MEMO CP-D/21

MEMO 4C-3/196

To: Distribution 23 February 1977

From: H.D. Lemmel Lemmel

Subject: CPND Supplement to Manual and Dictionaries, et al.

References: CP-C/8 and CP-B/6.

Note: Many items include new proposals and require updating of the Manual. All proposals have been formulated as updated Manual pages, which are attached, labelled in the bottom with "CPND 77/2". Holders of the NDS Exfor Manual may update their Manuals accordingly, but should realize that some of the proposals may still be revised.
Comments are welcome and should be discussed at the forthcoming meeting.

For a table of contents of this memo see next page. Items marked with an "X" contain new or revised proposals to be included in the Manual (unless an objection arises) and/or refer to a proposed or revised Manual page attached.

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Contents: Reply to Memo 4C-1/109 = CP-C/8

Reply to Memo CP-B/6

Attachments: Revised Manual pages, proposed.

I. General remarks (about maintaining the NNCSC Manual)

We do not understand why the updating of the NNCSC Manual does not work according to the agreed rules.

II. Dictionary 2 (Inclusion of coding rules)

We agree, but we would appreciate receiving specific proposals to be included in the Manual. (See the new page VIII.24a which probably follows NNCSC's intention). We would not be in favor of removing the coding rules from Dict. 2, even though they may be a duplication (in concise form) with the Manual. Dictionary 2 in its present form is a quite convenient tool for compilers and users of Exfor.

III. Manual Update for PART-DET (CP-D/16)

Lexfor is the compiler's part of the Manual. Any item which involves programming is to be included in the main part of the Exfor Manual. We therefore maintain that our proposal made in CP-D/16 is to be added on page VIII.4, as attached. Also attached is a proposed update of the Lexfor page "Particles".

IV. STATUS Keyword

The proposed machine intelligible formalism for cross-references to other subentries seems to be most useful. But the exact meaning must be defined carefully in each case. We therefore propose a revised text as given on the proposed Manual page VIII.4 attached. If any other Status code is to be used with this formalism, it must be explicitly entered here with an exact definition. See also item 4. below.

Surely, this item should not be entered, as proposed by NNCSC, on page VIII.20 since the pages from VIII.12 to VIII.24 deal exclusively with Keywords defining the contents of the DATA table. Thus, STATUS would be out of place here.
NNCSC states correctly that the LEXFOR entries on "STATUS" and "Dependent Data" require corresponding updating. Proposed revisions for these LEXFOR entries and also for "Interdependent Data" are attached.

V. Assumed Values (Re 4C-1/101)

We agree in principle to the proposed Manual wording, but we would have appreciated a more complete proposal. One cannot judge upon the wording proposed for page VIII.25 without having the corresponding Lexfor entry which is only announced to come.

We feel strongly that the proposed Keyword should at the present time be introduced right away with the REACTION formalism and not with the ISO-QUANT formalism. We therefore submit a counter-proposal (see page VIII.25 attached, the Lexfor entry on "Assumed values" attached which also includes our Memo 4C-3/194; we also found that pages VIII. and VIII.3 need corresponding updating as attached).

The new Keywords have not yet been entered into the Dictionaries, since we await official adoption of this proposal or discussion at the forthcoming meeting. Besides the data-heading keywords ASSUM, ASSUM1 etc, also others like ASSUM-ERR, ASSUM-MIN, etc will have to be added as they occur.

VI. STANDARD/MONITOR (incl. addition to Dict. 24)

Again, we remind NNCSC of the agreed procedures that new proposals should be submitted in the form of Manual wordings resp. Dictionary entries. See the Manual pages IX.4 and IX.5.

For the first paragraph of this item we shall await a CP-Memo containing the Manual wording. For the second paragraph we propose to enter in Dict. 24:

E-NRM ENERGY ØF THE ØUTGØING GAMMA-RAY ØR PARTICLE GRØUP FØR WHICH THE NØRMALIZATION VALUE ØF A PARTIAL CRØSS-SECTION IS GIVEN UNDER 'STAND' RESP. 'MØNIT'. (Without a flag in col. 66).

We hope that this wording describes the intention of the proposed Data-Heading Keyword correctly. This would entail updating of Manual page VIII.21a which was moved in CP-D/20 to page VII.14 as attached.

VII. DECAY-DATA

Since the nuclide to which the decay-data refer, is coded, we see no harm in using the Keyword DECAY-DATA also for nuclides occurring in the reaction used for normalization. We would not like to introduce a new Keyword for this purpose. We therefore propose to amend page VIII.24a as attached (see the arrow).

For the matter of unresolved energies coded under DECAY-DATA we used the more comprehensive wording from CP-B/6 on the same topic.

VIII. Multiple Representations of the same variable (re CP-B/3)

This item has been a controversy since the start of Exfor and will remain so unless someone changes his mind. Whether it is more appropriate to code in Exfor EN plus EN-CM if the author has given both, or to code only one of both (which?), is a matter of taste. It has however always been recognized that Exfor is not a computation format with standardized data representation, but a transmission format for various different data representations. I do therefore not support NNCSC's rejection of Kachapag's proposal, but suggest to discontinue this discussion because of its low importance.

IX. Isomeric Ratio Codes: will be treated separately.

X. Spallation: will be treated separately.

XI. Prompt Fission: we would appreciate receiving from Kachapag a definition for "prompt fission".

XII. Product Yield Data: I see no advantage in this proposal compared to our proposal in CP-D/11. In particular, a detailed discussion of the specific cases collected in CP-D/11 is missing. I will reply separately, taking into account also the Kachapag arguments.

We certainly do not like the proposal to code the isomer as a decimal under the MASS column, since 242.2 (second isomer of mass 242) may show up, after some data processing, as 2.422E+2 which is hard to decypher. I remember that for the same reason, some years ago, it had been disapproved to code Z and A together in one column as, e.g., 95.242 . Perhaps even more essential is, that the entry 242.2 under the heading MASS can too easily be misunderstood as atomic weight.

Reply to Memo CP-B/6

1. General remarks

We appreciate the large number of proposals made to improve the CPND Manual pages. Most proposals have been followed. See the attached altered Manual pages, where the changes are marked with the memo-number and its page-number where the change was proposed.

We have comments to the following items:

The cross-reference on pages IV.1 and VII.2 referring to page VII.10 relates to Memo CP-D/20 suggesting an addition to Section VII. of the Manual.

2. Re Edited Format, CP-B/6 page 2 re p. IV.2, item (4):

I regret that it is not in my power to follow this proposal, since the EXFOR agreement refers only to the standard transmission format and not to its edited format, which, therefore, was referred to in such weak statements ("may" etc.) only.

3. Re General Application of Pointers, CP-B/6 p. 2/3:

Item 3.) was, in this general formalism not accepted by NNCSC and should therefore be discussed at the forthcoming Meeting. NDS supports the proposed general use of pointers, but so far I cannot enter this proposal in the Manual.

4. STATUS code 'COREL', CP-B/6 p. 3 re Manual pages IV.3a and VIII.4

The code COREL had not yet been entered in Dict. 16, since I had to wait to see whether there would be an objection against introducing it. I regard it now as adopted and propose that this code may be followed by an accession-number within the parentheses. See altered pagesIV.3a and VIII.4 attached.

5. Missing pages in NDS EXFOR Manual

a) CP-B/6 p. 3, re Manual pages VIII and VIII.2:

The heading "Use of Codes" on page VIII.2 had been introduced by NNCSC in March 1976, and the new page VIII.2 had not yet been distributed as update to the "NDS EXFOR Manual", since the change was so trivial. Please, find the page attached. Sorry for this oversight.

b) CP-B/6 p. 5+7, Lexfor pages "Delayed Fission Neutron Data" and "Particle-out Reactions":

I am sorry that the Karlsruhe copy of the NDS EXFOR Manual, for whatever reason, did not contain the Lexfor entries on "Delayed Fission Neutron Data" and "Particle-out Reactions". The latest versions of these entries are attached.

6. Nomenclature of REACTION-Subfield Dictionaries, CP-B/6 pages 3,4, and 8:

Before receiving Memo CP-B/6 we had noticed the inconsistencies between the titles of the Dictionaries 32 and 36. We then changed them consistently

to the following:

30. Process (Reaction Subfield 3)
31. Branch (Reaction Subfield 5)
32. Parameter (Reaction Subfield 6)
33. Reaction Particles (SF2,3,7)
34. Modifier (Reaction Subfield 8)
35. Data-Type (Reaction Subfield 9)
36. Quantities (Reaction Subfields 5-8)

I hope this is acceptable. The term "Quantity", in analogy to Dict. 14, has historically developed and I personally would not like to change it.- Due to the different types of "quantities" existing, it seems almost impossible to find terms which describe exactly the contents of each Dictionary respectively Reaction Subfield. In particular, I would prefer the rather vague definition of the "branch" subfield given on the Manual page VIII.20b against the rather precise definitions proposed in CP-B/6 p.4. The contents of Dict. 31 shows that for certain data types this subfield occasionally must include codes which can be called "branch" only in a rather general sense.

If someone feels strongly, we may discuss the nomenclature of these subfields at the meeting, but I would hate losing too much time on this item.

7. Additional Subfield under REL-REF, CP-B/6 pages 3 and 8, Manual page VIII.6 and Dict. 2:

In principle I would not mind adding the proposed subfield to the coding under REL-REF, but I would like to have an example illustrating when this will be used. I suggest to refer this topic to the meeting.

8. Be-7 Emission Cross-Section, CP-B/6 pages 3/4, Manual p. VIII.20a and b:

I would propose the somewhat simplified formulation as entered on attached pages VIII.20a + b.

9. Multiple REACTIONS, CP-B/6 pages 5 and 6:

The proposed wording is rather a topic for Lex'or, and I suggest to add it there to the page "Isomeric States" rather than to the page "Cross-Sections" which however needs a cross-reference to the page "Isomeric States".

10. MONITOR, CP-B/6 p. 5, Manual page VIII.20c:

See the altered page VIII.20c attached. We feel however, that the coding under this keyword should be improved, as illustrated by the following examples:

present alternative:

(Z-S-A(P,A)Z'-S'-A', acc-nr., author, reference, EVAL)

preferable alternative:

(Z-S-A(P,A)Z'-S'-A',,SIG,,,EVAL, author, reference, acc-nr.)

The second preferable alternative allows the monitor-reaction to be coded exactly as under REACTION which seems essential both for compiling physicists and for simpler computer-programs. The preferred sequence "author, reference, acc-nr." (instead of "acc-nr., author, reference") would be the same as

suggested in CP-B/6 for the keyword REL-REF. Since the acc-nr. will frequently be added only subsequently, it will be more convenient to have it coded at the end of the string.

We submit this item for discussion at the forthcoming meeting.

11. Fission, and

12. Column-Heading ISOMER, CP-B/6 p. 6,7:

These topics will be treated separately, since a counter-proposal will have to be studied.

13. Light-Nuclei Reactions, and

14. Particle-out Reactions, CP-B/6 p. 7:

The tables of neutron-induced light-nuclei reactions and of "particle-out" reactions are needed only for neutron data in ISO-QUANT formalism.

15. Practice of Dictionary-Updates

Re the comment in CP-B/6 page 7 about Memo CP-D/17 (cancellation of keyword NOENTRY):

If we submit a proposal like this, we cannot make the corresponding Dictionary update simultaneously, since (according to Manual p. IX.4+5) we must wait 4 weeks to see whether no objection to the proposal is received. Only then the proposal is regarded as adopted and the Dictionary update is made.

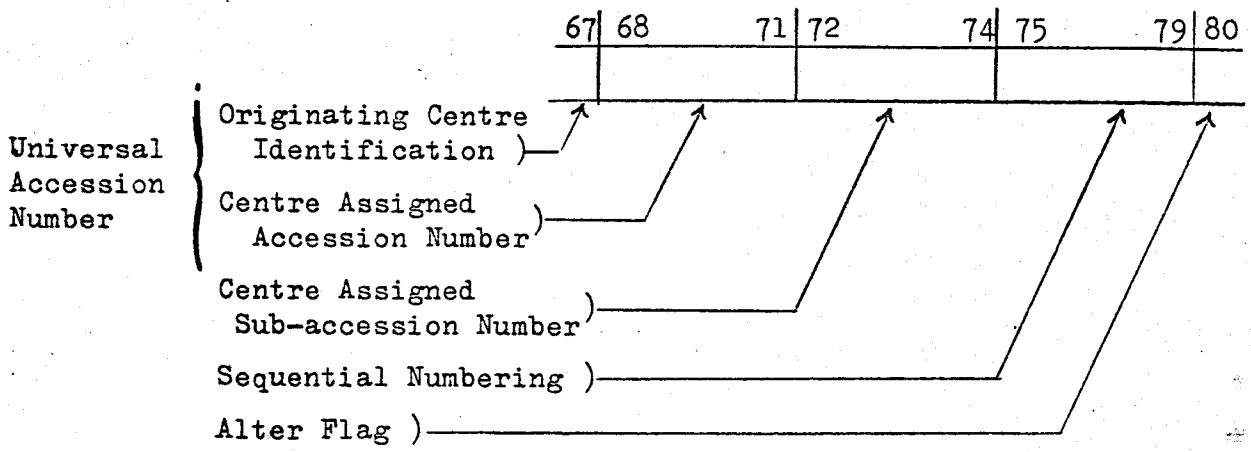
For the same reason, the new subfield proposed for REL-REF (accession-number), will not yet be entered in Dict. 2 but only after a waiting period during which the other centers have an opportunity to coment if they wish.

Re CP-B/6 page 7-8:

We are sorry for the difficulties which Kachapag had. Since the Dictionary transmission dated 1976/11/4, there have been intermediate updates on 11/11, 12/29, 1977/1/14, 2/14. We assume that the intermediate update sheet of 1976/11/11, which may have arrived at Karlsruhe at the same time or even earlier than the tape dated 1976/11/4, was not applied against this tape, so that the following updates, of course, could not work. Some of the comments about the position of a code within a dictionary therefore do not apply. In the meantime, however, nothing need be done, because a new Dictionary transmission tape is being prepared and will be sent soon. Similar difficulties will be avoided by observing carefully the dates of transmission tapes and of intermediate update sheets. We are sorry, that we can sometimes not avoid sending an intermediate update right after a Dictionary transmission tape, when a Memo proposing new codes is received at such time.

RECORD IDENTIFICATION SUMMARY

Columns 67-80 of each record is used to uniquely identify each record in the EXFOR system. This is accomplished by dividing the record identification into five fields as follows:



The first field (col.67) is alphameric, the next 3 fields (cols. 68-79) are strictly numeric and may vary over the following ranges:

(1) Originating Centre Identification: see page II.2
(2) Centre Assigned Accession Number: 1 to 9,999
(3) Centre Assigned Sub-accession Number: 1 to 999
(4) Sequential Numbering in a Sub-work: 1 to 99,999

They may be used in combination uniquely to reference information within the library at any of a number of levels as follows:

(1) Col. 67: Uniquely identifies all information from a given centre.
(2) Cols.67-71: Uniquely identifies a work within the EXFOR system.
(3) Cols.67-74: Uniquely identifies a sub-work within the EXFOR system.
(4) Cols.67-79: Uniquely identifies a record within the EXFOR system.

The first three fields (Cols. 67-74) are associated with a sub-work throughout the life of the system. That is, accession numbers and sub-accession numbers may not be changed, once they are assigned. If the sub-work is deleted from the system, the same identification should not be assigned to another sub-work. The fourth field (Cols.75-79) is maintained in sequential order, but this field may change.

Columns 67-79 should be padded with zeroes (0) rather than blanks. This will allow the entire library to be handled by the standard sort/merge packages available on a wide variety of computers. Indeed it will allow the cards to be sort/merged on a simple mechanical card sorter.

SYSTEM IDENTIFIERS

A set of basic system identifiers has been defined to identify different units of information contained on a transmission tape. These units and corresponding basic system identifiers are:

TRANS		A transmission tape is the unit
ENTRY	-	A work (accession number) is the unit
SUBENT	-	A sub-work (sub-accession number) is the unit
BIB	-	The BIB-section of a complete work
		or sub-work is the unit
COMMON	-	The common data section of a complete work
		or sub-work is the unit
DATA	-	The data table section of a sub-work is the unit

These basic system identifyers may be combined with the modifiers

NO

END

X

to indicate the following conditions

(1.) The beginning of a unit (basic system identifier only)

(2.) The end of a unit (modifier END preceding the basic system identifier)

(3.) A positive indication that a unit is intentionally omitted (modifier NO or X preceding the basic system identifier)

However, only those combinations of basic system identifiers and modifiers may be used, which are explained on the following pages and included in Dictionary 1.

The format of all system identifier records will be identical:

1 11	22	33	44	55	66
/System Identifier/	N_1	N_2	N_3	N_4	N_5

The fields N_3 to N_5 are assigned to a specific purpose only in few cases, see pages III.3 and III.6. In all other cases, these fields are usually blank but may contain any free text that the centre wishes to enter.

/System Identifier/ may be any of the permitted system identifiers (the brackets should not be included) left adjusted to begin in Col. 1; N_1 and N_2 are integers right adjusted into Cols. 22 and 33, respectively. The significance of N_1 and N_2 will depend on the system identifier used.

moved to P. III.1

The following pages describe all permitted system identifier records in detail. The detailed description is followed by a brief summary of the characteristics of the system-identifier records.

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(1.) TRANS N_1 N_2 N_3

This record must be the first one on the transmission tape. The following fields are defined:

N_1 - The transmission tape number, consisting of

col.19: the originating centre identification,

col.20-22: a three digit number, sequentially assigned to allow other centres a simple means of determining whether or not they have received all tapes transmitted

N_2 - A six-digit number containing the date (year, month, and day) on which the transmission tape was generated. The format should be: YYMMDD.

N_3 - This field may contain a library name, e.g. KACHAPAG.

The record identification (Cols. 67-79) should contain the originating centre identification code in Col. 67 and zeroes (not blanks) in Cols. 68-79.

(2.) ENDTRANS N_1

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This record must be the last one on the transmission tape.

N_1 is interpreted as:

N_1 - The number of works (accession numbers) on the tape.

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The record identification field contains a centre identification code in col.67 and 9's in cols.68-79. If the transmission tape contains data originating from the transmitting centre only, then col.67 of the ENDTRANS record contains the same centre identification code. If however the transmission tape contains data originating from different centres, then col.67 of the ENDTRANS record should be such that the record sorts at the end of the tape. For example, the centre identification of the last entry included on the tape may be used; KACHAPAG uses the character Z.

Trailing records to fill up the last block are repetitions of the ENDTRANS record.

BIB SECTION

This section is identified on a transmission tape as that information between the system-identifiers BIB and ENDBIB. Although it is called 'BIB-section' it contains information other than the strictly bibliographic. That is, information required to describe an experiment (e.g. neutron-source, method, facility, etc.) and administrative information (e.g. HISTORY) are also included in this section.

A BIB record consists of up to four parts: keyword, machine retrievable information, free text and identification. The identification has been described in Section II and will not be dealt with further.

(1) Keyword (Information Identifier)

The keyword is used to define the significance of the information given in columns 12-66. See Dictionary 2 for a list of all keywords and a summary of coding rules. For further details see chapter VIII.

Keywords must be left adjusted to begin in column 1 and must not exceed a length of 10 characters (this will insure they are followed by at least one blank or one pointer, see below). Within any one BIB-section a keyword must not be repeated, columns 1 - 10 of continuation cards must be blank and Col. 11 must be blank or contain a pointer. 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.

(2) Machine Retrievable Information

Machine retrievable information may be used to define the actual BIB-information or as a link to the CØMMØN and DATA sections. The machine retrievable information must be enclosed in parentheses and left adjusted so that the opening parenthesis appears in Col. 12. More than one piece of machine retrievable information may be associated with a keyword. (See Section VIII for formats and coding rules, see page VII.10 for maximum length of codes.)

For some keywords a restriction is placed upon the maximum length of the associated machine retrievable information; it may be continued onto 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 col.12 or following the closing parenthesis of the machine retrievable information, observing the formalism given under (4) below.

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 col.11 must be blank or contain a pointer). The free text may include parentheses, but a left parenthesis within the free text must 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.

(4) Codes and Free Text

A. Under the keywords

METHOD	PART-DET
FACILITY	RESID-NUC
DETECTOR	ADD-RES
ANALYSIS	STATUS
N-SOURCE	

there are two options for the interrelations between the coded information given in parentheses and the free text following.

First option indicated either by a point following the closing parenthesis, or by a blank field between the closing parenthesis and col.66: Both, the point or the blank field serve as an indicator to an "edit" program that the coded information requires expansion. Under this option the coded information should not be repeated in the free text, since an "edit" program would then create duplicate information.

Second option indicated by free text but no point following the closing parenthesis:
In this case the coded information is not supposed to be expanded in an "edit" program. Thus, the free text must be self-explanatory, repeating or specifying further the coded information. The code is a retrievable abstract of the free text and must not be considered as part of the free text. In an "edited" listing the coded information, which serves only as a means for computer retrieval, may as well be suppressed.

B. Under the keywords

INSTITUTE
REFERENCE
REL-REF
ISO-/CMPD-/NUC-QUANT resp. REACTION
STANDARD resp. MONITOR
RAD-DET
HALF-LIFE resp. DECAY-DATA

the contents of the coded information within the parentheses must not be repeated in the free text; a point following the closing parenthesis need not be given. For an "edit" program it may always be assumed that the coded information under these keywords may be expanded whereby the free text should not appear as a duplication of the expansion.

For the remaining keywords that may have machine retrievable information within parentheses, the rules above do not apply: AUTHOR, EXP-YEAR, ERR-ANALYS, MISC-COL, FLAG, HISTORY.

(5) 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 information-identifier keyword fields 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.

A pointer in the BIB-Section refers not only to the record which contains the pointer, but also to all following records until another pointer or another keyword is encountered.

The use of pointers is restricted to the cases of

1.) multiple iso-quants (see page VIII.15) and reactions (see page VIII.20c)
2.) vector common data (see page VI.6).

Pointers used for one of these cases 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 reactions, or to one of the vector common data. Example:

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

3.) pointers linking 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: NNCSC can accept this formalism but does not recommend to use it; instead NNCSC prefers to code this example as follows:

```
ISO-QUANT  (.....)
PART-DET   (G,N).
DETECTOR   (ABCDE). FOR GAMMAS
           (FGHIJ). FOR NEUTRONS
```

4.) different results of the same quantity obtained in the same experiment by, e.g., two different ways of analysis.

Example:

```
REACTION   (.....)
ANALYSIS   1(...) FREE TEXT
           2(...) FREE TEXT
ENDBIB
NOCOMMON
DATA
EN          DATA      1DATA      2
...         ...        ...
```

Note: This case is presently not accepted for NND coded under ISO-QUANT. Instead, two separate subentries are made linked to each other by a STATUS entry such as

```
STATUS     (COREL,B0123004) SEE SUBENTRY B0123004 FOR RESULTS
           FROM SAME EXPERIMENT BY xxx-ANALYSIS
```

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2. Format of Dictionaries

The Dictionaries contain explanations for all keywords and codes used in EXFOR. The format of the Dictionaries is in general similar to that of the BIB-Section in Exfor entries. There are 4 keyword Dictionaries:

Dict. 1 for System-Identifying keywords;
Dict. 2 for Information-Identifying keywords to be used within the BIB-Section;
Dict.24 for Data-Heading keywords, and
Dict.25 for Data-Units keywords, the latter two type of keywords being used in the COMMON and DATA Sections as Column-Headings.

The other Dictionaries explain codes to be used within the BIB-Section under specific Information-Identifying keywords (see the Table of Dictionaries on page VII.10).

The Dictionaries contain the following items of information:

(1) The keyword or code to be explained is given left adjusted in field 1 which is usually in cols. 1-11, but is longer in some cases. Keywords must not be longer than 10 characters. Codes may be restricted to a length; see the Table of Dictionaries on page VII.10.

(2) The explanation is contained in the explanation field which usually starts in col. 12 (sometimes in col. 23) and usually (with some exceptions) ends in col. 66. The explanation may be given

- either in free text,
- or in an "expanded form"
- or in an "expanded form" followed by free text.

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(3) The "expanded form" may be used to replace the code in an "edit"-program, so that the Exfor user may read the entries without having to consult the Dictionaries for finding the meaning of the codes. Expanded forms are provided only in certain Dictionaries (see the Table of Dictionaries on page VII.10) and not for keywords, which are self-explanatory and easy to remember. The expanded form is enclosed in parentheses, where the opening parenthesis is given in the first column of the explanation field (usually col. 12). Only one set of parentheses may be associated with a dictionary entry. The expanded form is in general restricted to the length of the explanation field; only in the Dictionaries 3.(Institutes), 7.(Books and Conferences), 14.(Quantities in Iso-quant formalism), and 36.(Quantities in REACTION formalism) the expanded form may continue, within the explanation field, on to follow-up records.

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(4) The free text may immediately follow the closing parenthesis of the expanded form or, if no expanded form is given, begin in the first column of the explanation field. It may continue, within the explanation field, onto any number of records. The free text may include parentheses but a left parenthesis which is part of the free text, must not be entered in the first column of the explanation field (where it would signal the presence of an expanded form).

(5) An "obsolete flag" in col. 80 indicates that the keyword or code given in the same record must not be used in new entries but may still exist in old entries. Explanation is given in free text why the code is obsolete and which code (if any) is to be used instead.

(6) The record identification field (cols. 67-79) of a Dictionary record contains "30000" in cols. 67-71, the Dictionary identification number in cols. 72-74 with leading zero(s), and in columns 75-79 the record sequence number with leading zeros. The

Table of Dictionaries

Number	Name	Code length	Expansion provided	Use presently restricted to:
1.	System-Identifier Keywords	≤10	-	
2.	Information-Identifier Keywords	≤10	-	
*3.	Institutes	5 to 7	✓	
4.	Reference Type	1	✓	
*5.	Journals	≤6*	✓	
*6.	Reports	≤11	-	
*7.	Conferences and Books	≤10	✓	
8.	Elements	3	✓	
*9.	Chemical Compounds	7 to 10*	✓	
10.-14.	ISO-QUANT subfields			NND
10.	Process/Parameter (Quantity SF1)	≤3	-	NND
11.	Function (Quantity SF2)	≤3	-	NND
*12.	Modifier (Quantity SF3)	≤3	*	NND
13.	Particle (PART-DET and Quantity SF4)	≤3	✓	
*14.	Quantity (SF1 - 4)	≤18	✓	NND
16.	Status	≤5	✓	
D/21 10 17.	REL-REF SF1	1	✓	CPND
18.	Facility	≤5	✓	
19.	N-Source	≤5	✓	NND
20.	Additional Results	≤5	✓	CPND
21.	Method	≤5	✓	
22.	Detectors	≤5	✓	
23.	Analysis	≤5	✓	
*24.	Data-Heading Keywords	≤10	-	
*25.	Data-Units Keywords	≤10	-	
30.-36.	REACTION subfields			CPND
30.	Process (REACTION SF3)	≤3	-	CPND
31.	Branch (REACTION SF5)	≤3+	-	CPND
32.	Parameter (REACTION SF6)	≤3	-	CPND
33.	REACTION Particles (REACTION SF2, 3, 7)	≤3	✓	CPND
*34.	Modifiers (REACTION SF8)	≤3	*	CPND
35.	Data-Type (REACTION SF9)	≤5	✓	CPND
*36.	Quantities (REACTION SF5-8)	≤18	✓	CPND
*41.	Conversion table of Quantity (Dict.14) to REACTION formalism (one-to-one correspondence to Dict.14)	≤18	✓	future NND→CPND conversion

* Additional information given on the following pages.

\+ Exceptionally, one code in this dictionary has 5 characters.

24. Data-heading keywords

These keywords are used in the COMMON and DATA sections, as columns headings for defining the contents of these columns.

No expanded form of the codes is given.

Column 66 is reserved for a flag.

For rules concerning the sequence of columns see page VI.3. For checking purposes, a series of flags is given in Dictionary 24, Column 66, which defines the category and the family within each category, according to the scheme in the following table.

Family	FLAGS		Class
	Variables	Associated Quantities	
EN	A	B	)
EN-RES	C	D	)
E**	E	F	) 1
ANG	G	H	)
F. Prod. THICKNESS	I K	*	)
FLAG	*	Z	)
TEMP	8	9	)
HL	6	7	) 2
J	4	*	)
L	2	*	)
Parity	0	*	)

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* No heading exist.

** Except E-LVL-INI, E-LVL-FIN and E-NRM.

Class 1 pertains to independent variables.

Class 2 pertains to additional information which in certain cases may act as an independent variable (cf. VI.3 point (5)).

VIII. Coded Information and Dictionaries (Details)

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Information-Identifier Keywords (Dictionary 2)

These keywords are used in the BIB section to identify specific information; these may then be coded, with or without free text explanation, or may have only free text associated with them. Codes are used for retrieval purposes. Information in free text cannot be used for retrieval purposes. The keywords may, in general, appear in any order within the BIB section. Compare page IV.1.

Use of Codes

Codes for use with a specific keyword are found in the relevant dictionary. In general, codes may be used singly or in conjunction with one or more codes from the same dictionary.

Rules to be used for combining codes for the keywords INSTITUTE, STATUS, FACILITY, N-SOURCE, METHØD, DETECTØR and ANALYSIS follow. For use of other codes see details under keyword writeups.

a) Both codes within the same set of parentheses, separated by a comma, for example:

KEYWORD (CODE1, CODE2) + free text , or

b) Each code enclosed in own set of parentheses followed by free text, with the stipulation that each new code entry start in column 12, for example:

```
KEYWORD     (CODE1) + free text ...
                free text ...
                (CODE2) + free text
```

Both of these possibilities, or a combination of the two, are allowed.

Keyword categories:

In the following list of information-identifying keywords certain flags indicate which keywords must, or need not, be present and which keywords must, or need not, be followed by coded information:

Use of keyword presently restricted to:		
	0	TITLE
	*	AUTHOR (( ))
	*	INSTITUTE ((3))
		EXP-YEAR (( ))
	*	REFERENCE ((4,5/6/7))
CPND		REL-REF ((17,Author,Ref.))
CPND	*	REACTION ((Z-S-A(P,N+P)Z-S-A,31,32,33,34,35))
NND	*	ISO-QUANT ((Z-S-A,14))
NND	*	NUC-QUANT ((Z-S-A,14))
NND	*	CMPD-QUANT ((Z-S-9,14))
CPND	C	MONITOR ((Reaction,Acc#, Author,Ref.))
NND	0	STANDARD (Z-S-A,14)
	0	METHOD (21)+
	0	FACILITY (18)+
	0	DETECTOR (22)+
	0	ANALYSIS (23)+
		N-SOURCE (19)+
		INC-SPECT
		SAMPLE
CPND		RAD-DET ((Z-S-A-MX,13))
CPND		DECAY-DATA ((Z-S-A-MX,HL,13,E,abund.))
		PART-DET ((13)) or (Z-S-A) see page VIII.4
		EN-SEC
NND		RESID-NUC (Z-S-A-M)
		HALF-LIFE (HL,Z-S-A-M)
CPND		ADD-RES (20)
		CORRECTION
	0	ERR-ANALYS (DATA-ERR)
		COMMENT
		MISC-COL ((MISC1))
		ASSUMED (ASSUM1)
		FLAG ((1.))
	0	STATUS (16)+ or (CODE,Acc#) see page VIII.4
	*	HISTORY ((see 2))

Explanations:

* This keyword must always be present. (Incidentally, all of these keywords must always be followed by coded information in parantheses as indicated by (( )).)

0 This keyword must always be present except when it is not relevant. For explanation of "not relevant" see in LEXFOR. For example: ERR-ANALYS is "not relevant" for quantum-numbers.

(( )) If the keyword is present, coded information in parentheses must be given. ((3)) refers to the relevant dictionary, No. 3. In other cases an example of coded information is shown in the table.

(19)+ Either free text or coded information in parentheses plus possibly free text may be given. The number refers to the relevant dictionary. If a pertinent code in the relevant dictionary exists, then keyword and code should be given. The "+" sign indicates that the coded information in parentheses must be repeated in the free text, except when a point is entered in the position following the closing parenthesis, or when the free-text field up to col.66 is totally blank.

For details see the following pages and in Lexfor.

Special cases:

ISO-QUANT NUC-QUANT CMPD-QUANT	One of these three keywords must be present; they are mutually exclusive.
METHOD FACILITY DETECTOR ANALYSIS	At least one of these keywords must be present; if a pertinent code in the relevant dictionary exists, then keyword and code should be given. It is advisable that all four of these keywords be given except when not relevant. For example: FACILITY is "not relevant" for spontaneous fission data.
PART-DET	The particle detected must be evident either from ISO-QUANT or from PART-DET. Examples: a proton detected in an NP reaction is regarded as evident from the ISO-QUANT; a proton from an NNP reaction is not. For details see the LEXFOR entry "Particles". For particle codes see Dict.13. Particles heavier than alfa-particles, if directly detected (e.g. by mass-separator), are coded in the Z-S-A formalism (see page VIII.12).
STATUS	The keyword STATUS is not relevant, only when the source of the data is given under REFERENCE and no other STATUS information applies. (In NDS entries this keyword is always present.) Under this keyword a code from Dict.16 is given followed by free text; or free text only if no code applies. In the following cases a code may be followed, within the parentheses, by an eight-character subaccession-number indicating a cross-reference: (SPSDD,10048009) - this means that the present subentry is superseded by subentry 10048009. (DEP,B0001004) - this means that the data of the present subentry have been deduced from the data in subentry B0001004. (COREL,B0123004) - this means that the data of the present subentry are correlated with the data of subentry B0123004 since both were obtained, e.g. by different analysis, from the same experimental raw data
STANDARD and ERR-ANALYS	The compiler should treat these items with special care, and whenever necessary, he should request further information from the author.
(GEOMETRY)	This keyword is obsolete but may still exist in old entries.
(TABLE-NR)	This keyword is obsolete but may still exist in old entries.

CPND keywords:

REACTION	replaces ISO-/NUC-/CMPD-QUANT
MONITOR	replaces STANDARD
RAD-DET	
DECAY-DATA	

Data Specification Keywords for Generalized EXFOR

For the generalized EXFOR system created for nuclear reaction data with incident particles other than neutrons, another set of data specification keywords has been introduced in order to signal to the computer programs the different coding formats required for data other than neutron data.

It is envisaged that also the neutron data Exfor transmission will be converted to the generalized EXFOR rules. So far, the following keywords and coding rules are used only for CPND.

REACTION (For a summary of coding rules see Dictionary 2.)

The information coded under the keyword REACTION has the following major fields:

REACTION (Reaction, Quantity, Data-Type)
1-4 5-8 9 ← subfield-numbers

The Reaction is coded in the form

(Z-S-A-Mx(P,N+HE3+4A)Z-S-A-Mx, Quantity, Data-Type)
1 2 3 4 5-8 9 ← subfield numbers

Rules for coding the Reaction:

1. Target nucleus in SF1 and residual nucleus in SF4 are coded as described on pages VIII.12 and VIII.20. Note that the isomeric state indicator G for ground-state must not be given for the target nucleus.

2. The residual nucleus is usually defined as the heaviest of the reaction products. For certain processes the residual nucleus is not defined. For fission, see in Lexfor under Fission. In the second example under 10. below, the residual nucleus is not necessarily the heaviest reaction product.

3. For integral CPND the residual nucleus must be coded except when it is not defined. For other data categories the coding of the residual nucleus is optional; when it is not coded, a comma is following immediately the closing reaction parenthesis.

4. Incident particle in SF2 and outgoing particles in SF3 are coded according to Dictionary 33. Particles heavier than an alfa particle are coded in the same way as the target nucleus.

5. Ions may be coded in the form 8-Ø-16(3+), in subfields 1-4.

6. Different outgoing particles within the reaction parentheses are separated by plus-signs. The outgoing particles are sorted such that smaller Z and A comes first: N sorts before P, and T sorts before HE3. Exception: When the quantity contains the code SEQ, particles are coded in the sequence as the reaction proceeds. Compare in Lexfor under Sequence of outgoing particles.

7. In SF3, gammas are coded only for a capture process, e.g. (P,G). When other particles are produced gammas are self-evident and therefore not coded. Write (P,N) and not (P,G+N), even if the gammas from this reaction have been detected. Compare the "particle-considered" in SF7 below. This consistency is needed for retrieval purposes: otherwise one has to retrieve for (P,N) and (P,G+N) if one wants complete information on the (P,N) reaction.

8. A number immediately preceding a particle code in SF3 indicates the multiplicity of this particle; see 4A in the example above. Two identical outgoing nuclides heavier than an alfa particle must be coded in the form 8-Ø-16+8-Ø-16.

9. Certain processes like total or absorption cross-sections are coded by entering in SF3, instead of outgoing-particle codes, a process code from Dictionary 30. In such cases the residual nucleus, in general, cannot be coded. Fission is coded as (Z-S-A(P,F)...; scattering may be coded as (Z-S-A(P,P)Z-S-A, but when elastic, inelastic or other types of scattering must be distinguished, the corresponding process-codes from Dictionary 30 must be used.

10. Unidentified complex reactions are denoted with an X, for example:

(Z-S-A(P,T+X), - emission of tritons and possibly other unidentified particles after proton absorption; this formalism is used when the emitted particle considered is an alpha particle or lighter;

(Z-S-A(P,X)4-BE-7, - emission of 4-Be-7 particles and possibly other unidentified (perhaps even heavier) particles after proton absorption; this formalism is used when the emitted particle considered is heavier than an alpha particle;

(Z-S-0(P,X)Z'-S'-A, - competing processes from different isotopes of the target element lead to the same residual nucleus.

The Quantity is coded in the following form

REACTION (Reaction, Quantity, Data-Type)

Branch, Parameter, Particle-considered, Modifier

subfield number

The codes permitted in each subfield are given in the Dictionaries 31 - 34 respectively. Coding rules are analogous to ISO-QUANT, see page VIII.12.

A code in the "branch" subfield, which is usually empty, indicates a partial reaction if, for example, only one of several energy levels or particle groups has been considered.

The "parameter" subfield contains information about the reaction-parameter given, such as integral or differential cross-section.

The "particle-considered" subfield is coded when it must be specified to which of several outgoing particles the quantity given refers. It should be noted that the "particle-considered" is not necessarily identical with the "particle-detected" if, for example, the angular distribution of an outgoing particle has been deduced from a recoil particle detected. For integral data this subfield will usually be empty.

The "modifier" subfield contains information on the representation of the data, for example relative data, fitting coefficients, etc.

All existing combinations of codes in subfields SF5-SF8 are entered in Dictionary 36. This serves as a guide to compilers in order that complex quantities are coded in a consistent manner, provides a useful tool for an input checking program, and provides expansions for an edited listing to be readable by customers without consultation of dictionaries. New quantities (code combinations in SF5-SF8) introduced by compilers should be communicated to NDS for inclusion in Dictionary 36. If more than one code is given in a subfield (separated by a slash), the combination must be given in the sequence listed in Dictionary 36.

For examples of quantity codes see in particular Dictionary 36 but also Lexfor entries such as Cross-Sections, Isomeric States, Sequence of outgoing particles, etc.

The Data-Type field may include codes indicating whether the data given are experimental, theoretical, evaluated, etc. See Dictionary 35. If no code is given, the data are experimental.

REACTION combinations (ratios, sums, etc) may be coded in the same way as described for ISO-QUANT combinations on pages VIII.14-15, using the explicit formalism of, e.g., ((REACTION$_1$)/(REACTION$_2$)).

This explicit formalism is however not used for certain frequently occurring sums and ratios for which specific quantity codes have been introduced. See Dictionary 36 and Lexfor entries Ratios, Isomeric States, and others.

Also sum reactions such as "absorption" or (Z-S-O(P,X)Z'-S*-A,,SIG) where the individual competing reactions may not be known, cannot be coded in the explicit formalism ((...)+(...)).

Multiple REACTIONS in a single subentry, distinguished by pointers, may be coded in the same way as described for "Multiple ISO-QUANT" on page VIII.15. In addition to the cases mentioned there, this formalism may also be used for isomeric branches and ratios of the same reaction such that

total reaction cross-section,
partial cross-sections leading to isomeric states,
sums and ratios of partial cross-sections

may all be entered in a single subentry, provided that the target nucleus, the incident particle and the outgoing particles are the same. This possibility is so far restricted to CPND.

MONITOR

If DATA are specified under the keyword REACTION (instead of ISO-/NUC-/CMPD-QUANT) then any reference data are specified under the keyword MONITOR (instead of STANDARD), and their numerical values may be entered in the COMMON or DATA section under the column-heading MONIT (instead of STAND).

For coding rules see Dictionary 2. The code for the monitor-reaction may be followed by the EXFOR accession-number of the monitor data, the author and the reference, as prescribed in Dictionary 2.

If possible, the monitor reaction should always be given in coded form; to give author and reference is obligatory; the Exfor accession-number of the monitor reaction should be given whenever possible (that means: if the data of the monitor reaction do not yet exist in Exfor, they should be compiled immediately).

HALF-LIFE This keyword is used to explain, to which nucleus a half-life value refers which may be given in the COMMON or DATA section. The coded information given under this keyword in parentheses, repeats the data-heading keyword used in the COMMON or DATA section, and specifies the relevant nucleus (see Example 17).

If more than one half-life is given, the relevant nuclei must be coded under this keyword. If only one half-life value is given under the data-heading keyword HL and no explanation is given under this keyword, then the half-life of the residual nucleus is meant.

See also in Lexfor under Isomeric States.

The free text must include the source of the half-life value.

Half-life values in Exfor entries serve a double purpose: they may define a metastable state; and they may be, like a standard, basic parameters for deducing the cross-section value from the experiment.

Consequently, the half-life should be coded in computer-intelligible form

- whenever a code indicating a metastable state occurs in target-nucleus, quantity or residual nucleus;
- when target nucleus or residual nucleus are not stable and their half-life is an essential parameter in the analysis of the experimental data.

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Furthermore, for certain data types the half-life functions as an independent variable to be coded under the data heading HL without an explanation under the BIB keyword HALF-LIFE. Compare in Lexfor under Delayed Fission Neutron Data.

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Half-life values may also be entered under the keyword DECAY-DATA; see next page.

moved to p. VIII.24a

DECAY-DATA Under this keyword, decay data pertinent to the table given in the DATA section are entered.

The use of this keyword is optional. But if the keyword is present, then coded information in parentheses is obligatory. Free text is optional.

The coded information is given in 5 or more subfields, separated by commas, in the following sequence:

SF1: the decaying nucleus coded in the form "Z-S-A-Mx" as in REACTION-subfield SF4.

SF2: the half-life in the form of a floating-point number and a unit-code without a blank in between. Permitted unit-codes are those from Dict.25 which have the dimension TIME.

SF3: the type of radiation using a code from Dict.13.

SF4: the energy of the radiation in keV, coded as a floating-point number without a unit-code. In cases where unresolved doublets (or multiplets) of γ-rays were used in the publication, the energies of all involved γ-rays should be given, separated by a slash. If only two energies are given, this can also mean the borders of an energy range containing all (unresolved) γ-rays which were used for analysis on the whole. - Example:

DECAY-DATA (Z-S-A,n.HRS,DG,E_1/E_2,I_{12})

Here I_{12} means the total abundance of the two γ-rays E_1 and E_2, or of all γ-rays lying in between the limits E_1 and E_2, respectively.

SF5: the abundance of the observed radiation per decay, given as a floating-point number.

SF3, SF4, SF5 may be repeated as often as necessary in order to give the data for additional competing decay modes. Trailing empty subfields are omitted.

Decay-data may be entered for any nuclide occurring in the reaction measured or in the reaction used for normalization,

- in order to define a metastable state,
- when used as basic parameters for deducing the data given in the DATA section,
- or as additional information resulting from or related to the experiment.

Free text explanation will often be desirable, for example to state whether the decay data were obtained from the experimert or quoted from another source.

The compiler has the choice whether he prefers to code a half-life value under DECAY-DATA or using the keyword HALF-LIFE. In many case the use of the keyword DECAY-DATA will be preferable. However, if half-life values are given in the COMMON section or as a variable in the DATA section, the keyword HALF-LIFE must be used.

At present, the keyword DECAY-DATA is not accepted for NND.

FLAG This is used to explain the meaning of flags used in the data table. The actual flags are given in parentheses (each on a separate line, starting in Column 12), followed by free text explanation, as in the following example:

```
BIB
...
FLAG          (1.)  Data averaged from 2 runs
              (2.)  Modified detector used at this energy
...
ENDBIB
...
DATA
EN            DATA        FLAG
KEV           MB          NO-DIM
1.2           123.        1.
2.3           234.
3.4           456.        2.
ENDDATA
```

This keyword must be present if flags are used in the data table. No dictionary. Flags should only be used to supply information on single points (not entire sub-work).

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See also LEXFØR FLAG

MISC-COL This keyword is used to explain the meaning of the miscellaneous column headings. In order to link explanations when more than one miscellaneous column is given, see the recommended form under ERR-ANALYS.

See also LEXFØR Miscellaneous

CP-C/8, CP-D/21, item 21

ASSUMED This keyword is used to explain the meaning of the column-heading keywords ASSUM, ASSUM1, etc, which may be given in the COMMON or DATA Section.

The coded information under this keyword gives the column heading keyword to be explained, followed by a comma and then by the isotope-reaction-quantity string in REACTION formalism (see pages VIII.20a+b) for which the assumed value(s) is(are) given. Free text, e.g. about the source of the values assumed, should follow.

In the case that information about values assumed is not suitable to be entered in the COMMON or DATA Section under a heading ASSUM, the keyword ASSUMED may be used with free text only and without coded information.

See also in LEXFOR under Assumed Values

Inter-centre Memos

Discussions among the cooperating centres on the subjects of data compilation, the Exfor system and its further development, Exfor Manual and Dictionaries, and Exfor transmission tapes, are continued by means of memos, which are called

4C-Memos, if dealing with neutron data matters only;

CP-Memos, if dealing with CPND and the generalized Exfor system.

Such memos are sequentially numbered in the form

Memo 4C-n/m respectively Memo CP-n/m

where n is the Originating Centre Identification (see page II.2), and m is the chronological memo number within each n-series.

Such memos should conform to the following general procedure:

1) Contents of each memo should be summarized in a covering-page index;

2) Each subject should begin on a new page to facilitate distribution to the appropriate staff at each center for action;

3) Items requiring agreement of the cooperating centres should be flagged with a special symbol in the index and on the appropriate subject page.

4) The Memo Number should appear on each page.

5) All proposed changes and additions to the dictionaries, EXFOR Manual, and LEXFOR should contain (where possible) a revised entry in the format of the appropriate document in addition to usual documentation.

6) In case of discussion the originating center is responsible for collecting the points of agreement and issuing a final wording in the format of the appropriate document(s).

7) Proposals which do not evoke discussion should be entered after 4 weeks by the Center responsible for maintenance of manuals, dictionaries, etc.

8) Updated manual pages documenting changes and additions should be issued to all Centers immediately.

new page proposed CP-D/21 item V.

Assumed values

Assumed values

The DATA table should contain under the column heading keywords DATA (DATA1, RATIO, etc.) only values obtained in the experiment. It is however also essential that numerical values used for the derivation of the experimental results, are also given in Exfor. Such values may be a reference cross-section to be entered under STANDARD resp. MONITOR, may be half-life values or other decay-data to be entered under HALF-LIFE resp. DECAY-DATA, or may be other values which do not fit under one of these two cases, for example a spin value or a resonance-width assumed for deducing other resonance parameters. Such assumed values may be entered under the column-heading ASSUM (or ASSUM1, ASSUM2 etc.) and defined in the BIB-Section under the keyword ASSUMED as described on page VIII.25.

Under this formalism values assumed by the author as an educated guess (e.g. a spin value) may be entered as well as values assumed by the author from another source. Free text explanation is desirable.

For the few quantities (e.g. the resonance-energy or a resonance spin) for which a quantity code and a column-heading keyword exist, assumed values are entered under the specific column-heading (e.g. EN-RES or SPIN J) and not under an ASSUM-heading; whereas such values obtained from the experiment are entered under a column-heading DATA with the appropriate quantity-code given under ISO-QUANT resp. REACTION.

Both, assumed values and experimental results, may occur for the same quantity in the same subentry, but a free-text comment should explain, for the convenience of the Exfor user, under which heading to find assumed or measured values, respectively.

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For the coding of cross-sections see Dictionaries 14 and 36 and the Manual pages VIII.12-VIII.20c. Below some cases requiring specific explanation, are given.

Independent and cumulative cross-sections

The coding of cross-sections requires special care when the formation of the residual nucleus can occur

- by direct (= independent formation), and/or
- via isomeric transition, and/or
- via radioactive decay.

The following examples are given in REACTION formalism:

code	application
,SIG	independent formation of the product nucleus can be assumed, but no definitive statement was given by the author
M+,SIG	only the activity of the ground-state was measured which includes however the feeding from a metastable state via isomeric transition. See also under Isomeric States.
IND,SIG	independent formation of the product nucleus, and it was clearly specified by the author that the formation via radioactive decay was excluded
IND/M+,SIG	formation of the product nucleus including independent formation and formation via isomeric transition
(CUM),SIG	the inclusion of the formation via radioactive decay was assumed by the compiler, but no definitive statement was given by the author
CUM,SIG	the cross-section includes the formation via radioactive decay and isomeric transition
CUM/M-,SIG	the cross-section includes the formation via radioactive decay but excludes the formation via isomeric transition
CUM/(M),SIG	the cross-section includes the formation via radioactive decay, the inclusion or exclusion of formation via isomeric transition is uncertain

Fission cross-sections see under Fission

Cross-sections leading to isomeric states see under Isomeric States

Delayed Fission Neutron Data

1.) Theory

In certain cases, a fission-product nucleus may decay by beta-decay to excited levels in the daughter nucleus which lie above the neutron binding energy. In this case, a "delayed" neutron may be emitted whose measured half-life is equal to that of the preceding beta-emitter (delayed neutron precursor). These half-lives are of the order of 0.1 to 60 sec, which is large compared to the period of prompt neutron emission (<< 4×10^{-14} sec, see Fission Yield)

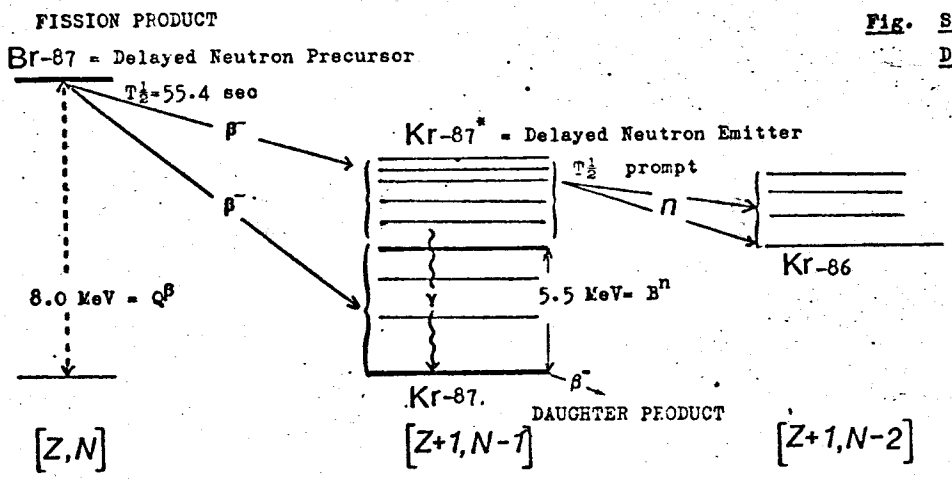

Fig. Schematic representation of Delayed neutron emission

B^n neutron binding energy

Q^β total β^--decay energy

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Delayed neutron groups

Delayed neutron emission is usually represented by 6 delayed neutron groups, distinguished by their half-lives. Each group is associated with, perhaps, several different precursor nuclides with similar half-life values (approximately 55 sec, 22 sec, 6 sec, 2 sec, 0.5 sec and 0.2 sec).

For further detail see:

S. Amiel, Fission Product Nuclear Data, Vol. II, p.33 (1973).
G.R. Keepin, Physics of Nuclear Kinetics (1965).
E.K. Hyde, The Nuclear Properties of Heavy Elements, Vol. III. (1964).

2.) Definitions and Codes of quantities for data to be Compiled in EXFOR

Total Average delayed fission neutron yield $\bar{\nu}_d = \bar{\nu}_t - \bar{\nu}_p$

Quantity code: NU,,DL

- Absolute delayed neutron yield
  Units: neutrons per fission (entered as NØ-DIM)
- Delayed neutron fraction ($\bar{\nu}_d/\bar{\nu}_{ToT}$) - coded as ((Z-S-A,NU,,DL)/(Z-S-A, NU)) with the units NØ-DIM

Partial delayed fission neutron yields

Quantity code: NU,,DL/PAR

There are two main types of measurements:

a.) Delayed neutron groups. Data should be coded using the average half-life of the group as an independent variable (with data heading HL which need not be explained in the BIB-section).

- Relative abundance (or relative group yield) - coded as the ratio ((Z-S-A,NU,,DL/PAR)/(Z-S-A,NU,,DL)) with units NØ-DIM. [The values for the six groups sum up to 1]
- Absolute group yield - coded with units PC/FIS (neutrons per 100 fissions) or NØ-DIM (neutrons per fission).

b.) Yield of delayed fission neutrons associated with an individual precursor. Data should be coded with the precursor nucleus as an independent variable given under the data headings ELEMENT and MASS, and are usually given with units PC/FIS, as above.

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Delayed-Neutron Energy Spectrum for a Given Neutron Group

Quantity code: NU,DE,DL/PAR

Data should be coded using the average half-life of the neutron group and the delayed neutron energy or energy range as independent variables.

The data may be given:

a.) in percent - the data unit PC/FIS should be used.
b.) as a relative measurement - the quantity-modifier "REL" and data units "ARB-UNITS" should be used.

For the quantities considered the nucleus to be entered is the target nucleus before the absorption of the incident neutron.

For spontaneous fission enter the fissioning nucleus, the quantity SF/NU instead of NU, and use the keyword NUC-QUANT instead of ISO-QUANT.

3.) Data not presently compiled in EXFOR

The energy spectrum of all delayed neutrons together is time dependent, due to the contributions from the different half-life groups. This is presently not coded in Exfor.

The delayed-neutron equilibrium spectrum as found in a steady-state reactor is presently not coded in Exfor.

There are other delayed-neutron quantities which are not properties of the fissioning nucleus but decay properties of the fission-product nucleus which is the "precursor" of the delayed neutron. Although such quantities are closely related to the quantities given above, they are presently not coded in Exfor. Quantities of this category are in particular

- the delayed neutron emission probability, and
- the energy spectrum of the neutrons emitted by a specific precursor.

For delayed neutron emission probabilities see for example:
Amarel, et.al., J. Inorg. Nuc. Chem., 31, 577, 69
Tomlinson, et.al., J. Inorg. Nuc. Chem., 33, 3609, 71
Asghar, et.al., Nucl. Phys. A, 247, 359, 75

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Dependent Data

Data that are deduced from other EXFOR data sets, should be labelled with the code "DEP" under STATUS, if the deduction is a rather trivial operation. Free text under "STATUS" and/or "ANALYSIS" should give information how the data were deduced, and cross-reference from which EXFOR-entries the data were deduced. This cross-reference may preferably be given in computer-intelligible coded form as described on page VIII.4 .

Examples: ALF, if it was obtained from ratioing two independent EXFOR sub-entries of NF and NG.

NG/WID, if it was obtained from a subtraction of two independent EXFOR sub-entries of TOT/WID and EL/WID.

Legendre- (or Cosine-) coefficients are considered as dependent data, if the originally measured differential cross-sections are also given in EXFOR.

If the same data are given in two subentries in different representations, e.g. σ_i and $\sigma_i \sqrt{E}$, one of them should have the status code (DEP).

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The status-code "DEP" should not be used when some data sets are mutually interdependent, as for example:

An experiment (Cabell, AERE-R-5874,68) may yield simultaneously ABS, NG and ALF, where all three interdependent quantities were derived from a common set of raw data. None of them should be labelled with the status-code "DEP".

Compare: Interdependent Data.

Interdependent data

Data that have been measured by the same technique, have certain systematic error-sources in common and are therefore interdependent. Their errors are correlated.

Examples:

1. 92-U-233,NU and 92-U-235,NU measured in the same manganese bath.
2. ABS; NG and ALF all obtained simultaneously in the same experiment (Cabell, AERE-R-5874,68).

Error-correlations must be considered carefully by evaluators. Therefore, the compiler may enter all required information on common error sources and cross-references between interdependent data-sets or subentries. This is particularly worth a try in the case of private communications; in other cases evaluators will rather use published references.

For the coding of different results of the same quantity obtained in the same experiment by, e.g., two different ways of analysis, see page IV.3a.

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1. Isomeric states of nuclei are indicated with an isomer code following the nucleus code, e.g. 95-AM-242-M1. The following isomer codes exist:

95-AM-242-G	ground-state This code is not to be used for a target nucleus, and is only to be used for nuclei which have a metastable state.
95-AM-242-M	isomer code used when the author considers only one isomeric state
95-AM-242-M1	first metastable state
95-AM-242-M2	second metastable state, etc

In all cases an unambiguous identification of the respective isomer, e.g. by its half-life and/or other decay properties (given under DECAY-DATA) is obligatory.

These isomer codes are used whereever a nucleus is coded, e.g. under ISO-QUANT, REACTION, HALF-LIFE, DECAY-DATA, RESID-NUC, etc. However, when nuclei are coded within a data table, using ELEMENT and MASS as column headings, numerical isomer codes are used under the column heading ISOMER:

0. for G
1. for M and M1
2. for M2, etc.

2. Partial reactions leading to isomeric states are treated differently in ISO-QUANT or REACTION formalism.

2.a ISO-QUANT: Quantity modifiers are used, e.g.

NP,,GND	partial (n,p) cross section populating the ground-state of the residual nucleus; to be used only, when a metastable state exists, otherwise use NP,,PAR.
NP,,MS	partial (n,p) cross section populating a metastable state of the residual nucleus;

For coding the residual nucleus see page VIII.20.

2.b REACTION

For CPND such a partial reaction is identified by the isomer code of the residual nucleus:

(Z-S-A(P,N)Z-S-A-M1,,SIG)

For NND when coded in REACTION formalism (not yet possible !), such a partial reaction can be coded either by a code in the "branch" field SF5, or by the isomer code of the residual nucleus, such that the following notations are equivalent:

(Z-S-A(N,P)Z-S-A,MS,SIG)
(Z-S-A(N,P)Z-S-A-M1,,SIG)
(Z-S-A(N,P)Z-S-A-M1,MS,SIG),

subject to a decision to be made at the time of ISO-QUANT/REACTION conversion.

2.c Isomeric ratios are coded as explicit ratios ((...)/(...)), in ISO-QUANT and in REACTION formalism.

3. Decay data:

It should be noted that the assignment of isomeric states (ground, first, second) for a given nucleus may vary in the literature according to the growing knowledge about this nucleus. In order to define an isomeric state uniquely, compilers must include in the Exfor entry also the decay properties of the isomer (see page VIII.24) under the keywords HALF-LIFE resp. DECAY-DATA.

Note: In the case of isomeric branches it must be clearly distinguished between the sum-coding and the usage of the "branch" code M+.

The sum-coding

((Z-S-A(,)Z-S-A-M,...) +

(Z-S-A(,)Z-S-A-G,...))

is used only in cases where the total formation cross section $\sigma_M+\sigma_G$ was obtained from separate measurements. If only the activity of the ground-state was measured which includes the feeding from the metastable state via the isomeric transition, the branch code

(Z-S-A(,)Z-S-A,M+,...) is applied.

Accordingly, $(\sigma_M+\sigma_G)$ is greater or equal to $(\sigma,M+)$.

Exception: In cases where the formation cross-section of a nucleus is determined from a daughter activity ensuring a 100 % inclusion of the produced isomer, the sum-code must be used, since the branch-code M+ stating formation via isomeric γ-transition in the residual nucleus does not apply unambiguously to this case.

Compare also Dictionaries 31, 36 and under Cross-Sections

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In the 'REACTION' formalism the coding of particle-producing reactions creates no problems (see page VIII.20a). In the older 'ISO-QUANT' formalism, where only 3 characters were available for the reaction code, the following neutron-induced "particle-out" reactions are defined:

N2N Interaction in which two neutrons and perhaps other particles are emitted Not to be used for the (n,2nf) reaction.

N3N Interaction in which three neutrons and perhaps other particles are emitted.

N4N Interaction in which four neutrons and perhaps other particles are emitted.

NP Two-body interaction which results in emission of one proton and no other particle.

NNP Interaction which results in emission of one neutron, one or more protons and perhaps heavier particles.

N2P Interaction in which two or more protons and perhaps other heavier particles are emitted.

ND Two-body interaction which results in emission of one deuteron and no other particle.

NND Interaction which results in emission of one neutron, one or more deuterons and perhaps heavier particles.

NT Two-body interaction which results in emission of one triton and no other particle.

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NNT Interaction which results in emission of one neutron, one or more tritons and perhaps heavier particles.

N3 Two-body interaction which results in emission of one He-3 particle and no other particles.

NN3 Interaction which results in emission of one neutron, one or more He-3 particles and perhaps heavier particles.

NA Two-body interaction which results in emission of one α-particle and no other particles.

N2A Interaction which results in emission of two or more α-particles.

4C-3/182 4C-1/100

NPA Interaction which results in emission of a proton and an α-particle (usually not occurring below 20 MeV).

NNA Interaction which results in emission of one neutron, and one or more α-particles.

For more detailed quantity-codes see dictionary 14. The above definitions refer to specific processes. See also under Light-Nuclei Reactions

For cross-sections resulting from a sum of several particle-out processes see Emission Cross-Sections. The above definitions exclude fission. Quantity-codes for reactions like (n,2nf) have not yet been defined; compare Ternary Fission.

1. Particles participating in the Reaction are

   - in ISO-QUANT formalism included in the process codes of Dictionary 10
   - in REACTION formalism explicitly coded in subfields SF2 and SF3 using the codes of Dictionary 33, within the formalism described on page VIII.20a.

2. Keyword "PART-DET": This keyword is used to identify the particle(s) actually detected in the experiment, regardless of the quantity given in the data-table. This keyword must be present if the particle detected is not evident from the data specification.

   For coding rules see pages VIII.3, VIII.4 and IV.2. See Dictionary 13 for particle codes.

   Particles detected in successive ISO-QUANT's of an ISO-QUANT combination should be coded on successive lines.

   The particles detected in a monitor reaction should not be coded.

   Distinguish the different codes for decay-gammas (DG) and other gammas (G), and also for different β-particles: decay-electrons (B-), decay-positrons (B+) and other electrons (E).

3. Keyword "RAD-DET": If the particle or radiation detected can be attributed to a specific decaying nucleus, this can be indicated by using the keyword "RAD-DET" rather than "PART-DET". For coding rules see page VIII.3 and Dictionary 2. This keyword is presently not accepted for neutron nuclear data.

4. "Particle-Designator" resp. "Particle Considered":

   The fourth quantity-subfield under ISO-QUANT resp. subfield SF7 under REACTION indicate, when necessary, which of several outgoing particles the quantity refers to. See pages VIII.12 and VIII.18 (ISO-QUANT) resp. page VIII.20b (REACTION).

   For examples see Dictionaries 14 resp. 36.

Under the information-identifier keyword "STATUS" various groups of information are combined. For coding rules see pages VIII.3 and VIII.4. For codes see Dictionary 16. Compare Example 6.

The codes in Dictionary 16 have rather detailed explanation, but some general items should be borne in mind:

1. Preliminary superseded final - If the codes (PRELM) or (SPSDD) are absent, the data are understood as final data. The status-code of a preliminary data set is changed from (PRELM) to (SPSDD) as soon as the final data are also entered. Therefore, the codes (PRELM) and (SPSDD) exclude each other.

The frequent case that a preliminary data set is replaced by its final version, can be solved in two ways:

a) the final set replaces the preliminary set under the same subentry-number so that the preliminary set is deleted from the file.

b) the final set is entered under a new subentry-number (preferably of the same entry), and the earlier set is labelled with (SPSDD); in both subentries cross-references to the other are entered in free text. This way is preferred to case a) if the earlier set had already been published.

2. Dependent - See under Dependent Data.

3. Approved - After the proof-copy has been approved by the author the code (APRVD) is entered. Absence of the code (APRVD) means: no reply on the proof-copy has yet been received from the author.

4. Source of the data - The actual source where the numerical values of the data set were taken from, may be entered in free text.

5. Normalization - If the codes (OUTDT) and (RNORM) are absent, data are compiled as resulting from the author's corrections and normalization. Only in exceptional cases it is allowed to compile re-normalizations or re-assessments of the data as given by an evaluator. Compare under Renormalization and Correction.
The renormalized or reassessed data set is labelled with (RNORM). The old data set which is superseded by the later renormalization or reassessment is labelled with (OUTDT).

6. The above status-codes may be missing even if they apply when the code (SCSRS) is given. Data with the code SCSRS were converted from SCISRS-1 or NEUDADA. The code (SCSRS) need not be followed by free text.

7. Unobtainable data - see Unobtainable Data.

8. Cross-references to other subentries may be given in free text, but in certain cases also in computer-intelligible form as defined on page VIII.4 .