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To: Distribution

From:   
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Subject: Reaction combinations

Reference: Memo CP-D/178

This proposal is supposed to solve 2 problems which are relevant for accurately coding R-values for fission product yield measurements, but also for other data types, such as some cross section ratios and fractional fission product yields, respectively:

- (1) Numerator and denominator of a REACTION ratio (()/()) refer to different incident projectile energies (or to different secondary particle angles or energies).
- (2) A commonly used quantity (e.g. R-values, or fractional independent fission-product yields and others) has to be coded as a combination (e.g. ratio) of 2 (or more) REACTIONs and is, therefore, difficult to retrieve and not easily recognizable for the user.

Therefore, the proposal for new coding rules for R-values of memo CP-D/178 is changed to a more general one allowing to properly compile all cases involving (1) or (2) above. It supersedes part 2.2 and part 3. of Memo CP-D/178, whereas the new codes proposed in part 2.1 of Memo CP-D/178 were approved at the NRDC meeting.


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We propose the following solution for these two problems.

- (1) For the REACTION code string, add a new separator '/' which would indicate that the numerator (i.e., the reaction string preceding the double slash) and the denominator (i.e., the reaction string following the double slash) refer to different incident particle energies (or different secondary particle angles or energies).

Add a new series of data headings with the extensions -NM (numerator) and -DN (denominator). This would only be legal to use when the reaction string contains the separator '/', and, when used, both would be coded.

Proposed headings:

Add to Dictionary 24:

<u>Heading</u>	<u>Family Flag</u>
EN-NM	A
EN-DN	A
EN-DUM-NM	A
EN-DUM-DN	A
EN-MEAN-NM	A
EN-MEAN-DN	A
KT-NM	A
KT-DN	A
E-NM	E
E-DN	E
ANG-NM	G
ANG-DN	G

- (2) Add a new Information-Identifier Keyword 'RESULT' which, if used, would always immediately follow the keyword REACTION. This keyword would contain a code to describe commonly used quantities that are coded as a reaction combination. Additions to this dictionary require NRDC approval.

See coding examples on page 4 and in the Appendix.

We propose to add a new Dictionary 37 (Result) initially containing codes for the following quantities.

RVAL	(R-VALUE) ratio of yields at 2 different incident energies
FRCUM	(FRACTIONAL CUMULATIVE YIELD) ratio of cumulative yield to chain yield
FRIND	(FRACTIONAL INDEPENDENT YIELD) ratio of independent yield to chain yield

CAPTA (CAPTURE AREA/2 π **2 LAMBDA(o)**2)
G*GAMMA(N)*GAMMA(GAMMA)/GAMMA
WHICH IS PROPORTIONAL TO THE CAPTURE AREA

We propose the following additions to the EXFOR manual.

Add on page 8.R.17:

RESULT

1. Used to describe common quantities which are coded as a reaction combination
2. Presence is obligatory when relevant. Will have coded information, with or without free text.
3. Contains a result code from Dictionary 37. Only one code will be entered for each reaction combination.
4. If more than one code is to be entered, each will be on a separate record, preceded by the relevant pointer.

Add on page 8.R.9:

// Used in the case where the numerator and denominator of a reaction ratio refer to different incident projectile energies (or to different secondary particle angles or energies)
(((.....)/(.....))//(((.....)/(.....)))

Add on page 6.6:

Reaction ratios

If the reaction combination contains the separator '///', signifying that the numerator and denominator of the ratio have different independent variables, then the data table will contain independent variable pairs with the extensions '-NM' and '-DN' (see Dictionary 24).

Add on page 7.10

37.# Result ≤ 5 yes

We propose the following additions to LEXFOR.

Under Fission Yields 6. Fractional Yields: add

the REACTION is coded as an explicit ratio and is followed by the keyword RESULT using the code 'FRIND' or 'FRCUM'

Fractional independent yield:

```
REACTION      ((      )/(      ))  
RESULT        (FRIND)
```

Fractional cumulative yield:

```
REACTION      ((      )/(      ))  
RESULT        (FRCUM)
```

Under Fission Yields add:

10. R-values

An R-value is a ratio of measurement results for 2 different incident energies or energy spectra (one of which is considered to be the monitor reaction), each of which is relative to the same standard.

Example:

$$R = \frac{(^{144}\text{Ce}/^{99}\text{Mo} \text{ activity from } ^{238}\text{U} \text{ fission by fast neutrons})}{(^{144}\text{Ce}/^{99}\text{Mo} \text{ activity from } ^{235}\text{U} \text{ fission by thermal neutrons})}$$

Example:

```
REACTION      (((92-U-238(N,F)58-CE-144,CUM,FY,,FIS)/  
                (92-U-238(N,F)42-MO-99,CUM,FY,,FIS))/  
                ((92-U-235(N,F)58-CE-144,CUM,FY,,MKW)/  
                (92-U-235(N,F)42-MO-99,CUM,FY,,MKW)))  
RESULT        (RVAL)
```

Under Single-level Resonance Parameters, Resonance area:

The quantity $\frac{g \Gamma_n \Gamma_\gamma}{\Gamma}$ is often presented as a result

of the resonance analysis and is proportional to the capture area. This should be coded as a reaction combination followed by the keyword RESULT using the code 'CAPTA'

Example:

```
REACTION      (((... (N,EL),,WID,,G)*(... (N,G),,WID))/  
                (... (,TOT),,WID))  
RESULT        (CAPTA)
```

Coding example for R-values

For illustration, we use the example given on page 4, but replace 58-CE-144 by ELEM/MASS, as in Memo CP-D/178, page 5:

Example 1: bibliographic information in subentry 1, R-values in subentry 2, fission yields for U-238 fission spectrum as given by the author in subentry 3:

subentry 2:

```

BIB
REACTION  (((92-U-238(N,F)ELEM/MASS,CUM,FY,,FIS)/
           (92-U-238(N,F)42-MO-99,CUM,FY,,FIS))//
           ((92-U-235(N,F)ELEM/MASS,CUM,FY,MXW)/
           (92-U-235(N,F)42-MO-99,CUM,FY,,MXW)))
RESULT    (RVAL)
ENDBIB
COMMON
EN-MEAN-NM EN-MEAN-DN
MEV         EV
2.0         0.0253
ENDCOMMON
DATA
ELEMENT     MASS      DATA      DATA-ERR
NO-DIM      NO-DIM    NO-DIM     NO-DIM
40.         95.       0.776     0.019
55.         137.     0.996     0.015
58.         144.     0.825     0.012
ENDDATA
ENDSUBENT

```

subentry 3:

```

BIB
REACTION  (92-U-238(N,F)ELEM/MASS,CUM,FY,,FIS)
METHOD    (RVAL)
MONITOR   ((MONIT1)92-U-238(N,F)42-MO-99,CUM,FY,,FIS)
           ((MONIT2)92-U-235(N,F)ELEM/MASS,CUM,FY,,MXW)
           ((MONIT3)92-U-235(N,F)42-MO-99,CUM,FY,,MXW)
STATUS    (DEP,subent 2) YIELD VALUES DERIVED FROM MEASURED R-VALUES AND
           MONITOR YIELDS
ENDBIB
COMMON
EN-MEAN   EN-NRM1   MONIT1   EN-NRM2   EN-NRM3   MONIT3
MEV       MEV      PC/FIS   EV        EV        PC/FIS
2.0       2.0     6.16    0.0253   0.0253   6.09
ENDCOMMON
DATA
ELEMENT   MASS      MONIT2   DATA     DATA-ERR
NO-DIM    NO-DIM    PC/FIS   PC/FIS    PC/FIS
40.       95.       6.51    5.11     0.15
55.       137.     6.14    6.00     0.12
58.       144.     5.44    4.54     0.09
ENDDATA
ENDSUBENT

```

Example 2: both, R-values and U-238 fission spectrum yields in one subentry

subentry 2:

BIB
REACTION 1(((92-U-238(N,F)ELEM/MASS,CUM,FY,,FIS)/
(92-U-238(N,F)42-MO-99,CUM,FY,,FIS))/
((92-U-235(N,F)ELEM/MASS,CUM,FY,,MXW)/
(92-U-235(N,F)42-MO-99,CUM,FY,,MXW)))
2(92-U-238(N,F)ELEM/MASS,CUM,FY,,FIS)
RESULT 1(R-VAL)
MONITOR 2((MONIT1)92-U-238(N,F)42-MO-99,CUM,FY,,FIS)
((MONIT2)92-U-235(N,F)ELEM/MASS,CUM,FY,,MXW)
((MONIT3)92-U-235(N,F)42-MO-99,CUM,FY,,MXW)
STATUS 2(DEP)YIELD VALUES DERIVED FROM MEASURED R-VALUES AND
MONITOR YIELDS

ENDBIB
COMMON
EN-MEAN-NM1EN-MEAN-DN1EN-MEAN 2EN-NRM1 2MONIT1 2EN-NRM2 2
EN-NRM3 2MONIT3 2
MEV EV MEV MEV PC/FIS EV
PC/FIS
2.0 0.0253 2.0 2.0 6.16 0.0253
0.0235 6.09
ENDCOMMON
DATA
ELEMENT MASS DATA 1DATA-ERR 1MONIT2 2DATA 2
DATA-ERR 2
NO-DIM NO-DIM NO-DIM NO-DIM PC/FIS PC/FIS
PC/FIS
40. 95. 0.776 0.019 6.51 5.11
0.15
55. 137. 0.996 0.015 6.14 6.00
0.12
58. 144. 0.825 0.012 5.44 4.54
0.09
ENDDATA
ENDSUBENT