MEMO CP-C/23

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## I <u>Restricted Sets of EXFOR Formats</u>

Perhaps we have reached the limit of compromise and should accept the fact that whereas the EXFOR format will be general and the same for everyone, groups compiling different data types may agree to use some restricted set of EXFOR. For example, NNDC can accept data coded in "Vector Common" format, but our compilers do not use it. Should we find cases where we feel that this method presents clear advantage we will use it.

In principle, we believe that processing and distributing centers should be able to accept data coded in any legal format, and that any restrictions should be imposed not by the EXFOR system but by the various compilation groups using EXFOR. At present, there are two recognized groups, the 4-C (neutron centers) and the CPND (integral charged particle centers) networks. In the future there may be other identifiable networks. I propose that each compilation network be responsible for determining any compilation restrictions it wishes to observe and that these restrictions be explicitly given in separate sections of the LEXFOR (not EXFOR) manual.

An example of restrictions of this type is:

COMMON - KACHAPAG does not like to use the COMMON feature, and has made some proposals for fission products which are unacceptable to us. We will propose that these restrictions apply only to integral CPND.

In short, we believe that there is room for individual style and preferences in coding within the EXFOR format. If after some experience, it is decided to relax some restrictions, there should be no effect on data already compiled. Our recommendation concerning formal recognization will accomplish this end.

II Manual Updates (updated pages attached)

a) Codes and free text. This was moved to Section VIII in Memo CP-D/23 and we think, since it refers to specific keywords it belongs there. However, it should have a cross reference in Section IV.

b) Use of Characters as pointers. There is a statement that characters may be used. There is no agreement to give special significance to any pointers in the EXFOR format. However, we will include in LEXFOR a statement about any special uses.

c) Use of pointers. Rewrote section.

d) Variable families. Added cross-reference to page VII.14.

e) Free text under REACTION. This belongs in LEXFOR under COMMENT.

III BIBFLG

We prefer, at present, to limit BIBFLG to the keywords specified. However, if there are good reasons to add it to other keywords we would consider doing so. COMMENT and ERR-ANALYSIS are poor examples as they contain free text only and the purpose of BIBFLG is to link coded information to lines in the data table. For free text we already have the column-heading keyword 'FLAG'. It is also unlikely that any of the other keywords mentioned in CP-B/14 would be linked in a unique way to a particular decay string. For example, there may be two detectors used for 20 reaction products for which decay properties are given. Linking to DETECTOR by using the BIBFLG code would require having 20 detector codes and much repetition. More likely, the detector code should be linked to the particle detected.

IV. Multiple Residual Nucleus Formalism. We would like to break the discussion of this into two parts. The first part will discuss the case where SF1, SF2, and SF3 of the REACTION are the same. The second part will discuss the case where only SF1 and SF2 are equal.

A. Variable product nucleus (REACTION SF1, SF2, SF3 the same)

We believe that the multiple residual nucleus formalism makes sense only when SF1, SF2 and SF3 are identical. In practice this means so far it can be used only for SF3 = X or F.

We believe that we have reached agreement in principle on the format to describe variable product nuclei. However, we are unable to accept some of the restrictions Kachapag wishes to impose.

We do not want to see restrictions on the number of incident energies in one subentry when the variable product nucleus formalism is used. Nor do we wish to see restrictions on using Z or A in COMMON. We have no objections to KACHAPAG imposing such restrictions on integral CPND compilation at this time. These restrictions could be rescinded at some future date with no difficulty. See discussion under Restricted sets of EXFOR formats.

If KACHAPAG is unwilling to use Z or A in COMMON, then, according to our last proposal, they must put data for each Z and A combination in a different subentry or they must repeat the common variable in each line of the data table.

| ELEM | MASS | DATA |
|---|---|---|
| 92 | 238 | —— |
| 92 | 239 | —— |
| 92 | 240 | —— |

There is no possibility for putting only one of Z and A in SF4.

A copy of our proposed LEXFOR entry for Product Yields from memo CP-C/15 is enclosed.

B. Multiple Reaction Products (REACTION SF1, SF2 the same).

We believe that KACHAPAG's desire to code in one subentry data for which SF1 and SF2 are the same is not unreasonable. The proper mechanism is the multiple REACTION formalism. We, therefore, believe that the restriction on use of the multiple-REACTION format should be removed in such cases.

Our proposal for expansion of the use of the multiple reaction formalism is attached as a revision to page VIII.3.3 of our proposed manual update.

Our objection to unlimited use of the multiple-REACTION formalism is that one could then code all the data from an entire article in one subentry. Such a coding procedure would be a violation of the principles which governed the development of EXFOR. The case mentioned in the past of coding, (p,2n), (p,3n) (p,4n) etc., in a single table is appealing because the results will probably appear in a single table in the publication, and are likely to be closely related (i.e. derived from a single experimental run).

If the basic principles as given below are adhered to, we would be open to other proposals for further expansion. They are:

1. Incident projectile and target should be the same.
2. Quantities should be functions of the same independent variables.
3. Quantities should be integrally related to each other.

V Branch code 'PRD' (SF5)

We think that the branch code PRD is superfluous and could be dropped. It does not define a partial reaction, but rather the Sum of all possible reactions.

The code 'EM' would be still used to define the special case where elastic scattering is not included.

(-----(N,X)0-NN-1,,SIG)

The code string as given would define the neutron production cross section as for any other incident projectile.

See attached LEXFOR entry on Production Cross Sections which would replace Emission Cross Sections-

VI Dictionary 24 Flag Change (Memo CP-C/17)

The change requested for the flag on momentum was meant for the headings MOM, etc.

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Attachments
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successive records. Information on continuation records must not begin before Col. 12 (Cols. 1-10 must be blank and Col. 11 must be blank or contain a pointer (see (1) Keyword, above). The machine retrievable information should be kept as concise as possible if it is to be used efficiently.

Note that some keywords have no machine retrievable information associated with them and that, for many keywords that may have machine retrievable information associated with them, it need not always be present.

(3) Free Text

Under each of the keywords in the BIB-section free text may be entered either starting in column 12 or following the closing parenthesis of the machine retrievable information. The free text may be continued on to any number of records. Free text on continuation records must not begin before Col. 12 (Cols. 1-10 must be blank and Column 11 must be blank or contain a pointer). The free text may include parentheses if necessary, although, in order to avoid confusion a left parenthesis in text should not be placed in col. 12 (as this implies the opening parenthesis of machine retrievable information).

The free text must use clear English phrasing and no codes should be used within the free text.

See page VIII.1.3 for relationship between codes and free text.

## Pointers

Different pieces of EXFOR information can be linked together by pointers. These are numeric or alphabetic characters (1,2,...9,A,B,...Z) placed in the eleventh column of the information-identifier keyword in the BIB section in the data-heading keywords in the COMMON or DATA section. Pointers can link, for example,

- one of several iso-quants with its DATA column;
- one of several iso-quants with a specific piece of information in the BIB section (e.g. ANALYSIS), and/or with a value in the COMMON section, and/or with a column in the DATA section;
- a value in the COMMON section with any column in the DATA section; etc.

In general, a pointer is valid for one subentry only. A pointer used in the first subentry must apply to all subentries and must have a unique meaning throughout the entire entry.

In the BIB-section the pointer should be given in the first record of the information to which it is attached and should not be repeated on continuation records. The pointer is assumed to refer to all BIB - information until either another pointer is encountered or until a new keyword is encountered. This implies that pointer-independent information for each keyword appears first.

The use of pointers is restricted to:

1) Multiple Reaction Formalism (See page VIII.3.3).
In certain cases more than one code unit may be given under the data specification keyword for a subentry, each unit having its own data column(s). Each data column is then linked to the appropriate code string by means of a pointer.

   See Examples.2.

2) Vector Common Data (See page V.2)
Two-dimensional tables may be coded using pointers.

   See Examples.13

Note: The 'vector common formalism' cannot be combined with the 'multiple reaction formalism'.

3) BIB/DATA links

Pointers used for "multiple reactions" or for "vector common data" may also be used elsewhere in the BIB-Section in order to link, for example, certain information under STANDARD, ANALYSIS, COMMENT, etc., to one of the multiple iso-quants or to one of the vector common data.

4) BIB/BIB links

Pointers may be used to link pieces of BIB information, but all referring to the same REACTION (or ISO-QUANT).

Example:

```
REACTION    (.....)
PART-DET   1(G).
           2(N).
DETECTOR   1(ABCDE).
           2(FGHIJ).
```

Note: This use cannot be combined with the 'multiple reaction' formalism.

5) Alternative results

Different results for the same quantity obtained in the same experiment by, e.g., two different methods of analysis, may be entered in the same subentry, distinguished by pointers. In this case the code unit under the data specification keyword must be repeated. (See also Interdependent Data).

From a processing point of view, this is the same concept as "multiple reactions" described on page VI.2.

See Examples.2.

## Product Yields

[Use in REACTION formalism]

### Definition

Product yield data shall be defined as all data for which the reaction as specified may lead to more than one reaction product and for which the reaction product is one of the parameters of the data presented.

Note: Currently the processes for which this applies are fission and production data (F or X in SF3).

See also: Fission Yields, Reaction Mechanisms

### Specification of the product nucleus

a.) In the case where there is one specific reaction product given for the data table, the product may be coded as specified for reaction SF4. (See Reaction Products).

b.) In the case where the data are given for more than one nucleus, the nuclei will be specified in the COMMON and DATA sections using the Data-Heading Keywords ELEMENT and MASS.

In this case SF4 contains the code:

ELEM - if the column-heading ELEMENT is used in the DATA table

MASS - if the column-heading MASS is used in the DATA table

ELEM/MASS - if the column-headings ELEMENT and MASS are used in either the COMMON section or the DATA table.

SF4 is the only subfield that may become a variable by using this formalism. All other subfields of the REACTION code must apply unchanged for the given subentry.

Note: For CPND this "Variable Product Nucleus" formalism must not be used until the time that an improved indexing resp. retrieval program becomes available, which considers not only the REACTION code but also the Product Nuclei given under the column-headings ELEMENT, MASS.

Examples for coding product-nuclei as variables in the DATA tables:

(8-0-16(P,X)ELEM/MASS,,SIG) = cross section of specified product nuclei which are given in the DATA table under the column headings ELEMENT and MASS and (if applicable) ISOMER. If the DATA table contains only isotopes of a single element, the column ELEMENT may be given in the COMMON section. Similarly, if a "charge dispersion" is given, MASS may appear in the COMMON section with ELEMENT as a variable in the DATA table.

(92-U-235(N,F)MASS,CHN,YLD) = "chain yield" of several mass-numbers given in the DATA table under the column heading MASS (compare under Fission Yields). The DATA table may consist of only a single line, when the "chain yield" for only one mass-number is given.

Multiple Reaction Formalism

Pointers may be used with these keywords, in which case the code fields associated with each pointer may be a reaction unit or a reaction combination.

See page VI.1 for general information on pointers.

The use of the multiple reaction formalism is restricted to specific classes of data which are, in general, subject to the following constraints.

1) The incident projectile and the target nucleus are constant.
2) Quantities are functions of the same independent variables.
3) Quantities are integrally related to each other.

At present, the following classes of data may be coded using the Multiple Reaction Formalism.

- resonance parameters of the same isotope (Example 2a)
- multiple representations of the same data (Example 2b)
- partial cross sections of the same reaction (i.e., for the REACTION keyword, all subfields except SF5 (Branch) are equal).
  a) isomeric data (branches, ratios, etc.) of the same reaction.
  b) compound-nucleus and direct interaction parts for the same reaction.
  c) high-energy fission and spallation parts for the same reaction.
  d) binary and ternary parts for fission measured.
- data measured for the production of a specific particle or nuclide, where the author has assigned values to given reactions.

  Example 1: (p,2n)
  (p,3n)
  (p,4n)

  Example 2: $(n,\alpha)$
  $(n,n\alpha)$

  Note: In the case of a variable product nucleus for a given reaction (i.e., for the REACTION keyword, SF1, SF2 and SF3 are constant) the Variable Product Nucleus Formalism is used. See LEXFOR Product Yields.

- data for the same reaction obtained by different types of analysis on the same experimental data; in this case the reaction code must be repeated for each analysis. (Example 2.d)

## Production Cross-Sections

Definition: The production cross section for a particle Y is defined as the sum of all energetically possible reactions resulting in the production of at least one particle Y in the exit-channels, each reaction weighted by its multiplicity. The interactions involved and their multiplicity need not be known.

The term emission cross section is defined as a special case and excludes elastic scattering. In the case where the incident projectile is not equal to Y, the production and emission cross sections are equal.

Note: These quantities are sum cross sections, which should be used only when two or more reactions are energetically possible.

Quantity codes:

QUANT formalism - the appropriate code is entered in quantity SF1 as follows:

GEM Non-elastic Gamma-Emission. (For gamma-emission due to inelastic scattering see Inelastic Gamma-Emission)

NEM Neutron-Emission

NPR Neutron-Production

PEM Proton-Emission

AEM Alfa-Emission

NX Charged-Particles Emission. This quantity should only be used if the type(s) of particles emitted could not be specified. If the data given can be described as a sum of two or more iso-quants, this sum representation should be preferred.

See Dictionary 14 for a complete list of codes.

Sum rule:

NPR = NEM + EL

REACTION formalism - the code X is entered in SF3 (Process) and the particle (or nuclide) for which the production is measured is entered in SF4.

For emission cross sections, the code EM is entered into SF5 (Branch). This is coded only when the incident projectile is not equal to the particle Y.

Examples:

(.....(.....,X)0-G-0,,SIG) gamma-production cross section

(.....(N,X)0-NN-1,EM,SIG) neutron-induced neutron emission cross section