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# Memo CP-D/585

**Date:** 16 September 2009
**To:** Distribution
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**Subject:** **Mass distribution and fractional yield in fission data**

NDS is working for compilation of fission fragment mass distribution (S. Singh *et al*. [1] and H. Naik *et al*.[2]). Below a new analysis code `GAUSS` and revision of LEXFOR entry "Fission Yields" are proposed.

## 1. Derivation of total chain yield

In LEXFOR total chain yield of fission fragment $Y(A)$ is defined as follows:

Total chain yield `(…(…,F)MASS,CHN,FY)`:
Sum of the cumulative yields of all stable fission products having the same mass $A$

In two articles [1,2],

- S. Singh *et al*. [1] tabulated cumulative or independent yield of a nuclide for each mass chain, and then derived $Y(A)$ by charge distribution correction assuming Gaussian distribution for independent yield and also unchanged charge distribution (UCD) for the most probable charge ($Z_p$).

- H. Naik *et al*. [2] tabulated cumulative yield of a nuclide near beta- stability line for each mass chain, and then assumed it is approximately equal to $Y(A)$.

Derived total chain yield may depend on the assumptions used by authors (especially when $Z_p$ is close to the beta stability line.). Therefore compilers are asked to give explanation of derivation of total chain yield under `ANALYSIS`. A new analysis code is proposed for the total chain yield obtained by charge distribution correction:

### Dictionary 23 (Analysis codes)

`CHGDS` Corrected by charge distribution
(for derivation of total chain yield, typically by Gaussian assumption)

## 2. Revision of definition of fractional yield in LEXFOR

The following revision of definition for fractional yields in the LEXFOR entry "Fission Yields" is proposed. Main points are.

(1) A.C. Wahl *et al*. [3] gives fractional independent yield (FIY) without integration over $\Delta z$=1. Probably this is due to simplification of calculation in old time. Now independent fractional yield is often treated in integral form. For compilation of old literature, we would keep both expressions in LEXFOR.

(2) A review by A. C. Wahl [4] to the reference of this LEXFOR entry is proposed. This article gives a good summary of fission quantities.

LEXFOR entry update (equations and underlined parts):

**5. Total chain yield** The total chain yield per fission of fission-fragment mass *A* is the sum of the cumulative yields of all stable fission products having the same mass *A*. When only one stable fission product per mass A exists, the total chain yield for mass A is identical with the cumulative yield of the stable end product *Z,A*.

**REACTION Coding:** Branch code `CHN` in SF5.
***Example***: `(…(N,F)MASS,CHN,FY)`

If the total chain yield is derived from cumulative yield by charge distribution correction assuming Gaussian distribution of independent variable, a code `CHGDS` must be coded under the keyword `ANALYSIS`. In the correction, unchanged charge distribution (UCD) assumption $Z_p = Z_f A/A_f$ is often used to determine $Z_p$, where $A_f$ and $Z_f$ are mass and atomic number of compound nucleus, and *A* is the fragment mass.

…

**7. Fractional yields** Ratios of fission-product yield to total chain yield *Y*(*A*). The distribution of charge *Z* within a given fragment mass A is called charge dispersion. It can empirically be approximated by a Gaussian distribution with a most probable charge $Z_p$ (see following).

The fractional independent yield *FIY*(*Z*,*A*) and fractional cumulative yield *FCY*(*Z*,*A*) of a fission product at the beta-minus decay side (after prompt neutron emission) is given by:

$$FIY(Z,A) = Y_{ind}(Z,A)/Y(A)$$

$$\sim \frac{1}{\sigma\sqrt{2\pi}} \int_{z-1/2}^{Z+1/2} \exp\left[-\left(z - Z_p\right)^2 / 2\sigma^2\right] dz \sim \frac{1}{\sqrt{c\pi}} \exp\left[-\left(z - Z_p\right)^2 / c\right]$$

$$FCY(Z,A) = Y_{cum}(Z,A)/Y(A) \sim \frac{1}{\sigma\sqrt{2\pi}} \int_{0}^{Z+1/2} \exp\left[-\left(z - Z_p\right)^2 / 2\sigma^2\right] dz$$

The parameters *c* and σ are width of the distributions related by $c \sim 2(\sigma^2 + 1/12)$.
…

**Reference**

[1] S. Singh *et al*., J. Radioanal. Nucl. Chem. **279** (2009) 547 (EXFOR D6077)
[2] H. Naik *et al*., Nucl. Instrum. Meth. B**267**(2009)1891 (EXFOR G0015)
[3] A. C. Whal *et al*., Phys. Rev. **126** (1962)1112
[4] A. C. Wahl, At. Data and Nucl. Data Table **39** (1988) 1

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