APPENDIX F

Summary of Important ENDF Rules

General

1. Cross sections for all significant reactions should be included.
2. The data in ENDF are specified over the entire energy range 10^{-5} eV to 20 MeV. It should be possible to determine values between tabulated points with use of the interpolation schemes provided.
3. All cross sections are in barns, all energies in eV, all temperatures in degrees Kelvin, and all times in seconds.
4. Summary documentation and unusual features of the evaluation should appear in the File 1 comments.
5. Threshold energies and Q-values must be consistent for all data presented in different files for a particular reaction.

File 2 - Resonance Parameters

1. Only one energy region containing resolved resonance parameters can be used, if needed.
2. The cross section from resonance parameters is calculated only within the energy range EL to EH, although some of the resonance parameters may lie outside the range.
3. Every ENDF Material has a File 2 even if no resonance parameters are given in order to specify the effective scattering radius.
4. In the unresolved resonance region interpolation should be done in cross section space and not in unresolved resonance parameter space. Any INT is allowed.
5. The Breit-Wigner single-level or multilevel formalisms should be used in the resolved resonance region unless experimental data prove that use of the other allowed formalisms is significantly better.

File 3 - Tabulated Cross Sections

1. All File 3 data are given in the laboratory system.
2. The total cross section MT=1 is the sum of all partial cross sections and has an energy mesh that includes all energy meshes for partial cross sections.

(Exceptions MT=26, 46-49, 719, 739, 759, 779, and 799 are not included in the MT=1.)

3. The following relationships among MT numbers are expected to be satisfied if data are presented:

$$
\begin{aligned}
1 &= 2 + 3 \\
3 \text{ (or } 1 - 2) &= 4 \text{ (or } 51 \rightarrow 91) + (6 \rightarrow 9+16) + 17 + 18 \\
&\quad \text{(or } 19 \rightarrow 21+38) + (22 \rightarrow 25) + (28 \rightarrow 37) \\
&\quad + (102 \rightarrow 114) \\
4 &= \text{sum } (51 \rightarrow 91) \\
18 &= \text{sum } (19 \rightarrow 21) + 38 \\
101 &= \text{sum } (102 \rightarrow 114) \\
103 &= \text{sum } (700 \rightarrow 718) \\
104 &= \text{sum } (720 \rightarrow 738) \\
105 &= \text{sum } (740 \rightarrow 758) \\
106 &= \text{sum } (760 \rightarrow 778) \\
107 &= \text{sum } (780 \rightarrow 798)
\end{aligned}
$$

4. Threshold reactions begin at zero cross sections at the threshold energy.

Files 2 and 3

1. If there are resonance parameters in File 2, there are contributions to the total (MT=1) and scattering (MT=2) cross sections and to the fission (MT=18) and capture (MT=102) cross sections if fission and capture widths are also given. These must be added to the File 3 Sections MT=1, 2, 18, and 102 over the resonance region in order to obtain summation values for these cross sections.
2. The cross sections in File 3 for MT=1, 2, 18, and 102 in the resonance region are used to modify the cross section calculated from the resonance formalisms, if necessary. The File 3 "background" may be positive or negative or even zero if no modifications are required. <u>The summation cross section (File 2 + File 3) should be everywhere positive.</u>
3. Double-value points (discontinuities) are allowed anywhere but are required at resonance region boundaries. A typical situation for MT=1, 2, 18, and 102 in File 3 is a tabulated cross section from 10-5 to 1 eV, tabulated "background" to the cross sections calculated in the resolved resonance region between EL1 and EH1, tabulated "background" to the cross sections calculated in the unresolved region between EL2=EH1 and EH2, and tabulated cross sections from EH2 to 20 MeV. Double-value points occur at EL1, EL2, and EH2.

4. the tabulated "background" used in File 3 to modify the cross sections calculated from File 2 should not be highly structured or represent a large fraction of the cross sections calculated from File 2. It is assumed that the "background" cross section is assumed to be at 0 Kelvin. (The "background" cross section is usually obtained from room temperature comparisons, but this should be unimportant if the "background" cross section is either small or slowly varying).
5. The generalized procedure for Doppler-broadening cross sections from File 2 + 3 is to generate a pointwise cross section from the resolved resonance region on an appropriate energy mesh at 0K and add it to File 3. This summation cross section can be kernel-broadened to a higher temperature.

File 4 - Angular Distributions

1. Only relative angular distributions, normalized to an integrated probability of unity, are given in File 4. The differential scattering cross section in barns per steradian is determined by multiplying File 4 values by the File 2 + File 3 summation scattering cross section σ_s divided by 2π.
2. Discrete channel angular distributions (*e.g.*, MT=2,51-90,701...) should be given as Legendre coefficients in the center-of-mass system, with a maximum of 64 higher order terms, the last being even, in the expansion. If the angular distribution is highly structured and cannot be represented by a Legendre expansion, a tabular angular distribution in the CM system must be given.
3. When the elastic scattering is represented by Legendre coefficients, an energy-independent transformation matrix must be given to perform a CM to laboratory conversion.
4. Angular distributions for continuum and other reactions must be given as tabulated distributions in the Lab system.
5. The angular distribution, whether specified as a Legendre expansion or a tabulated distribution, must be everywhere positive.
6. Angular distribution data should be given at the minimum number of incident energy points that will accurately describe the energy variation of the distributions.

File 5 - Secondary Energy Distribution

1. Only relative energy spectra, normalized to an integrated probability of unity, are given in File 5. All spectra must be zero at the end points. The differential cross section in barns per eV is obtained by multiplying the File 5 values by the File 2 + File 3 cross section times its multiplicity (2 for the (n,2n) reaction).
2. While distribution laws 1, 3, 5, 7, 9, and 10 are allowed, distribution laws 3 and 5 are discouraged but can be used if others do not apply.
3. The sum of all probabilities for all laws used for a particular reaction must be unity at each incident energy.
4. The constant U must be specified, where applicable, to limit the energy range of emitted spectra to physical limits.