Memo CP-D/178

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To: Distribution

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Subject: Fission Yields

At the Specialists' Meeting on Fission Yield Evaluation (Studsvik, 11-14 Sept. 1987) it was decided that EXFOR should be the format for the compilation and exchange of experimental fission yield data, to be used in future by all evaluators. For the treatment of experimental data in the evaluation process, the evaluators need some information on the experiments, in particular on the method used and the type of measurement (absolute, relative, R-value). To facilitate the automatic processing of the data contained in EXFOR, we propose the extended use of coded information and some new codes.

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1. General

Coded information should be used under as many keywords, as applicable for a given entry, even if not obligatory. In particular:

METHOD: Several codes can be used, e.g.:
- for the principal measurement method (absolute, relative, R-value)
- for the determination of the number of fissions
- for the determination of the number of nuclides or activities of fission products

Similarly, more than one DETECTOR should be coded, if applicable.

MONITOR: At least the monitor reactions should be coded, if mentioned in a publication, even if no numerical values are given.

2. Proposals for new codes.

2.1 METHOD, Dictionary 21:

The new codes are proposed especially for fission yield measurements, which is therefore in some cases reflected by the codes and expansions.

Principal measurement methods:

ABSFY (ABSOLUTE FISSION YIELD MEASUREMENT)

RELFY (RELATIVE FISSION YIELD MEASUREMENT)

RVAL (R-VALUE MEASUREMENT) see LEXFOR under fission yields

Determination of the number of fissions:

FISCT (ABSOLUTE FISSION COUNTING) of the total number of fissions with a detector to be specified

HADT (HEAVY ATOM DIFFERENCE TECHNIQUE) by mass spectrometry

FLUX (N-FLUX MONITORING) by a reaction to be coded under MONITOR.

Fission product separation and measurement:
(this includes the existing code ASEP)

OLMS (ON-LINE MASS SEPARATION)

RCHEM (RADIOCHEMICAL SEPARATION)

FPGAM (DIRECT GAMMA-RAY SPECTROMETRY) of unseparated fission products

GSPEC (GAMMA RAY SPECTROMETRY)

BSPEC (BETA-RAY SPECTROMETRY)

BGCT (BETA-GAMMA COINCIDENCE TECHNIQUE)

2.2. Codes needed for R-value measurements

Fission yield measurement methods, including R-values, will be described in a revision of the LEXFOR entry on fission yields. However, some peculiarities of R-values, which require the introduction of new codes, should be mentioned:

An R-value is a dimensionless ratio of measurement results from 2 different fission reactions - one of them being the monitor reaction - which often involves 2 different neutron spectra. Therefore we propose the following new codes:

Dictionary 24:

| | | |
|---|---|---|
| EN-MEANMON | AS EN-MEAN, BUT FOR THE MONITOR REACTION. EXPLANATION IN FREE TEXT IS REQUIRED. | A |
| KT-MON | SPECTRUM TEMPERATURE FOR THE MONITOR REACTION. | A |

Dictionary 32:

R R-values relative to the monitor reaction, to be combined with 'NO-DIM' in the DATA table.

Dictionary 36 (under "FISSION-FRAGMENTS"):

| | |
|---|---|
| CUM,FY/R | FY (R-VALUE FOR CUMULATIVE FISSION PRODUCT YIELDS, RELATIVE TO THE MONITOR REACTION) = to be combined with the UNIT NO-DIM |
| CHN,FY/R | FY (R-VALUE FOR TOTAL CHAIN YIELDS OF FISSION PRODUCTS, RELATIVE TO THE MONITOR REACTION) = to be combined with the UNIT NO-DIM |

These are the most common fission yield types where the R-value method is applied. Other codes may be introduced as the need arises.

3. Coding rules for R-values

The definition of the R-value given in the LEXFOR entry on Fission Yields (page 9) is correct, but the coding rules shown there have to be revised. This definition is given here:

$$R=\frac{\text{(Activity Ce-144 from fast U-238)/(Activity Mo-99 from fast U-238)}}{\text{(Activity Ce-144 from thermal U-235)/(Activity Mo-99 from thermal U-235)}}$$

thermal U-235 is the monitor reaction
Mo-99 is the monitor fission product
the yield of Ce-144 from fast fission of U-238 is the value to be determined (from the formula given in the LEXFOR entry).
Note, that Ce-144 can be replaced by more than one fission product (to be coded as ELEM/MASS), the yields of which are to be determined.

The simplest solution would be to compile only R-Values together with the associated errors in the data table, which would be sufficient for evaluators. In this case it would also be sufficient to code the monitor reaction and monitor fission product under MONITOR, without including the numerical values. In the above example this would be the yields of:

Ce-144 and Mo-99 from U-235 thermal fission
Mo-99 from U-238 fast fission.

In the general case, Ce-144 should be replaced by ELEM/MASS.

However, in some cases the fission yields themselves may be compiled, i.e. the yield of Ce-144 (or ELEM/MASS) from fast fission of U-238 (see LEXFOR on fission yields, page 9), either because only these values are given in a publication (without the original R-values), or together with the R-values for the convenience of those users who are not evaluators.

In the first case, the reaction should be coded as cumulative yield, but the method (RVAL) must be coded.

In the second case, 2 reactions with pointers have to be coded for the R-values and the yields as obtained by the measurer using his own monitor yield values. Also, it has to be clearly stated in the subentry that the "absolute" yield values are derived (dependent) from the originally measured R-values.

In both cases, the MONITOR reactions have to be coded as MONIT1,2,3, and the numerical values compiled:

- the Mo-99 yields from both reactions in the COMMON Section
- the Ce-144 (or ELEM/MASS) yield(s) from U-235 thermal fission in the data table.

The main problem with this solution (and we don't know any better proposal) is that the COMMON as well as the DATA section contain values from (e.g.) thermal neutron and fast neutron fission. This has to be stated clearly in the EXFOR entry, if necessary with additional free text information.

EXAMPLE
For illustration, we use the example of the LEXFOR entry, but with 3 fission products in the ELEM/MASS formalism instead of Ce-144 alone (error values are omitted):

```
REACTION    1(92-U-238(N,F)ELEM/MASS,CUM,FY/R,,SPA) R-VALUES
            2(92-U-238(N,F)ELEM/MASS,CUM,FY,,SPA) DEDUCED YIELDS
METHOD       (RVAL)
             (FPGAM)
MONITOR      ((MONIT1)92-U-235(N,F) 42-MO-99,CUM,FY,,MXW)
             ((MONIT2)92-U-235(N,F)ELEM/MASS,CUM,FY,,MXW)
             ((MONIT3)92-U-238(N,F)42-MO-99,CUM,FY,,SPA)
 ...
STATUS      2(DEP) NUMERICAL YIELD VALUES DERIVED FROM MEASURED R-VALUES
              AND MONITOR VALUES.
 ...
COMMON
EN-MEANMON  MONIT1          EN-MEAN     MONIT3
EV          PC/FIS          KEV         PC/FIS
0.0253      6.09            300.        6.16
ENDCOMMON
DATA
ELEMENT     MASS            MONIT2      DATA      1DATA      2
NO-DIM      NO-DIM          PC/FIS      NO-DIM     PC/FIS
40.          95.            6.51        0.776     5.11
55.         137.            6.14        0.966     6.00
58.         144.            5.44        0.825     4.54
ENDDATA
```