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Memo CP-D/584 (Rev.)

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To: Distribution
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Subject: **Transmission and reaction yield**
Reference: Memo CP-D/368, CP-D/392

Recently NNDC has received transmission data and capture yield measured at Rensselaer Polytechnic Institute [1]. In an old EXFOR Manual [2], the following two quantities are considered as "raw" data encountered in EXFOR compilation.

1. measured transmissions:

$$\langle T \rangle = \langle \exp(-n\sigma_T) \rangle = 1 - n\langle \sigma_T \rangle + \frac{1}{2} n^2 \langle \sigma^2{}_T \rangle + \ldots$$

2. measured reaction yields:

$$\langle Y_r \rangle = \left\langle [1 - \exp(-n\sigma_T)] \frac{\sigma_r}{\sigma_T} + \sum_{i=1}^{\infty} Y_{r,i} \right\rangle$$

, where <…> denotes resolution broadening, n is the sample thickness in nuclei/barn

σ_T and σ_r are the Doppler-broadened, abundance-weighted total and partial reaction cross sections, respectively. $Y_{r,i}$ is the reaction yield from neutrons scattered i times before inducing the reaction of type r (=fission, scattering or radiative capture).

…

At that time these quantities were compiled with "`,SIG,,RAW`". After Memo CP-D/368 and 392, we have used a quantity code "`,TRN`" for transmissions, but we still do not have a quantity code for reaction yields.

The following new codes are proposed for compilation of reaction yield.

Dictionary 34 (Modifiers)

`RYL` Reaction yield

Dictionary 236 (Quantities)

`,TRN,,RYL` Reaction yield

Unit code or Quantity	Reaction Type	Dimension
236	**213**	**26**
`,TRN,,RYL`	`CS+`	`NO`

Remarks:

1. Various corrections have to be applied to raw neutron transmission and capture yield data for resonance analysis. Typical equations with correction factors are, for example,

$$T = N\frac{C'_{in} - B'_{in}}{C'_{out} - B'_{out}} \qquad Y_r = N\frac{C'_r - B'_r}{C'_\varphi - B'_\varphi}Y_\varphi$$

, where in, out, r and ϕ stands for sample-in, sample-out, reaction channel and neutron flux measurement, and C' and B' denote count and background count corrected for dead time, respectively. Y_φ denotes the yield for the flux measurements (e.g., ^{10}B(n,α)^{7}Li). This yield is deduced from the reaction and total cross section of the neutron induced reaction used to measure the flux. In some cases the thin sample approximation can be applied such that this yield is directly proportional to the reaction cross section.

Corrections applied to compiled data should be described under keyword `CORRECTION`. If appropriate corrections were not applied to data received by compilers, it should be indicated by `RAW` in SF8.

2. It is obvious from the definition that sample thickness (atoms/b) is an essential independent variable of these quantities. In order to (re-)analyze compiled data taking into account Doppler Broadening effect, sample temperature (in K) is also useful information. Therefore `THICKNESS` and `TEMP` should be coded information. (Modifier `TMP` may be coded in SF8 if sample temperature is significantly different from room temperature (300 K).)

3. The relation between time-of-flight (T_n) and energy (E_n) of incident neutron is not one-to one, but related by resolution function $R(T_n,E_n)$, and it is

$$T(T_n) = \int R(T_n, E_n)\exp\left[-n\sigma_T(E_n)\right]dE_n$$

for neutron transmission. Therefore compilers are encouraged to inclusion of time-of-flight if point-wise transmission data are received from authors. See also EXFOR template prepared by the IRMM (Geel) group in WP2009-06, where time-of-flight is treated as a primary independent variable.

Because this issue is related to LEXFOR "Self-indication" update, a new LEXFOR entry "transmission" will be submitted later.

References

[1] M. J. Trbovich et al., Nucl. Sci. Eng. **161** (2009) 303 (EXFOR 14239)
[2] H. D. Lemmel (ed.), NDS EXFOR Manual, IAEA-NDS-3 (Rev.85/8)

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