31. FILE 31. COVARIANCES OF THE AVERAGE NUMBER OF NEUTRONS PER FISSION

31.1. General Description

For materials that fission, File 31 contains the covariances of the average number of neutrons per fission, given in File 1. MT=452 is used to specify $\bar{\nu}$, the average total number of neutrons per fission. MT=455 and MT=456 may be used to specify the average total number of delayed neutrons per fission, $\bar{\nu}_d$, and the average number of prompt neutrons per fission, $\bar{\nu}_p$, respectively.

The average number of neutrons per fission is given as a function of incident energy for induced fission. This energy dependence may be given by tabulating the values as a function of incident neutron energy or (if MT=452 alone is used) by providing the coefficients for a polynomial expansion as a function of incident neutron energy. Whichever method is used, the result is that the quantities are specified as a function of incident neutron energy and in this sense are similar to the data given in File 3. Therefore, the problems associated with representing the covariances of the average number of neutrons per fission are identical to those in File 33.

For spontaneous fission, in the sub-library for a radioactive decay, the average multiplicities are given by zero-order terms in polynomial expansions, and the lack of any energy dependence is recognized in the formats.

31.2. Formats

Induced fission formats for fission neutron multiplicity in File 31, MT=452, 455, and 456, are directly analogous to those for File 33 given in Section 33.2.

Spontaneous fission formats for neutron multiplicity in File 31, MT=452, 455 and 456, are modified from those in Section 33.2 because there is no energy dependence to express for $\bar{\nu}$ or its covariance components. There, NC- and NI-type sub-subsections for spontaneous fission neutron multiplicity have no energy variables present.

"NC-type" sub-subsections for spontaneous fission $\bar{\nu}$, MT=452, 255, or 456, have the following structure, using definitions given in Section 33.2.

For LTY=0:

```
[MAT,31, MT/ 0.0, 0.0,     0, LTY,     0,     0] CONT          (LTY=0)
[MAT,31, MT/ 0.0, 0.0,     0,    0, 2*NCI, NCI/ {CI,XMTI}] LIST
```

For LTY=1, 2, or 3:

```
[MAT,31, MT/ 0.0, 0.0,     0, LTY,     0,     0] CONT
[MAT,31, MT/ 0.0, 0.0, MATS, MTS,     4,     1/
              ------(XMFS,XLFSS)(0.0, Weight) ] LIST
```

"NI-type" sub-subsections for spontaneous fission neutron multiplicity are allowed with LB=0 and LB=1, and have the structure:

```
[MAT,31, MT/ 0.0, 0.0,     0,  LB,     2,     1/(0.0,F)] LIST
```

where F gives the absolute or relative covariance component depending on whether LB=0 or LB=1. (See Section 33.2 of this manual for notation.)

31.3. Procedures

All procedures given in 33.3 concerning the ordering and completeness of sections of File 33 apply to sections of File 31: $\bar{\nu}$ (MAT,31,452), $\bar{\nu}_d$ (MAT,31,455) and $\bar{\nu}_p$ (MAT,31,456).

Note that in File 1 $\bar{\nu}$ (MT=452), $\bar{\nu}_d$ (MT=455) and $\bar{\nu}_p$ (MT=456) satisfy the relation:

$$\bar{\nu}(E) = \bar{\nu}_d(E) + \bar{\nu}_p$$

Therefore, if one of these quantities is "derived" in terms of the other two, it is permissible to use "NC-type" sub-sections with LTY=0 to indicate that it is a "derived redundant cross section". See section 33.2.1.a. for an explanation of this format.

If a section of File 31 is used with MT=456, there must also be a section of File 31 with MT=452.

When a section of File 31 for either MT=452, 455 or 456 is used for induced fission, there must be a section in File 33 for the fission cross sections, *i.e.*, section (MAT,33,18).

Note:

1. Since $\bar{\nu}_d$ is much smaller than $\bar{\nu}_p$, it should never be evaluated by subtracting $\bar{\nu}_p$ from $\bar{\nu}$.
2. When a polynomial representation is used to describe the data in File 1 MT=452, the covariance file applies to the tabular reconstruction of the data as a function of energy and not to the polynomial coefficients.
3. The ENDF-6 formats do not provide for covariance references between different sublibraries except by use of File 30. Therefore, it is not possible to express the covariances between, for example, the $\bar{\nu}$ for spontaneous fission of ^{252}Cf and the $\bar{\nu}$(E) for the major fissile materials by use of NC-type sub-subsections with LTY=1, 2, and 3.
4. In ENDF-6 formats there is no provision to express uncertainty in MT=455 for the decay constants for the various precursor families.