15. File 15. CONTINUOUS PHOTON ENERGY SPECTRA

File 15 provides a means for representing continuous energy distributions of secondary photons, expressed as normalized probability distributions. The energy distribution of each photon continuum occurring in Files 12 and 13 should be specified in File 15 over the same neutron energy range used in Files 12 and 13. Each section of File 15 gives the data for a particular reaction type (MT number) and the sections are ordered by increasing MT number. The energy distributions, $f(E_\gamma \leftarrow E)$, are in units of eV^{-1} and are normalized so that

$$\int_0^{E_\gamma^{\max}} f\left(E_\gamma \leftarrow E\right) dE_\gamma = 1 \quad ,$$

where $E_\gamma^{\max}$ is the maximum possible secondary photon energy and its value depends on the incoming neutron energy as well as the particular nuclei involved.[1] The energy distributions $f(E_\gamma \leftarrow E)$ can be broken down into the weighted sum of several different normalized distributions in the following manner:

$$f\left(E_\gamma \leftarrow E\right) = \sum_{j=1}^{NC} p_j(E)\, g_j\left(E_\gamma \leftarrow E\right) \qquad (\text{eV})^{-1} \tag{15.1}$$

where

NC	= the number of partial distributions used to represent $f(E_\gamma \leftarrow E)$,
$g_j(E_\gamma \leftarrow E)$	= the j^{th} normalized partial distribution in the units eV^{-1} , and
$p_j(E)$	= the probability or weight given to the j^{th} partial distribution, $g_j(E_\gamma \leftarrow E)$.

The following condition is imposed.

$$\int_0^{E_\gamma^{\max}} g_j\left(E_\gamma \leftarrow E\right) dE_\gamma = 1 .$$

Thus,

$$\sum_{j=1}^{NC} p_j(E) = 1.$$

The absolute energy distribution cross section, $\sigma^\gamma(E_\gamma \leftarrow E)$, can be constructed from the expression

$$\sigma^\gamma\left(E_\gamma \leftarrow E\right) = \sigma^\gamma\left(E\right) f\left(E_\gamma \leftarrow E\right) \qquad (\text{b/eV}) ,$$

where $\sigma^\gamma(E)$ is the integrated cross section for the continuum given either directly in file 13 or through the combination of Files 2, 3, and 12.

The system used to represent continuous photon energy distributions in File 15 is similar to that used in File 5. At present, however, there is only one continuous distribution law activated for File 15, *i.e.*,

$$g_j\left(E_\gamma \leftarrow E\right) = g\left(E_\gamma \leftarrow E\right) \quad ,$$

where $g(E_\gamma \leftarrow E)$ represents an arbitrary tabulated function. In the future, new laws (for example, the fission gamma-ray spectrum) may be added.

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[1] Note that the subscript k used in describing Files 12 and 13 has been dropped from $f(E_\gamma \leftarrow E)$. This is done because only one energy continuum is allowed for each MT number, and the subscript k has no meaning in File 15. It is, in fact, the NK^{th} subsection in File 12 or 13 that contains the production data for the continuum.

15.1. Formats

The structure of a section is

```
[MAT, 15, MT/  ZA, AWR,    0,    0,  NC,    0] HEAD
                  <subsection for j=1>
                  <subsection for j=2>
              ------------------------------
              ------------------------------
                  <subsection for j=NC>
[MAT, 15,  0/ 0.0, 0.0,    0,    0,    0,    0] SEND
```

For LF=1, the structure of a subsection is

```
[MAT, 15, MT/ 0.0, 0.0,    0,  LF,  NR,  NP/ Eint / pj(E)] TAB1  (LF=1)
[MAT, 15, MT/ 0.0, 0.0,    0,   0,  NR,  NE/ Eint ] TAB2
[MAT, 15, MT/ 0.0,   E1,   0,   0,  NR,  NP/ Eγ int/ g(Eγ□E1)] TAB1
[MAT, 15, MT/ 0.0,   E2,   0,   0,  NR,  NP/ Eγ int/ g(Eγ□E2)] TAB1
             ----------------------------
             ----------------------------
[MAT, 15, MT/ 0.0,  ENE,   0,   0,  NR,  NP/ Eγ int/g(Eγ□ENE)] TAB1
```

Only one distribution law is presently available (tabulated secondary photon energy distribution). Therefore, formats for other laws remain to be defined, but their structures will probably closely parallel those in File 5 for LF=5, 7, 9, and 11. When histogram representations are used (interpolation scheme, INT=1), 0.25 to 0.5-MeV photon energy bands should be used. The incident energy ranges must agree with data given in file 12 and/or 13. Other procedures are the same as those recommended for File 5 data (tabulated distribution).

15.2. Procedures

1. Photon energies, E_γ, within a subsection are given in order of increasing magnitude.
2. The TAB1 records for the $g(E_\gamma \square E_i)$ within a subsection are given in increasing order of neutron energy, E_i.
3. The tabulated functions, $g(E_\gamma \square E_i)$, should be normalized to unity within four significant figures.
4. The interpolation scheme for $p_j(E)$ must be either linear-linear or log-linear (INT=1, 2, or 3) to preserve probabilities upon interpolation. Like-wise, the interpolation scheme for $g(E_\gamma \square E)$ must be linear-linear or log-linear with respect to E.
5. The neutron energy mesh should be a subset of that used for the $y_{NK}(E)$ tabulation in File 12 or for the $\sigma^{\gamma}_{NK}(E)$ tabulation in File 13, and the energy ranges must be identical. However, the neutron energy mesh for $p_j(E)$ need not be the same as that for $g(E_\gamma \leftarrow E)$, as long as they span the same range.
6. For an MT number appearing in both File 12 and File 13, a continuous photon energy distribution (LF=1) can appear in only one of those files. Otherwise the distribution as given in File 15 could not in general be uniquely associated with a corresponding multiplicity or production cross section.

7. Use the minimum amount of data that will accurately represent the energy distribution as a function of both E_γ and E. However, do not use too coarse a mesh for E, even if the distributions are slowly varying functions of E, since the interpolated distribution will always have a nonzero component up to the maximum energy at which either of the original distributions has a non-zero component.
8. The limit on the number of neutron energy points for either $p_j(E)$ or $g(E_\gamma \Box E)$ is 200. The limit on the number of photon energy points for $g(E_\gamma \Box E)$ is 1000.