209.0
Elastic	= 3.1
Capture	= 205.9

<u>Computed resonance integral (barns)</u> = 2983

SMOOTH CROSS SECTIONS (File 3)

The <u>total cross section</u> is small but non-zero due to small cross sections for MT = 22 and 107. The total cross section is revised above 100 keV, based on the measurements of Shamu, et al., [4]. ^{152}Sm σ_{tot} = ^{148}Sm $\sigma_{tot}\times$ R, where R is defined as: R = 1.0 + (^{152}Sm σ_{tot} - ^{148}Sm σ_{tot})/^{148}Sm σ_{tot}.

<u>Elastic and capture</u> are set to zero in the resonance range (1.0×10^{-5} eV to 100 keV). The elastic cross section is revised above 100 keV; the capture cross section is revised between 100 keV and 3.5 MeV to agree with the experimental values of Kononov, et al [2], and Zhou, et al. [3].

REFERENCES
1. S. F. Mughabghab, **Neutron Cross Sections, Vol 1, Neutron Resonance Parameters and Thermal Cross Sections**, Part B (Academic Press, NY, 1984)
2. V. N. Kononov, et al., ***Soviet J. Nucl. Phys.*** **27**, 5 (1978); translated from ***Yad. Fiz.*** **27**, 10
3. Zhou Zuying, et al., ***Chinese J. Nucl. Phys***. **6**, 174 (1984)
4. R. E. Shamu, et al., ***Phys.Rev. C*** **22**, 1857 (1980)

ENDF/B-VI MOD 0 (NNDC, February 1990)
ENDF/B-V MAT 9811 converted to ENDF-6 format.

ENDF/B-V EVALUATION (R. Schenter, F. Schmittroth, F. Mann, et al., HEDL, RCN, February 1980)

SMOOTH CROSS SECTIONS (File 3) (for energy region above resonance region)

Total cross section calculated using the Moldauer potential [3].

Elastic cross section from σ_{tot} - $\sigma_{n,\gamma}$ - σ_{inl}.

Inelastic cross section calculated using COMNUC-3 [4]. Level scheme data taken from Nuclear Data Tables and Igarasi [5]

(n,2n), (n,3n), (n,nd), (n,np), (n,p), (n,d), (n,t), (n,^{3}He), (n,α) calculated using the THRESH code [6].

Neutron capture was evaluated using COMNUC-3 and (NCAP code) of Schmittroth [1,2], updated by combining available integral and differential data using the generalized least squares adjustment code FERRET [8].

ANGULAR DISTRIBUTIONS (File 4)

Elastic angular distribution calculated from Moldauer potential. Nonelastic angular distribution assumed isotropic.

SECONDARY NEUTRON ENERGY DISTRIBUTIONS (File 5)

Energy distributions of secondary neutrons given as histogram using calculations of nuclear temperature from Gilbert and Cameron [7].

REFERENCES
1. T. Tamura, **ORNL-4152** (1967) Oak Ridge National Laboratory
2. F. Schmittroth, **HEDL TME 73-79** (1973) Hanford Engineering Development Laboratory
3. P. A. Moldauer, ***Nucl. Phys.*** **47**, 65 (1963)
4. C. L. Dunford, **AI-AEC-12931** (1970) Atomics International, and private communication
5. S. Igarasi, private communication
6. S. Pearlstein, ***J. Nucl. En.*** **27**, 81 (1973)
7. A. Gilbert and A. G. W. Cameron, ***Can. J. Phys.*** **43**, 1446 (1965)
8. F. Schmittroth, **HEDL-TME 77-51** (1978) Hanford Engineering Development Laboratory

Evaluation:	**^{155}Eu Incident Neutron Sublibrary, Release 1 (MAT 6337)**
Energy Range:	10^{-5} eV to 20 MeV
Files:	1, 2, 3, 4, 5
Evaluators:	R. Q. Wright (ORNL), R. Schenter (HEDL), A. Prince (BNL)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, August 1991)

Illegal J-values in File 2 were corrected.

ENDF/B-VI MOD 1 NEW EVALUATION (R. Q. Wright, ORNL, August 1991)

See ENDF-201 Summary Documentation, 4th Edition (1991), page 298, for documentation of ENDF/B-VI evaluation.

Evaluation: **^{152}Gd Incident Neutron Sublibrary, Release 4 (MAT 6425)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL), Fission Product Working Group (JNDC)

ENDF/B-VI MOD 1 (R. Q. Wright, ORNL, December 1994)

This evaluation is a revision of the JENDL-3.2 evaluation below 100 keV, and includes the resolved and unresolved resonance data, and (n,α) below 2,660 eV. Small changes in the (n,γ) cross section between 100 and 700 keV were also made.

RESOLVED RESONANCE RANGE

Resonance parameters are given for the resolved resonance range $1.0{\times}10^{-5}$ to 2,660 eV using the MLBW formalism; the highest resonance included is 2,657.7 eV. The resolved resonance parameters are based on the data of Macklin [2]. Macklin gives values of Γ_n and Γ_γ for 30 resonances and $g\Gamma_\gamma\Gamma_n/\Gamma$ values for a total of 128 resonances. For the 98 resonances which do not have values given for Γ_n and Γ_γ, the strategy used is to assign a value for Γ_γ and then pick Γ_n to match the values of $g\Gamma_\gamma\Gamma_n/\Gamma$ given in Macklin. For many resonances, Macklin's average value for Γ_γ = 58.6 meV is used. All resonances are assumed to be *s*-wave. In the JENDL-3.2 evaluation, which is also based on Macklin, 17 resonances were assigned as *p*-wave. The low energy resonances at 3.31, 8.00, and 9.55 eV given in Mughabghab [3] were not found by Macklin [2] and are not included in this evaluation. The parameters for the bound level at -1.0 eV given in Mughabghab [3] are revised to give the desired value of the thermal capture cross section; Γ_γ is taken as 58.6 meV, Γ_n as 4.516 meV. The scattering radius, R = 8.2 fm.

UNRESOLVED RESONANCE RANGE

For the unresolved resonance range, 2.66 to 50 keV, the average Γ_γ is 58.6 meV. D_0 = 11.25 eV, $S_0 = 3.3{\times}10^{-4}$, $S_1 = 1.1{\times}10^{-4}$, and $S_2 = 2.4{\times}10^{-4}$; scattering radius, R = 5.40 fm. Unresolved parameters are energy independent.

SMOOTH CROSS SECTIONS (File 3)

The <u>total, elastic, and capture cross sections</u> are given as zero for energies up to 50 keV. The capture cross section is revised to 700 keV based on average capture of Beer and Macklin [4]. The elastic cross section was also revised to keep the total unchanged. Above 700 keV, the evaluation is unchanged from the JENDL-3.2.

The <u>(n,α) cross section</u> below 2,660 eV has been changed. The histogram interpolation region was eliminated and (n,α) is given in pointwise form with log-log interpolation. An attempt was made to preserve the infinitely dilute (n,α) resonance integral between 10 eV and 2,660 eV.

<u>2200 m/sec Cross Sections (barns)</u>

Total	= 1,074.0
Elastic	= 23.4
Capture	= 1,050.6

<u>Capture resonance integral (barns)</u> = 474.7

The revised thermal capture cross section is based on the measured total cross section of Vertebniy [5] and on JENDL-3.2 thermal capture of 1056 barns. The revised capture resonance integral is about 19% higher than Holden's [6] recommended value of 400 barns, but is 52% lower than the JENDL-3.2 evaluation, therefore, the resonance integral should be considered uncertain at present.[4] The difference is primarily due to eliminating the three low energy resonances. It should also be noted that 99.3% of the thermal capture cross section is due to the bound level at -1 eV.

The average capture cross sections, flat weighting, calculated with NJOY, using this evaluation are compared with the measured values of Beer and Macklin [4] for the energy range 3 to 700 keV in Table I.

Table I. Gd-152 Average Capture (mb)

Energy (keV)	Measured	Calculated	Energy (keV)	Measured	Calculated
3 - 4	3664	3400	60 -80	658	662
4 - 6	2730	2782	80-100	622	611
6 - 8	2246	2158	100-150	569	570
8 -10	1785	1808	150-200	538	542
10 -15	1426	1480	200-300	531	530
15 -20	1186	1217	300-400	461	452
20 -30	1008	1019	400-500	398	406
30 -40	905	869	500-600	393	393
40 -60	784	763	600-700	390	393

REFERENCES

1. S. F. Mughabghab, D. I. Garber, **BNL-325**, 3rd edition, Vol. 1 (1973) Brookhaven National Laboratory
2. R. L. Macklin, ***Nucl. Sci. Eng.,*** **95**, 304 (1987)
3. S. F. Mughabghab, **Neutron Cross Sections, Vol. 1, Neutron Resonance Parameters and Thermal Cross Sections**, Part B (Academic Press, NY, 1984)
4. H. Beer and R. L. Macklin, ***Astrophysical J.*** **331**, 1047 (1988)
5. V. P. Vertebnyi, et al., ***Sov. At. En.*** **57**, 718 (1984); translated from ***At. En.*** **57**, 260 (1984)
6. N. E. Holden, ***Trans. Am. Nucl. Soc.*** **53**, 163-164 (1986)

[4] The evaluator (RQW) believes that 475 barns is a much better estimate than 991 barns (JENDL-3.2).

Evaluation: **^{154}Gd Incident Neutron Sublibrary, Release 4 (MAT 6431)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL), JNDC Fission Product Working Group

ENDF/B-VI MOD 1 NEW EVALUATION (R. Q. Wright, ORNL, December 1994)

This evaluation is a revision of the JENDL-3.2 evaluation below 100 keV. Small changes were also made in the (n,γ) cross section between 100 keV and 1.152 MeV.

RESOLVED RESONANCE REGION

Resonance parameters are given for the resolved resonance range 1.0×10^{-5} to 2,680 eV using the MLBW formalism; the highest resonance included is 2751.8 eV. The resolved resonance parameters are based on the data of Mughabghab [2] for energies below 486 eV and of Macklin [3] above 486 eV. Mughabghab has values of Γ_n for 28 resonances below 486 eV; nine of these resonances have values for Γ_γ, the others assume an average value of 0.088 eV. Macklin [3] gives values of Γ_n and Γ_γ for 18 resonances and values of $g^*\Gamma_\gamma\Gamma_n/\Gamma$ are given in for a total of 134 resonances. For the 116 resonances which do not have values given for Γ_n and Γ_γ, the strategy used is to assign a value for Γ_γ and then pick Γ_n to match the values of $g\Gamma_\gamma\Gamma_n/\Gamma$ given in Macklin. For most resonances, an average value of 0.088 eV is used for Γ_γ. All resonances are assumed to be s-wave. The parameters of the bound level at -3.0 eV [2] give the desired value of the thermal capture cross section; Γ_γ = 88 meV, and Γ_n = 3.55 meV. The scattering radius, R = 8.0 fm.

UNRESOLVED RESONANCE REGION

The unresolved resonance range is 2.68 to 50 keV. The average Γ_γ = 0.088 eV. D_0 = 19.2 eV, $S_0 = 2.0\times10^{-4}$, $S_1 = 1.110^{-4}$, and $S_2 = 2.410^{-4}$, $S_{\gamma0} = 45.810^{-4}$; scattering radius = 6.78 fm. The unresolved parameters are energy independent.

SMOOTH CROSS SECTIONS (File 3)

Total, elastic, and capture cross sections are zero for energies up to 50 keV. Capture cross section is revised up to 1.152 MeV based on the average capture of Beer and Macklin [4]. Elastic cross section was also revised to keep total cross section unchanged. The total cross section is unchanged above 100 keV.

2200 m/sec Cross Sections (barns)	
Total	= 92.34
Elastic	= 7.29
Capture	= 85.05

Capture resonance integral (barns) = 215.91

The revised thermal capture cross section is based on the recommended value from Mughabghgab [2]. The capture resonance integral is 6.5% lower than the previous evaluation. About 96% of the thermal capture cross section is from the bound level at -3 eV.

The average capture cross sections, flat weighting, calculated with NJOY, using this evaluation are compared with the measured values from Beer and Macklin for the energy range 3 to 500 keV in Table I.

Table I. Gd-154 Average Capture (mb)

Energy (keV)	Measured	Calculated	Energy (keV)	Measured	Calculated
2 - 4	2818	2931	40 -60	682	680
4 - 6	2196	2258	60 -80	591	594
6 - 8	1692	1781	80-100	560	559
8 -10	1640	1512	100-150	486	490
10 -15	1239	1258	150-200	393	392
15 -20	1044	1055	200-300	337	337
20 -30	914	898	300-400	302	303
30 -40	771	777	400-500	292	293

REFERENCES

1. S. F. Mughabghab, D. I. Garber, Brookhaven National Laboratory report **BNL-325**, 3rd edition, Vol. 1 (1973) Brookhaven National Laboratory
2. S. F. Mughabghab, **Neutron Cross Sections, Vol. 1, Neutron Resonance Parameters and Thermal Cross Sections**, Part B (Academic Press, NY, 1984)
3. R. L. Macklin, ***Nucl. Sci. Eng.,*** **95**, 304 (1987)
4. H. Beer and R. L. Macklin, ***Astrophysical J.*** **331**, 1047 (1988)

Evaluation: **^{174}Hf Incident Neutron Sublibrary, Release 2 (MAT 7225)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, April 1992)

RESONANCE PARAMETERS (File 2)

Resonance parameters are given using a MLBW formalism in the resolved resonance range up to 230 eV. A bound level at -0.99 eV [1] is used in this evaluation. Values of Γ_γ, except for the bound level, are set to 0.060 eV. The value for the scattering radius is 7.7 fm [1].

The unresolved resonance range is 230 eV to 90 keV. The thermal capture cross section is 44% higher than in the previous evaluation, while the capture resonance integral is 26% lower. The unresolved resonance parameters have been revised based on:

D_0 = 21 eV, $S_0 = 2.8\times10^{-4}$, $S_1 = 0.910^{-4}$, and $S_2 = 2.510^{-4}$

D_1 = 6 eV, $S_{\gamma 0} = 28.5710^{-4}$, $S_{\gamma 1} = 10010^{-4}$

<u>2200 m/s cross sections (barns)</u>

Total	= 577.36
Elastic	= 15.51
Capture	= 561.85

<u>Computed resonance integral (barns)</u> = 355.18

SMOOTH CROSS SECTIONS (File 3)

Elastic, and capture are set to zero in the resolved and unresolved resonance range (10^{-5} eV to 90 keV).

REFERENCES

1. S. F. Mughabghab, **Neutron Cross Sections, Vol 1, Neutron Resonance Parameters and Thermal Cross Sections**, Part B (Academic Press, NY, 1984)
2. M. K. Drake, D. A. Sargis, and T. Maung, **SAI-76-677-LJ** (1976)

ENDF/B-VI MOD 0 (R. Q. Wright, ORNL, February 1990)

ENDF/B-V MAT 1374 converted to ENDF-6 format.

ENDF/B-V EVALUATION Hafnium isotopes (M. Drake, D. Sargis, T.Maung, SAI, April 1976)

SMOOTH CROSS SECTIONS (FILE 3)

Total cross section:
- < 1.0 eV: elemental data of Moore [1] and Joki [2], isotopic data of Conrad, et al. [3]
- 100 - 500 keV: data of Sherwood, et al. [4]
- 500 keV - 2.5 MeV: data of Sherwood [4] and Green and Mitchell [5]
- > 2.5 MeV: data of Foster and Glasgow [6]

Elastic scattering cross section:
- < 500 keV and >2.5 MeV: σ_{tot} - σ_{non}
- 500 keV - 2.5 MeV: data of Sherwood, et al. [4] and Walt and Barschall [7]

Inelastic scattering cross section: 12 level excitation cross sections based on data of Sherwood, et al. [4].

Capture cross section: extended from 15 to 20 MeV by S. Pearlstein (BNL), following total cross-section measurements [8] for Ta and W, corrected for Hf size.

ANGULAR DISTRIBUTIONS (File 4)

Elastic scattering taken from ^{182}W, ENDF/B-V MAT 1128.

REFERENCES

1. W. E. Moore, ***Bull. Am. Phys. Soc.*** **6**, 70, paper X11 (1961)
2. E. G. Joki, et al., ***Nucl. Sci. Eng.*** **11**, 298 (1961)
3. C. A. Conrad, et al, ***Bull. Am. Phys. Soc.*** **14**, 496, paper AH16 (1969)
4. G. L. Sherwood, et al, ***Nucl. Sci. Eng.*** **39**, 67 (1970)
5. L. Green and J. A. Mitchell, **WAPD-TM-1073** (1973) Bettis Atomic Power Laboratory
6. D. G. Foster and D. W. Glasgow, ***Phys. Rev. C*** **3**, 576 (1971)
7. M. Walt and H. H. Barschall, ***Phys. Rev.*** **93**, 1062 (1954)
8. Peterson, et al, ***Phys. Rev.*** **120**, 521 (1960)

Evaluation: **^{176}Hf Incident Neutron Sublibrary, Release 2 (MAT 7231)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, August 1992)

RESONANCE PARAMETERS (File 2)

The resolved resonance region is revised to 1080.0 eV using the MLBW formalism; the highest energy resonance included is 1563 eV.

The resolved resonance parameters are taken from Mughabghab, et al. [1]. Bound levels at -80 and -20 eV are used in this evaluation. Values of Γ_γ, except for the first three levels, are set to 0.051 eV. The value for the scattering radius is 7.6 fm [1].

The parameters of the 7.886 eV resonance are based on the data of Moxon [3]: E_0 = 7.886±0.01 eV; Γ_n = 4.71 (+5.50 -2.57) MeV; Γ_γ = 57±12 MeV. The parameters of the two bound levels are also changed.

The thermal capture cross section is 67% lower than in the previous evaluation and is in good agreement with the data of Pavlenko, et al. [4] which is 11.30±5.0 barns, and with the unpublished M. C. Moxon [3] value of 13.7±3.2 barns. The capture resonance integral is 15% higher than in the previous evaluation.

The unresolved resonance range is 1080 eV to 90 keV. The thermal capture cross section is 44% higher than in the previous evaluation, while the capture resonance integral is 26% lower. The unresolved resonance range fit is based on the average capture cross sections from Beer, et al. [2]; the parameters are based on:

$D_0 = 35$ eV, $S_0 = 2.5\times10^{-4}$, $S_1 = 0.87\times10^{-4}$, $S_2 = 2.0\times10^{-4}$

$D_1 = 10$ eV, $S_{\gamma0} = 15.43\times10^{-4}$, $S_{\gamma1} = 54\times10^{-4}$

<u>2200 m/s cross sections (barns)</u>

Elastic	= 6.70
Capture	= 13.76
Total	= 20.46

<u>Computed resonance integral (barns)</u>= 401.33

SMOOTH CROSS SECTIONS (File 3)

Elastic, and capture are set to zero in the resolved and unresolved resonance range (10^{-5} eV to 90 keV). Capture cross sections for the energy range 90 to 700 keV are taken from Beer, et al. [2], Table IV.

REFERENCES

1. S. F. Mughabghab, **Neutron Cross Sections, Vol 1, Neutron Resonance Parameters and Thermal Cross Sections**, Part B (Academic Press, NY, 1984)
2. H. Beer, et al., ***Phys. Rev. C*** **30**, 464 (1984)
3. M. C. Moxon, private communication to R. Q. Wright, August 1992
4. Pavlenko, et al., **Neutron Physics**, Conference, Kiev 9-13 June, 1975 Vol. 3 (Moscow, 1976) p. 171
5. M. K. Drake, D. A. Sargis and T. Maung, **SAI-76-677-LJ** (1976)

ENDF/B-VI MOD 0 (R. Q. Wright, ORNL, February 1990)

ENDF/B-V MAT 1376 converted to ENDF-6 format. See ^{174}Hf for documentation of the ENDF/B-V evaluation.

Evaluation: **^{177}Hf Incident Neutron Sublibrary, Release 2 (MAT 7234)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, September 1991)

RESONANCE PARAMETERS (File 2)

The resolved resonance region is revised and extended from 300 to 700 eV using the MLBW formalism; the highest energy resonance included is 1563 eV. The resolved resonance parameters are taken from Mughabghab, et al. [1]; the bound level is not included. Values of Γ_γ not given explicitly in Mughabghab are set to 0.065 eV.

The value for the scattering radius is 8.0 fm. The thermal capture cross section is about 1% lower than in the previous evaluation and the capture resonance integral is about 1.6% lower. The negative elastic scattering cross section below 0.8 eV in the previous evaluation has been eliminated.

The unresolved resonance range is 700 eV to 90 keV. The resonance parameters are based on the average capture cross sections from Beer, et al. [2]; the parameters are based on:

D_0 = 2.3625 eV, $S_0 = 1.7\times10^{-4}$, $S_1 = 1.0\times10^{-4}$, $S_2 = 2.1\times10^{-4}$

D_1 = 1.4175 eV, $S_{\gamma 0} = 275\times10^{-4}$, $S_{\gamma 1} = 459\times10^{-4}$

<u>2200 m/s cross sections (barns)</u>

Total	= 373.49
Elastic	= 0.02
Capture	=373.47

<u>Computed resonance integral (barns)</u> = 7175

SMOOTH CROSS SECTIONS (File 3)

Elastic, and capture are set to zero in the resolved and unresolved resonance range (1.0×10^{-5} eV to 90 keV). Capture cross sections for the energy range 90 to 700 keV from Beer, et al. [2].

REFERENCES

1. S. F. Mughabghab, **Neutron Cross Sections, Vol 1, Neutron Resonance Parameters and Thermal Cross Sections**, Part B (Academic Press, 1984)
2. H. Beer, et al., ***Phys. Rev. C*** **30**, 464 (1984)
3. M. K. Drake, D. A. Sargis and T. Maung, **SAI-76-677-LJ** (1976)

ENDF/B-VI MOD 0 (R. Q. Wright, ORNL, February 1990)

ENDF/B-V MAT 1377 converted to ENDF-6 format. See ^{174}Hf for documentation of the ENDF/B-V evaluation.

Evaluation: **^{178}Hf Incident Neutron Sublibrary, Release 2 (MAT 7237)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, September 1991)

RESONANCE PARAMETERS (File 2)

The resolved resonance region is revised to 2100 eV using the MLBW formalism; the upper limit is unchanged from the previous evaluation. The highest energy resonance included is 1563 eV. The resolved resonance parameters are taken from Mughabghab, et al. [1], except for the value of Γ_γ for the 446.5 eV level; the bound level at -54.5 eV [1] is used in this evaluation.

The value for the scattering radius is 7.77 fm. The thermal capture cross section is 13% higher than in the previous evaluation and the capture resonance integral is 7.6% higher. The negative elastic scattering cross section in the previous evaluation below 4 eV has been eliminated.

The upper limit for the unresolved resonance range is 2100 eV to 90 keV. The unresolved resonance range fit is based on the average capture cross sections from Beer, et al. [2]; the parameters are based on:

D_0 = 51 eV, $S_0 = 2.2\times10^{-4}$, $S_1 = 0.51\times10^{-4,}$ $S_2 = 1.66\times10^{-4}$
D_1 = 14.67 eV, $S_{\gamma0} = 10.59\times10^{-4}$, $S_{\gamma1} = 36.82\times10^{-4}$

<u>2200 m/s cross sections (barns)</u>

Total	= 88.90
Elastic	= 4.87
Capture	= 84.03

<u>Computed resonance integral (barns)</u> = 1905

SMOOTH CROSS SECTIONS (File 3)

Elastic, and capture are set to zero in the resolved and unresolved resonance range (1.0×10^{-5} eV to 90 keV). Capture cross sections for the energy range 90 to 2 MeV are taken from Beer, et al. [2], Table IV.

REFERENCES

1. S. F. Mughabghab, **Neutron Cross Sections, Vol 1, Neutron Resonance Parameters and Thermal Cross Sections**, Part B (Academic Press, 1984)
2. M. K. Drake, D. A. Sargis and T. Maung, **SAI-76-677-LJ** (1976)

ENDF/B-VI MOD 0 (R. Q. Wright, ORNL, February 1990)

ENDF/B-V MAT 1378 converted to ENDF-6 format. See ^{174}Hf for documentation of the ENDF/B-V evaluation.

Evaluation: **^{179}Hf Incident Neutron Sublibrary, Release 2 (MAT 7240)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, September 1991)

RESONANCE PARAMETERS (File 2)

The resolved resonance region is revised to 450 eV using the MLBW formalism; the upper limit is unchanged from the previous evaluation. The highest energy resonance included is 1563 eV. The resolved resonance parameters are taken from Mughabghab, et al. [1]; the bound level at -6.1 eV [1] is included. Values of Γ_γ not given explicitly in [1] are set to 0.066 eV.

The thermal capture cross section is 6.5% lower than in the previous evaluation while the capture resonance integral is 2.2% higher.

The upper limit for the unresolved resonance range is 450 eV to 90 keV. The unresolved resonance range fit is based on the average capture cross sections from Beer, et al. [2]; the parameters are based on:

$D_0 = 4.356$ eV, $S_0 = 1.8\times10^{-4}$, $S_1 = 0.83\times10^{-4}$, $S_2 = 2.1\times10^{-4}$

$D_1 = 2.512$ eV, $S_{\gamma0} = 152\times10^{-4}$, $S_{\gamma1} = 263\times10^{-4}$

2200 m/s cross sections (barns)	
Total	= 49.83
Elastic	= 7.23
Capture	= 42.60
Scattering Radius	= 7.83 fm

Computed resonance integral (barns) = 548

SMOOTH CROSS SECTIONS (File 3)

Total, elastic, and capture are set to zero in the resolved and unresolved resonance range (1.0×10^{-5} eV to 90 keV). Capture cross sections for the energy range 90 to 2 MeV are taken from Beer, et al. [2], Table IV.

REFERENCES

1. S. F. Mughabghab, **Neutron Cross Sections, Vol 1, Neutron Resonance Parameters and Thermal Cross Sections**, Part B (Academic Press, 1984)
2. H. Beer and R. L. Macklin, ***Phys. Rev. C* 26**, 1404 (1982)
3. M. K. Drake, D. A. Sargis, and T. Maung, **SAI-76-677-LJ** (1976)

ENDF/B-VI MOD 0 (R. Q. Wright, ORNL, February 1990)

ENDF/B-V MAT 1383 converted to ENDF-6 format. See ^{174}Hf for documentation of the ENDF/B-V evaluation.

Evaluation: **^{180}Hf Incident Neutron Sublibrary, Release 1, 2 (MAT 7243)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5
Evaluators: R. Q. Wright (ORNL); M. K. Drake, D. A. Sargis, T. Maung (SAI)

ENDF/B-VI MOD 2 REVISION 1 (R. Q. Wright, ORNL, September 1991)

RESONANCE PARAMETERS (File 2)

The resolved resonance region is revised using the MLBW formalism and the upper limit is reduced from 12 to 10 keV; the highest energy resonance included is 1563 eV. The resolved resonance parameters are taken from Mughabghab, et al. [1]; the bound level at -48.7 eV is included. Values of Γ_γ, not explicitly given in [1], are set to 0.051 eV, or in some cases a different value is used in order to preserve the value of $g\Gamma_n\Gamma_\gamma/\Gamma$, given in [2].

The thermal capture cross section is 1.3% lower than in the previous evaluation and the capture resonance integral is 0.3% lower.

The upper limit for the unresolved resonance range is 10 to 90 keV. The resonance parameters are fit to the average capture cross sections from Beer, et al. [2]; the parameters are based on:

D_0 = 100 eV, $S_0 = 1.9\times10^{-4}$, $S_1 = 0.44\times10^{-4}$, $S_2 = 1.08\times10^{-4}$
D_1 = 30 eV, $S_{\gamma0} = 5.10\times10^{-4}$, $S_{\gamma1} = 17.0\times10^{-4}$

<u>2200 m/s cross sections (barns)</u>

Total	= 34.16
Elastic	= 21.15
Capture	= 13.01

Scattering radius = 8.0 fm [1]

<u>Computed resonance integral (barns)</u>= 34.48

SMOOTH CROSS SECTIONS (File 3)

Total, elastic, and capture are set to zero in the resolved and unresolved resonance range (1.0×10^{-5} eV to 90 keV). Capture cross sections for the energy range 90 to 2 MeV are taken from Beer, et al. [2], Table IV.

REFERENCES

1. S. F. Mughabghab, **Neutron Cross Sections, Vol 1, Neutron Resonance Parameters and Thermal Cross Sections**, Part B (Academic Press, 1984)
2. M. K. Drake, D. A. Sargis, and T. Maung, **SAI-76-677-LJ** (1976)

ENDF/B-VI MOD 2 REVISION 1 (NNDC, August 1991)

The second J-value for L=1 in the unresolved resonance region. (Note that the revised evaluation from Release 2 has also been labeled as MOD 2, Revision 1).

ENDF/B-VI MOD 0 (NNDC, February 1990)

ENDF/B-V MAT 1384 converted to ENDF-6 format. See ^{174}Hf for documentation of the ENDF/B-V evaluation.

Evaluation: **^{nat}W Incident Neutron Library, Release 1 (MAT 7400)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5, 12, 13, 14, 15
Evaluators: E. D. Arthur, P. G. Young, R. Boicourt (LANL)

ENDF/B-VI MOD 2 REVISION 1 (E. D. Arthur, LANL, July 1991)

File 3: For total, elastic, and capture, unequal energies at several discontinuities marking resonance region boundaries were corrected.

File 14: For inelastic scattering, NK(N1) corrected.

ENDF/B-VI MOD 0 (NNDC, February 1990)

ENDF/B-V MAT 1474 converted to ENDF-6 format.

See ENDF-201 Summary Documentation, 3rd Edition, Suppl. 1 (1985), page 115, for documentation of the ENDF/B-V evaluation.

Evaluation: **^{191,193}Ir Incident Neutron Library, Release 4 (MAT 7725)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5, 12, 14, 15
Evaluators: R. Q. Wright, R. R. Spencer (ORNL)

ENDF/B-VI MOD 1 NEW EVALUATION (R.Q.Wright, R. R. Spencer, ORNL, March 1995)

This evaluation uses the BROND natural iridium evaluation, and includes resolved and unresolved resonance data. Changes for this evaluation are given following.

RESOLVED RESONANCE RANGE

The MLBW resonance formalism is used in this evaluation. The resonance parameters are taken from Mughabghab [1] and are unchanged from the BROND evaluation with the exception of the bound level in ^{193}Ir.

$\underline{^{191}\text{Ir}}$ Resolved resonance range upper limit is 160 eV; the highest energy resonance included is at 171 eV. 51 s-wave (1 bound level) resonances are given. The last five (highest energy) resonances are fictitious resonances above the upper cutoff of the resolved resonance range. The scattering radius is 9.9 fm which gives a thermal scattering cross section of 13.92 barns.

$\underline{^{193}\text{Ir}}$ Resolved resonance range upper limit is 300 eV; the highest energy resonance included is at 336 eV. 45 s-wave (1 bound level) resonances are included; the last five (highest energy) resonances are fictitious resonances above the upper cutoff of the resolved resonance range. The scattering radius is 11.3 fm which gives a thermal scattering cross section of 19.34 barns.

The parameters for the bound level at -21.7 eV [1] are not the same as those in the BROND evaluation. This change gives a thermal capture cross section of 112 b which is adopted for this evaluation.

UNRESOLVED RESONANCE RANGE

The unresolved resonance range includes parameters for s-wave and p-wave resonances. Unresolved parameters are energy independent but are specified using an energy dependent format (energies given in the file). The SESH program [2] was used to determine the total, elastic, and capture cross sections in the unresolved range in order to compare calculated cross sections with measurements.

$\underline{^{191}\text{Ir}}$ The unresolved resonance range is 160 eV to 10 keV. The average Γ_γ is 0.077 eV. D_0 = 2.15 eV, $S_0 = 2.2\times10^{-4}$, $S_1 = 0.4\times10^{-4}$, $S_{\gamma0}$ = 358.14 and the scattering radius = 8.8 fm.

$\underline{^{193}\text{Ir}}$ The unresolved resonance range is 300 eV to 10 keV. The average Γ_γ is 0.093 eV. D_0 = 5.54 eV, $S_0 = 2.0\times10^{-4}$, $S_1 = 0.4\times10^{-4}$, $S_{\gamma0}$ = 167.87 and the scattering radius = 9.0 fm.

SMOOTH CROSS SECTIONS (File 3)

The <u>total cross section</u> for ^{191}Ir was modified from 10 to 130 keV; it is 19% higher than natural iridium at 10 keV and unchanged above 130 keV. The total cross section for ^{193}Ir was modified from 10 to 150 keV; it is 17% higher than natural iridium at 10 keV and unchanged above 150 keV.

The <u>elastic cross section</u> is taken from total - nonelastic.

The inelastic cross section was obtained from the sum of MT = 51, 52, 53, 54, and 91. The discrete inelastic levels correspond to MT = 53, 54, 56, and 57 for ^{191}Ir, and to MT = 51, 52, 55, and 58, respectively, for ^{193}Ir in the BROND natural iridium evaluation.

The capture cross section is based on Macklin, et al., [3] from 10 keV to 2 MeV. From 2 to 20 MeV, the capture was obtained by renormalizing the natural iridium capture to the Macklin capture value at 2 MeV.

2200 m/s cross sections (barns)	^{191}Ir	^{193}Ir
Total	968.26	131.34
Elastic	13.92	19.34
Capture	954.34	112.00
Resonance integral (barns)	3551.5	1373.0

PHOTON PRODUCTION (File 12)

The separation of the natural element into ^{191}Ir and ^{193}Ir is based on information given in the file 1 comments for MF = 12, MT = 102 in the original BROND evaluation and on Kruger [4].

REFERENCES

1. S. F. Mughabghab, **Neutron Cross Sections, Vol 1, Neutron Resonance Parameters and Thermal Cross Sections**, Part B (Academic Press, 1984)
2. F. H. Fröhner, **GA-8380** (1968) Gulf General Atomic
3. R. L. Macklin (ORNL), D. M. Drake and J. J. Malanify, **LA-7479-MS** (1978) Los Alamos National Laboratory
4. H. Kruger, et al., ***Nucl. Phys.*** **A169**, 363-384 (1971)

Evaluation: **^{197}Au Incident Neutron Library, Release 1 (MAT 7925)**
Energy Range: 10^{-5} eV to 30 MeV
Files: 1, 2, 3, 4, 5, 8, 10, 12, 13, 14, 15, 33
Evaluators: P. G. Young, E. D. Arthur (LANL)

ENDF/B-VI MOD 2 REVISION 1 (P. G. Young, LANL, July 1991)

File 1: The comments following were added regarding estimated (expanded) covariance for the Standards Cross Sections.

File 3: Q-value corrected for capture cross section.

STANDARDS COVARIANCES

Phase 1 reviewers of the ENDF/B-VI standards cross sections have expressed the concern that the uncertainties resulting from the combination of R-matrix and simultaneous evaluations might have led to uncertainties that are too small. As a result, the Standards Subcommittee produced (at the May, 1990 CSEWG meeting) a set of expanded covariance estimates for the standard cross section reactions. These uncertainties are estimates such that if a modern day experiment were performed on a given standard cross section using the best techniques, approximately 2/3 of the results should fall within these expanded uncertainties. The expanded uncertainties for the ^{197}Au(n,γ) cross section are given in the following table and are compared to values from the combined output of the standards covariance analysis:

Energy Range (keV)	Estimated Uncertainty %	Combined Analysis %
2.53×10^{-5}	0.14	0.14
200 - 500	3.0	1.31
500 - 1000	3.5	2.1
1000 - 2500	4.5	2.0

ENDF/B-VI MOD 1 NEW EVALUATION (P. G. Young, E. D. Arthur, LANL, January 1984)

See ENDF-201 Summary Documentation, 4th Edition (1991), page 325, for documentation of the ENDF/B-VI evaluation.

Evaluation: **^{207}Pb Incident Neutron Library, Release 1 (MAT 8234)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 6, 12, 14, 15, 33
Evaluators: C. Y. Fu, N. M. Larson, D. C. Larson (ORNL)

ENDF/B-VI MOD 2 REVISION 1 (C. Y. Fu, N. M. Larson, D. C. Larson, ORNL, July 1991)
Resonance parameters have been revised.

ENDF/B-VI MOD 1 NEW EVALUATION (C. Y. Fu, N. M. Larson, D. C. Larson, ORNL, March 1989)

See ENDF-201 Summary Documentation, 4th Edition (1991), page 336, for documentation of the ENDF/B-VI evaluation.

Evaluation: **^{209}Bi Incident Neutron Library, Release 3 (MAT 8325)**
Energy Range: 10^{-5} eV to 20 MeV
Files: 1, 2, 3, 4, 5, 12, 13, 14, 15, 33
Evaluators: A. B. Smith, D. Smith, P. T. Guenther (ANL)

ENDF/B-VI MOD 1 REVISION 1 (V. McLane, NNDC, May 1995)
Minor correction to File 1 comments made in Release 3; MOD not changed.

ENDF/B-VI MOD 1 NEW EVALUATION (A. Smith, D. Smith, P. Guenther, et al., ANL, August 1989)
For complete documentation, see Guenther, et al. [1] and Summary Documentation, 4th Edition (1991), page 351.

REFERENCE

1. P. T. Guenther, R. D. Lawson, J. W. Meadows, A. B. Smith, D. L. Smith, M. Sugimoto, R. J. Howerton, **ANL/NDM-109** (1989) Argonne National Laboratory