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EXFOR Exchange Formats Manual

Compiled and edited by

Victoria McLane
National Nuclear Data Center
Brookhaven National Laboratory, USA

on behalf of the
Nuclear Reaction Data Centers Network

with
minor changes and updates by

Otto Schwerer
Nuclear Data Section
International Atomic Energy Agency
Vienna, Austria

August 2004

Abstract: EXFOR is the exchange format for the transmission of experimental nuclear reaction data between national and international nuclear data centers for the benefit of nuclear data users in all countries. This report contains the agreed coding rules and format.

Nuclear Reaction Data Centers

Exchange Formats Manual

Part II

EXFOR

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Brookhaven National Laboratory
Upton, NY 11973-5000

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INTRODUCTION

EXFOR is an exchange format designed to allow transmission of nuclear reaction data between the members of the Nuclear Reaction Data Centers Network (NRDC)[1] which has been organized under the auspices of the International Atomic Energy Agency to coordinate the collection, compilation, and dissemination of nuclear data on an international scale. This document has been written for use by the members of the Network and includes matters of procedure as well as detailed rules for the compilation of data. Users may prefer to consult EXFOR Basics[2] for a brief description of the format.

History

The "EXFOR System" consists, primarily, of all experimental nuclear reaction data that has been exchanged between the members of the NRDC, and presently includes neutron, charged-particle, and photonuclear data files.

The EXFOR format has been designed for flexibility rather than optimization of data processing in order to meet the diverse needs of the nuclear reaction data centers. It was originally conceived for the exchange of neutron data through discussions among personnel from centers situated in Saclay, Vienna, Livermore and Brookhaven. It was accepted as the official exchange format of the neutron data centers at Saclay, Vienna, Brookhaven and Obninsk, at a meeting held in November 1969.[3] As a result of two meetings held in 1975 and 1976 in which several charged-particle data centers participated, the format was further developed and adapted to cover all nuclear reaction data.[4]

The EXFOR format is continuously refined and expanded to include new types of data as the need arises. This is accomplished through discussions among the member centers of the NRDC.

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[1] See V.G. Pronyaev, O. Schwerer, ed., The Nuclear Reaction Data Centers Network, IAEA report INDC(NDS)-401 Rev. 4 (2003).

[2] V. McLane, EXFOR Basics: A Short Guide to the Nuclear Reaction Data Exchange Format, Brookhaven National Laboratory report **BNL-NDC-63380**, Rev. 2000 (May 2000).

[3] See IAEA report **INDC(NDU)-16/N** (December 1969).

[4] See IAEA reports **INDC(NDS)-69** (December 1975) and **INDC(NDS)-77** (October 1976).

EXFOR Format

The EXFOR format allows a large variety of numerical data tables with associated textual information, *i.e.*, bibliographic and descriptive information, to be transmitted in a format:

- that is machine-readable (for checking and processing);

- that can be read easily by personnel (for updating, evaluating, *etc*.).

The format was designed for flexibility in order to allow a wide range of data types to be exchanged and stored. A series of keywords and codes have designed to implement this; these keywords and codes are defined in the EXFOR Dictionaries.

The working language of EXFOR is English.

The following chapters describe the exchange format in detail, in addition to discussing the use of keywords and codes. The content and format of the EXFOR Dictionaries is also included, as well as the protocol for the Nuclear Data Center Network cooperation.

The exchange format should not be confused with a center-to-user format. Although users may obtain data from the centers in the EXFOR format, other center-to-user formats have been developed to meet the needs of the users within each center's own sphere of responsibility.

Acknowledgements

Chapter 1

GENERAL STRUCTURE OF THE EXCHANGE FORMAT

Nuclear reaction data is exchanged within the EXFOR System on EXFOR exchange files (transmissions).

This section describes the general structure and the general format of an EXFOR exchange file. More specific information may be found in the following chapters.

Structure of an EXFOR Exchange File

An exchange file contains a number of entries (works). Each entry is divided into a number of subentries (data sets). The subentries are composed of bibliographic (including descriptive and bookkeeping) information, and data. The data is further divided into data values that are common throughout the subentry (common data) and a data table.

The file may, therefore, be considered to be of the following form:

File	Entry	Subentry
		Bibliographic Information
		Common Data
		Data Table
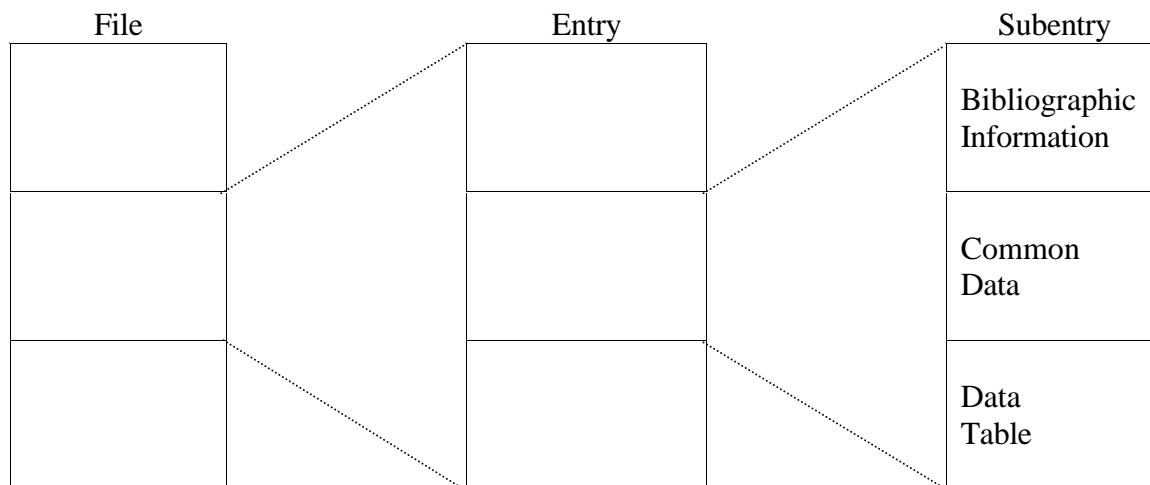
In order to avoid repetition of information that is common to all subentries within an entry or to all lines within a subentry, information may be associated with an entire entry or with an entire subentry. To accomplish this, the first subentry of each work contains only information that applies to all other subentries. Within each subentry, the information common to all lines of the table precedes the table. Two levels of hierarchy are thereby established:

Entry		Subentries
Common Subentry	·····························>	**Bibliographic Information**
		Common Data
Data Subentry	·····························>	**Bibliographic** Information
		Common Data
		Data Table
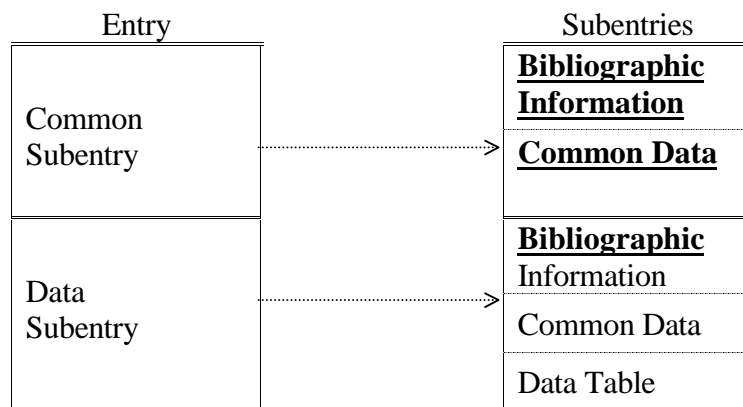
Definition of a subentry.

The originating center[1] is responsible for dividing entries into appropriate subentries prior to transmission. This ensures that an entry is divided into subentries in a unique manner, which may be referenced by all centers.

1. A subentry is defined as a data table as a function of one or more independent variables: *i.e.*, X, X' vs. Y with associated errors for X, X' and Y (*e.g.*, X = energy; X' = angle; Y = differential cross section) and any associated variables (*e.g.*, standard)

2. When more than one representation of Y is present, the table may be X vs. Y and Y', with associated errors for X, Y and Y' (*e.g.*, X = energy, Y = absolute cross section, Y' = relative cross section), and possible associated information. The criteria for grouping Y with Y' are that they both be derived from the same experimental information by the author of the data.

3. Variables may appear either in the common data portion of a subentry (when uniformly applied to all points), or as a field of the data table (when applied point-wise).

4. For some data, the data table does not have an independent variable X but only a function Y. (*Examples*: Spontaneous $\bar{\nu}$; resonance energies without resonance parameters)

5. If the function Y is given for a single value of the variable X, and if this value of X is common for all subentries in a given entry, then X may be entered in the common data section of the first subentry. The following subentries may then contain only the value of Y in the data table.

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[1] Or a designated center, see Compilation Responsibility, Part IV, Protocol.

Permitted character set

The following characters are permitted for use in the exchange format:

All Roman characters, A to Z and a to z
All numbers, 0 to 9
The special characters:

+	(plus)	>	(greater than)
-	(minus)	:	(colon)
.	(decimal point/full stop)	;	(semi-colon)
)	(right parenthesis)	!	(exclamation mark)
(	(left parenthesis)	?	(question mark)
*	(asterisk)	&	(ampersand)
/	(slash)	#	(number symbol)
=	(equals)	[	(opening bracket)
'	(apostrophe)	]	(closing bracket)
,	(comma)	"	(quotation mark)
%	(percent)	~	(varies as sign)
<	(less than)	@	at symbol)

Identification of Files, Entries, and Subentries.

In order to track, access, and identify data within the EXFOR Exchange System, the following labeling systems have been adopted for files, entries and subentries.

- An EXFOR Exchange File is labeled using a four-character file identification.

- An entry is labeled using a five-character accession number.

- A subentry is labeled using an eight-character subaccession number.

Each of these labels includes a center-identification character as the first character in the string. The table on the following page lists the center-identification characters that have been assigned. These characters define both the center at which the information was compiled and the type of data compiled.[2]

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[2] Neutron, charged-particle, and photonuclear reaction data must be compiled in separate entries with appropriate identification, even if they were reported in the same reference. See Part IV, Protocol, Data Compilation Responsibility.

Center Identification Characters		
0	Preliminary	For internal center use (*i.e.*, not included on exchange files).
1	NNDC (Brookhaven)	Neutron nuclear data
2	NEA-DB (Paris)	Neutron nuclear data
3	NDS (Vienna)	Neutron nuclear data
4	CJD (Obninsk)	Neutron nuclear data
6	data from area 2	Data entered by NNDC; not part of the normal neutron nuclear
8	data from area 4	data 2, 4 series.
9	NDS (Vienna)	Dictionary transmission (see page 6.1)
A	CAJaD (Moscow)	Charged-particle nuclear data
B	KaChaPaG (Karlsruhe)	Charged-particle nuclear data[3]
C	NNDC (Brookhaven)	Charged-particle nuclear data
D	NDS (Vienna)	Charged-particle nuclear data
E	JCPRG (Sapporo)	Charged-particle nuclear data
F	NPDC (Sarov)	Charged-particle nuclear data
G	NDS (Vienna)	Photonuclear data
H	NNDC (Brookhaven)	Special internal use for relativistic particle reaction data
L	NNDC (Brookhaven)	Photonuclear data
M	CDFE (Moscow)	Photonuclear data
N	NEA-DB (Paris)	Special use for memos only
O	NEA-DB (Paris)	Charged-particle nuclear data
P	NNDC (Brookhaven)	Charged-particle nuclear data from MacGowen file[4]
Q	CJD (Obninsk)	Photonuclear data
R	RIKEN	Charged-particle nuclear data[5]
S	CNDC	Charged-particle nuclear data
T	VNIIEF/NNDC	Charged-particle nuclear data
V	NDS (Vienna)	Special use for selected evaluated neutron data 'VIEN' file.

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[3] Updates of these entries are the responsibility of CAJaD.

[4] Updates of these entries are the responsibility of NNDC.

[5] Updates of these entries are the responsibility of JCPRG.

EXFOR Records

EXFOR Exchange files consist of 80 character ASCII records. The format of columns 1-66 varies according to the record type as outlined in the following chapters. Columns 67-79 is used to uniquely identify a record within the file. The records on the file are in ascending order according to the record identification. Column 80 is reserved for an alteration flag.

Record identification. The record identification is divided into three fields: the accession number (entry), subaccession number (subentry), and record number within the subentry. This guarantees that each record can be uniquely referenced (*i.e.*, no two records on a given file will have the same identification).

The format of these fields is as follows.

Columns	67-71	Center-assigned accession number
	72-74	Subaccession number
	75-79	Sequence number

Accession number (columns 67-71). Columns 67-71 contain the five-character accession number assigned by the originating center to a given work[6]. Column 67 is the file identification character (see page 1.4); columns 68-71 contain a center-assigned entry number,[7] allowing 9,998[8] entries for each file identification character (*e.g.*, A0198). The entries will appear on the exchange file in ascending order by accession number.

An accession number is associated with one work throughout the life of the EXFOR system. If an entry is deleted from the system, the accession number is not reassigned to another work.

Subaccession number (columns 72-74). Columns 72-74 contain a three-digit subaccession number assigned by the originating center. The subaccession number is used to divide an entry into a number of subentries while maintaining an interrelationship between the subentries (*i.e.*, all subentries within a given entry contain the same accession number). Each subentry may be conceptually thought of as an individual data set (a data table and its associated descriptive information). Up to 998[9] subentries (data sets) may be associated with each entry (work), *i.e.*, subaccession numbers are sequentially assigned within each entry, starting at 1 and increasing toward 998.

A subaccession number is associated with a table throughout the life of the EXFOR system. If a subentry is deleted from the system, the subaccession number is not reassigned to another data table within the same entry.

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[6] Leading zeros should always be included on an exchange file.
[7] See Part IV, Protocol, for more information on the assignment of accession numbers.
[8] The integer 9999 is reserved for use in identifying the end of an exchange file (see Chapter 2).
[9] The integer 999 is reserved for use in identifying the end of an entry or a file (see Chapter 2).

<u>Sequence number (columns 75-79)</u>. Columns 75-79 contain a five-digit sequence number, which is used to uniquely define a record within a subentry (all records within a subentry are labeled with the same subaccession number). The numbering is sequential within a subentry. Up to 99,999[10] records may be associated with each subentry, *i.e.*, the record numbering within each subentry begins at 1 and increases sequentially toward 99998.

The sequence number allows referencing at the record level, *e.g.*, for updating and checking. A given sequence number need not be associated with a given record over time. The records within a subentry are renumbered sequentially following an update (alteration) procedure.

EXFOR records are always transmitted in sequential order.

<u>Summary of Record Identification</u>.

The first field (column 67-71) is alphanumeric; the next 2 fields (columns 72-79) are strictly numeric and may vary over the following ranges:
1) Accession Number: File identification + 0001 to 9999
2) Subaccession Number: 001 to 999
3) Sequence Number: 00001 to 99999

Used in combination, these fields uniquely reference information within the EXFOR System as follows:
1) Columns 67-71:   Uniquely identifies an entry within the EXFOR systems.
2) Columns 67-74:   Uniquely identifies a subentry within the EXFOR system.
3) Columns 67-79:   Uniquely identifies a record within the EXFOR system.[11]

The first two fields (columns 67-74) are associated with a subentry throughout the life of the system; that is, if a subentry is deleted from the system, the same identification is not assigned to another subentry.

<u>Alteration flag (column 80)</u>. The last column of each record contains the alteration flag, which is used to indicate that a record and/or following records has been altered (*i.e.*, added, deleted or modified) since the work was last transmitted. The flag field will normally contain a blank to indicate an unaltered record. See Chapter 8 for the use of Alteration Flags.

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[10] The integer 9999 is reserved for use in identifying the end of a subentry, entry, or file.
[11] Columns 67-79 are padded with zeros (0) rather than blanks on an exchange file. This allows the entire library to be handled by the sort/merge packages on a wide variety of computers.

Chapter 2

SYSTEM IDENTIFIERS

Each of the following basic system identifiers refers to one of the hierarchy of units contained on an exchange file. These units and their corresponding basic system identifiers are:

TRANS	- A transmission is the unit
ENTRY	- An entry (work) is the unit
SUBENT	- A subentry (data set) is the unit
BIB	- The Bibliographic Information section (hereafter referred to as 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 identifiers are combined with the modifiers

NO
END

to indicate three conditions:
- The beginning of a unit (basic system identifier only)
- The end of a unit (modifier END preceding the basic system identifier)
- A positive indication that a unit is intentionally omitted (modifier NO preceding the basic system identifier)

However, only those combinations of basic system identifiers and modifiers that are defined on the following pages, and are included in Dictionary 1, are used.

System identifier records

The general format of a system identifier record is:

11	22	33	66
SYSTEM IDENTIFIER	N1	N2 Free text	

SYSTEM IDENTIFIER may be any of the permitted system identifiers, left adjusted to begin in column 1. N1 and N2 are integers, and are right adjusted to columns 22 and 33, respectively. The significance of N1 and N2 depends on the system identifier used (see following pages).

Columns 34-68, with the exception of the special uses listed under the system identifiers, may contain any free text that a center wishes to use or may be used internally by the centers for additional coded information.

The following pages describe the hierarchy of an exchange file and the use of system identifier records in detail.

1. An exchange file (transmission) is one logical file.

   TRANS is the first record on an exchange file.
   N1 - The exchange file identification (CXXX), consisting of:
   column 19:   the center-identification character,[1]
   column 20-22:   a three-digit number (padded with zeros), sequentially assigned to allow other centers a simple means of determining whether or not they have received all exchange files.
   N2 - An eight-digit integer containing the data (year, month, and day) on which the exchange file was generated. The format is: YYYYMMDD.

   The record identification contains the file-identification character in column 67 and zeros in columns 68-79.[1]

   ENDTRANS is the **last record** of the exchange file.
   N1 - The number of entries (accession numbers) on the file.
   N2 - Presently unused (may be blank or zero).

   The record identification contains a character, whose value is $\geq$ the file identification number of the previous record, in column 67 and 9's in columns 68-79.

2. An exchange file is made up of one or more entries (works).

   ENTRY is the **first record** of each entry.
   N1 - 5-character accession number
   N2 - Date of last update (or date of entry if never updated) (YYYYMMDD)

   The record identification contains the accession number (columns 67-71), the subentry number zero (000) (columns 72-74), and the sequence number one (00001) (columns 75-79).

   The following special uses are made of the free text field in the ENTRY record:

   NDS: For entries containing evaluated or recommended data, a "V" is inserted in column 44. Columns 45-55 contain the initials of the physicist who compiled the entry or made the last revision.

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[1] On files that contain entries with different file-identification characters, column 67 is assigned such that the record sorts at the beginning of the file.

ENDENTRY is the **last record** of each entry.

N1 - The number of subentries in the work.[2]

N2 - Presently unused (may be blank or zero).

The record identification contains the accession number (columns 67-71), the subentry number 999 (columns 72-74), and the sequence number (99999) (columns 75-79).

3. Entries are divided in subentries (data sets).

SUBENT is the **first record** of each subentry.

N1 - 8-character subaccession number (accession number and subentry number).

N2 - Date of last update (or date of entry if never updated) (YYYYMMDD).

The record identification contains the subentry number (columns 67-74) and sequence number one (00001) (columns 75-79).

ENDSUBENT is the **last record** of each subentry.

N1 - The number of records within the subentry.[3]

N2 - Presently unused (my be blank or zero).

The record identification contains the subaccession number (columns 67-74) and sequence number 99999 (columns 75-79).

NOSUBENT is a positive indication that no subentry exists for a subaccession number.[4]

N1 - 8-character subaccession number (accession number and subentry number).

N2 - Date of last alter or blank (if merely assigned and not yet used).

The record identification is the same as on a SUBENT record.

4. Each subentry but the first contains three sections or, for each section, a positive indication that the section is not given. The sections are BIB, COMMON, and DATA. The first subentry (Common Subentry) does not contain a DATA section.

The record identification for these system identifiers contains the subaccession number (columns 67-74), and the sequence number, assigned sequentially within the subentry (columns 75-79).

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[2] NOSUBENT records are counted as subentries when computing the number of subentries in an entry.

[3] Not counting the SUBENT and ENDSUBENT records.

[4] A subentry number has been assigned, but that either the information associated with it was not ready at the time the file was transmitted by the center, or that the subentry has been deleted or combined with another subentry.

BIB section contains bibliographic information.

BIB is the **first record** of each BIB section
N1 - Number of information-identifier keywords in the BIB section.
N2 - Number of records within the BIB section.[5]

ENDBIB is the **last record** of each BIB section.
N1 - Number of records within BIB section (same as N2 on BIB record).
N2 - Presently unused (may be blank or zero).

NOBIB is a positive indication that no BIB section is given in the subentry.
N1 - Presently unused (may be blank or zero).
N2 - Presently unused (may be blank or zero).

COMMON section contains common data.

COMMON is the **first record** of each common data section.
N1 - Number of common data fields.
N2 - Number of records within the common section.[6]

ENDCOMMON is the **last record** of each common data section.
N1 - Number of records within the common section (same as N2 on COMMON record).
N2 - Presently unused (may be zero or blank).

NOCOMMON is a positive indication that no common data section is given in the subentry.
N1 - Presently unused (may be blank or zero).
N2 - Presently unused (may be blank or zero).

DATA section contains the data table.[7]

DATA is the first record of each data table section. (May not appear in the first (SAN=1) subentry).
N1 - Number of fields (variables) associated with each line of a data table.
N2 - Number of data lines within the table (excluding headings and units). Note that if N1> 6, a line will consist of more than one record.

ENDDATA is the **last record** of each data table section. (May not appear in the first (SAN=1) subentry).
N1 - Number of records within the data section.[8]
N2 - Presently unused (may be zero or blank).

NODATA is a positive indication that no data table section is given in the subentry. (May not appear in the first (SAN=1) subentry).
N1 - Presently unused (may be zero or blank).
N2 - Presently unused (may be zero or blank).

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[5] Not counting the BIB and ENDBIB records.
[6] Not counting the COMMON and ENDCOMMON records.
[7] Does not appear in the first (common) subentry.
[8] Not counting the DATA and ENDDATA records.

System identifier sequence

The following table specifies the permissible order in which system identifiers may appear.

SYSTEM IDENTIFIER	LEGAL FOLLOWING RECORD	LEGAL PRECEDING RECORDS
TRANS	ENTRY	No information precedes TRANS
ENDTRANS	(no information follows ENDTRANS)	ENDENTRY
ENTRY	SUBENT, NOSUBENT	ENDENTRY, TRANS
ENDENTRY	ENTRY, ENDTRANS	ENDSUBENT, NOSUBENT
The following applies to the first subentry (subentry number = 1).		
SUBENT	BIB, NOBIB	ENTRY
ENDSUBENT	SUBENT, ENDENTRY, NOSUBENT	ENDCOMMON, NOCOMMON
NOSUBENT	SUBENT, ENDENTRY, NOSUBENT	ENTRY
BIB	(a bibliographic record)	SUBENT
ENDBIB	COMMON, NOCOMMON	(a bibliographic record)
NOBIB	COMMON, NOCOMMON	SUBENT
COMMON	(a common data record)	ENDBIB, NOBIB
ENDCOMMON	ENDSUBENT	(a common data record)
NOCOMMON	ENDSUBENT	ENDBIB, NOBIB
The following apply to the remaining subentries (subentry number ≠ 1).		
SUBENT	BIB, NOBIB	ENDSUBENT,NOSUBENT
ENDSUBENT	SUBENT, ENDENTRY, NOSUBENT	ENDDATA, NODATA
NOSUBENT	SUBENT, ENDENTRY, NOSUBENT	ENDSUBENT, NOSUBENT
BIB	(a bibliographic record)	SUBENT
ENDBIB	COMMON, NOCOMMON	(a bibliographic record)
NOBIB	COMMON, NOCOMMON	SUBENT
COMMON	(a common data record)	ENDBIB, NOBIB
ENDCOMMON	DATA, NODATA	(a common data record)
NOCOMMON	DATA, NODATA	ENDBIB, NOBIB
DATA	(a data heading record)	ENDCOMMON, NOCOMMON
ENDDATA	ENDSUBENT	(a data record)

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Chapter 3

BIB SECTION

The BIB section contains the bibliographic information (*e.g.,* reference, authors), descriptive information (*e.g.*, neutron source, method, facility), and administrative information (*e.g.*, history) associated with the data presented. It is identified on an exchange file as that information between the system identifiers BIB and ENDBIB.

A BIB record consists of three parts:

columns 1-11:   information-identifier keyword field,
columns 12-66:   information field, which may contain coded information and/or free text,
columns 67-80:   record identification and alteration flag fields (see Chapter 1).

A set of information identifiers has been devised so that each item of BIB information can be identified for computer processing.

BIB information for a given data set consists of the information contained in the BIB section of its subentry together with the BIB information in subentry 001. That is, information coded in subentry 001 applies to all other subentries in the same entry. A specific information-identifier keyword may be included in either subentry or both.

Information-identifier keywords

The information-identifier keyword is used to define the significance of the information given in columns 12-66. The keyword is left adjusted to begin in column 1, and does not exceed a length of 10 characters (column 11 is either blank, or contains a pointer, see Chapter 5). These keywords may, in general, appear in any order within the BIB section.

An information-identifier keyword is not repeated within any one BIB section. If pointers are present, they appear on the first record of the information to which they are attached and are not repeated on continuation records. A pointer is assumed to refer to all BIB information until either another pointer or a new keyword is encountered. As this implies, pointer-independent information for each keyword appears first. (See Chapter 5 for use of pointers).

A list of all Information Identifiers is given in Dictionary 2. For detailed coding rules, see Chapter 7.

Coded (machine-retrievable) information

Some information-identifier keywords have associated with them a standard set of coded information. A set of dictionaries is provided for defining the meaning of any coded information that is not self-explanatory.[1]

Coded information may be used:
* to define the actual BIB information,
* as a link to the COMMON and DATA section,
* to enter associated numerical data.

Coded information may also be useful for retrieval or for identification of a data set.

Coded information is enclosed in parentheses and left adjusted so that the opening parenthesis appears in column 12. Several pieces of coded information may be associated with a given information-identifier keyword.

For some keywords, a restriction is placed upon the maximum length of the associated coded information.[2] For some cases, the information may be continued onto successive records. Information on continuation records does not begin before column 12 (columns 1-10 are blank and column 11 is blank or contains a pointer (see Information-Identifier Keyword, above)). The coded information is kept as concise as possible so that it may be used efficiently.

Note that some information-identifier keywords have no coded information associated with them and that, for many keywords, which may have coded information associated with them, it need not always be present.

Use of codes. Codes for use with a specific keyword are found in the relevant dictionary. However, for some keywords, the code string may include retrievable information other than a code from one of the dictionaries.

In general, codes given in the dictionaries may be used singly or in conjunction with one or more codes from the same dictionary. Two options exist if more than one code is used:

a) two or more codes within the same set of parenthesis, separated by a comma; for example:
   KEYWORD   (CODE1,CODE2) + free text

b) each code on a separate record, enclosed in it's own set of parenthesis starting in column 12, followed by free text, for example:
   KEYWORD   (CODE1) + free text ...
                       free text ...
                       (CODE2) + free text

---

[1] Authors' names, for example, are self-explanatory, and no dictionary is needed.
[2] See Part III, Nuclear Reaction Data Dictionaries, for maximum length of codes.

Both of these options, or a combination of the two, are allowed, in general. However, for keywords for which the code string includes retrievable information in addition to a code, only (b) is permitted.

See detailed coding rules for each information-identifier keyword in Chapter 7 and the Dictionaries (described in Part III) for codes.

<u>Embedded blanks</u>. For many information-identifier keywords, embedded blanks are explicitly forbidden in the codes. With those exceptions, embedded blanks in the coding are allowed if they follow a code from the dictionary. They are not permitted preceding any code.

Examples:
```
STATUS   (DEP  )
STATUS   (DEP  ,COREL)
```

Forbidden:
```
STATUS   (COREL,  DEP)
STATUS   (DEP, 10048007)
```

Free text

Free text may be entered in columns 12-66 under each of the information-identifier keywords in the BIB section and may be continued onto any number of records. It may include parentheses, if necessary, although, in general, a left parenthesis in the text must not be used in column 12 (as this implies the opening parenthesis of coded information).

The language of the free text is English, and clear English phrasing should be used; no EXFOR codes are to be used within the free text.[3]

Unlimited free text is permitted with each information identifier.

See also **LEXFOR, Free Text**.

Codes and free text

If both coded information and free text are given under an information-identifier keyword, the free text may appear either on records given before the coded information, on the same record as code (always after the code), or on records following the code, as appropriate.

In general, coded information given with an information-identifier keyword is for the purpose of machine processing and the free text is self-explanatory. That is, coded information is expanded into clear English and amplified as necessary in the free text. However, for some keywords, such an expansion of the codes is not given, on the assumption that such expansion, when needed, will be done by an editing program. For other keywords, an indication may be given that the coded information is not expanded in the free text.

---

[3] Expansions of these codes may be used, at the compiler's discretion, embedded in free text.

An indication that the code is not expanded is given by:

either   a decimal point (full stop) immediately following the closing parenthesis,

or   a completely blank field between the closing parenthesis and column 66.

Example:

```
ERR-ANALYS  Total uncertainties are not given.
            (DATA-ERR) Statistical uncertainty.
```

See Chapter 7 for details on specific information-identifier keywords.

Example of BIB sections

```
1              11                22         33          44          55          66
ENTRY                         00001
SUBENT                     00001001
BIB
AUTHOR         (J.W.Dow,M.P.Jones)    This space may contain any free text.
               The beginning of a new BIB entry is indicated by a non-blank in the keyword field (columns 1-
               10).
INSTITUTE      (3AAABBB)     Since the keyword field is non-blank, this is considered a new BIB entry.
INC-SOURCE     (ABC,WXYZ)    This is an example of a BIB entry with more than one piece of machine-
               retrievable information in one set of parenthesis.  The absence of a pointer in column 11 shows
               that this information refers to all data.
COMMENT        This is an example of a BIB entry without coded information.
              1The pointer in column 11 indicates that this record and the following records, until a new
               pointer is encountered, refer to all data with the same pointer in all following subentries.
ENDBIB
NOCOMMON
ENDSUBENT
SUBENT
BIB
REACTION      1(92-U-235(N,EL),,WID)    This is an example of multiple reactions
              2(92-U-235(N,F),,WID)       with pointers
ANALYSIS      1(CDEFG).     This is an example of a BIB entry with more than one piece of machine-
                            retrievable information, each coded in its own set of parenthesis.  The pointer in
                            column 11 links each part of the BIB entry to other information in this subentry
              2(HIJ).       and in subentry 1 with the same pointer.  The point after the closing parenthesis
                            indicates that the content of the code in parenthesis is not expanded in free text,
                            as would be required if the point were absent.
ENDBIB
...
...
...
ENDSUBENT
ENDENTRY
```

Chapter 4

COMMON AND DATA SECTIONS

The format of the Common Data (COMMON) and Data Table (DATA) sections is identical; however, the significance of the content is different. Each section is a table of data with its associated data headings and units. The common data consists of fields containing constant parameters that apply to each line of a point data table; *i.e.*, there is only one data line in the Common Data section. The Data Table contains fields of information; each field, generally, contains values as a function of one or more independent variables (*e.g.*, angle, angular error, cross section, cross section error), *i.e.*, one or more lines of data. A data field that has a constant value over all rows of the DATA section, *e.g.*, gamma-ray energy, could better be entered as a constant parameter in the COMMON section.

The number of fields in a data line is restricted to 18. Each physical record may contain up to six information fields, each 11 columns wide. If more than six fields are used, the remaining information is contained on the following records. Therefore, a data line consists of up to three physical records.

Records are not packed; rather, individual point information is kept on individual records; *i.e.*, if only four fields are associated with a data line, the remaining two fields are left blank, and, in the case of the data table, the information for the next line begins on the following record. Similarly, if eight fields are used, the remaining four fields on the second record remain blank. These rules also apply to the headings and units associated with each field. (See example on page 4.4).

The <u>content of the COMMON and DATA sections</u> are as follows:

- Data headings for each field (if more than six fields are needed, the headings are continued onto successive records). The data headings are left adjusted to the beginning of each field (columns 1, 12, 23, 34, 45, 56). The list of legal data headings is given in Dictionary 24 (see Part III, Dictionaries).

   A one-character pointer may be placed in the last (eleventh) column of a field heading to link the field with specific BIB records, COMMON fields, and/or DATA fields of the same subentry or subentry 001. See Chapter 5 for more information on pointers.

- Data units for each field (if more than six fields are needed, the units are continued onto successive records). The data units are left adjusted to the beginning of each field (columns 1, 12, 23, 34, 45, 56). The list of legal data units is given in Dictionary 25 (see Part III, Dictionaries).

- Records containing the numerical data (if more than six fields are used, the data is continued onto successive records). The numerical data is FORTRAN-readable using a floating-point format.

  FORTRAN-readable according to a floating-point format means, in detail:
  - A decimal point is always present, even for integers.
  - A decimal number without an exponent can have any position within the 11-character field.
  - No blank is allowed following a sign (+ or -).
  - A plus sign may be omitted, except that of an exponent when there is no E.
  - In an exponential notation, the exponent is right adjusted within the 11-character field. The mantissa may have any position.

  The values are either zero or have absolute values between 1.0000E-38 and 9.999E+38. The following table contains examples of valid entries:

Fixed point numbers with a decimal point	Floating point numbers with an exponent	
0.14	+0.014E+01	1.4-1
0.14	0.0014E+2	1.4E-1
0.14	0.0014E2	1.40 E-01
+0.14	.0014E+2	
-0.14	-0.140E+00	
-.14	-.14E0	

A data set consists of the three sections:
COMMON section of subentry *nnn* ≠ 001,
DATA section of subentry *nnn* ≠ 001,
COMMON section of subentry 001 of same entry.

The following restrictions apply within a data set.

Multiple representations of independent variables. Only one representation of an independent variable may be given for each data set (*e.g.*, either angle or cosine may be given, not both).

Repetition of data headings. No field heading (data heading plus, perhaps, a pointer) may be repeated except for the following cases. Fields with identical data headings will be adjacent and will appear within only one of the three sections mentioned above.

1. Two or more unresolved secondary energies are entered, *e.g.*, as follows:

```
E-LVL           E-LVL           E-LVL
MEV             MEV             MEV
0.077           0.107           0.177
```

Similarly, the data heading EN-RES may be repeated in the case of unresolved resonance energies.

2. An angle given in degrees and minutes and/or seconds is entered in two or three separate fields with the data heading ANG repeated, as follows:

```
ANG             ANG             ANG
ADEG            AMIN            ASEC
90.             47.             10.
```

Other data headings beginning with ANG may be repeated in the same way.

3. Half-life values in different units, such as SEC, DAY, YR, are entered as follows:

```
HL              HL              HL
SEC             D               YR
15.
                28.3
                                4.8
```

Any other data heading starting with HL (*e.g.*, HL1) may be repeated in the same way. This usage cannot occur in a COMMON section.

4. Errors or resolutions given in different units over an energy range are entered as follows:

```
EN-RSL          EN-RSL
KEV             PER-CENT
20.
                10.
```

5. Two or more unresolved masses (for mass yields) are entered as follows:

```
MASS            MASS
NO-DIM          NO-DIM
 135.            136.
```

6. Two or more flags defined under the information-identifier keyword FLAG that apply to the same line of the data table are entered as follows:

```
FLAG            FLAG
NO-DIM          NO-DIM
1.
2.              3.
```

COMMON Section

The COMMON section is identified as that information between the system identifiers COMMON and ENDCOMMON. (See page 2.4 for details on the COMMON and ENDCOMMON records).

In the common data table, only one value is entered for a given field, and successive fields are not integrally associated with one another.

The data heading DATA and its derivatives are not used in the COMMON section, except for those derivatives that contain the suffix -ERR.

An example of a common data table:

1	12	23	34	45	56	66
COMMON						
EN	EN-ERR	E	E-ERR			
MEV	MEV	MEV	MEV			
2.73	0.16	1.38	0.21			
ENDCOMMON						

An example of a common data table with more than 6 fields:

1	12	23	34	45	56	66
COMMON						
EN	EN-ERR	EN-RSL	E-LVL	E-LVL	MONIT	
MONIT-ERR						
MEV	MEV	MEV	MEV	MEV	MB	
MB						
2.73	0.02	0.05	2.73	2.78	3.456	
0.123						
ENDCOMMON						

DATA Section

The DATA section is identified as that information between the system identifiers DATA and ENDDATA. (See page 2.4 for details on the DATA and ENDDATA records.)

In the DATA table, all entries on a record are integrally associated with an individual point. If more than six fields are used, the point data is continued on successive records (maximum of 3 records or 18 fields). The following record or records are then associated with the next point.

Every line in a data table gives data information. This means, for example, that a blank in a field headed DATA is permitted only when another field contains the data information on the same line, *e.g.*, under DATA-MAX. In the same way, each independent variable occurs at least once in each line (*e.g.*, either under data headings E-LVL or E-LVL-MIN, E-LVL-MAX, see example on page 4.6). Supplementary information, such as resolution or standard values, is not given on a line of a data table unless the line includes data information. Blanks are permitted in all fields.

An example of a point data table is shown below with its associated DATA and ENDDATA records.

1	12	23	34	45	56	66
DATA						
ANG	ANG-ERR	DATA	DATA-ERR	DATA-MAX		
ADEG	ADEG	MB/SR	MB/SR	MB/SR		
10.7	1.8	138.	8.5			
22.9	1.2	127.	4.2			
39.1	0.9			83.2		
46.7	0.7	14.8	2.9			
ENDDATA						

Field Sequence in a DATA Table

There are four categories of data occurring in data tables, namely

- independent variables (EN, EN-MIN, EN-RES, E, ANG, *etc.*);
- dependent variables (DATA);
- associated quantities (EN-ERR, ANG-RSL, DATA-ERR, *etc.*);
- additional information (MONIT, MISC, FLAG, HL, *etc.*).

The division between different categories and families within categories is defined in EXFOR Dictionary 24 (Data Headings)[1] (see Part III, Dictionaries).

DATA tables are arranged as follows:

- All fields with **independent variables** precede fields with **dependent variables**. Fields to the left of the first dependent-variable field are considered as independent-variable fields, or independent-variable associated quantities.

- Fields with **additional information** are, preferably, placed after the last dependent-variable field, but, if they refer to a specific field, they may be placed next to it.

- Fields with **associated quantities** are placed right after the field to which they refer.

The EXFOR table will then look as follows.

```
DATA
   independent variable(s)     dependent variable(s)          additional information
      + associated quantities     + associated quantities
ENDDATA
```

Line sequence of a DATA Table

Values of the independent variable increase or decrease monotonically throughout the table. If fields for more than one independent variable are given, they are arranged so that the rate with which the values change within each field increases from left to right. Values in a given independent-variable field increase or decrease monotonically until the value in the preceding independent-variable field changes or the end of the table is reached.

---

[1] Note that some data headings may be used either as independent variables or as additional information.

Example:

```
DATA
EN          EN-ERR      ANGLE       ANGLE-ERR   DATA
MEV         MEV         ADEG        ADEG        MB/SR
1.          .02         35.         10.         …
1.          .02         60.         10.         …
1.          .02         90.         10.         …
2.          .02         30.          5.         …
2.          .02         60.          5.         …
2.          .02         90.          5.         …
3.          .03         30.          5.         …
3.          .03         60.          5.         …
3.          .03         90.          5.         …
ENDDATA
```

Alternatively, this table may be given in the vector common data formalism using pointers; see page 5.2.

A slight complication arises with families of independent variables referring to basically the same quantity, as, for instance, the fields referring to excitation energies of the residual nucleus in the following example. In this case, the monotone rule applies to the sequence of numbers consisting of the first (left-most) non-blank value within the group on each line.

Example:

```
DATA
EN          E-LVL       E-LVL       E-LVL-MIN   E-LVL-MAX   DATA
MEV         MEV         MEV         MEV         MEV         B
3.0         0.506
3.0         0.81                                            …
3.0         0.990       0.998                               …
3.0                                 1.250       1.300       …
3.0         1.400                                           …
4.5         0.405                                           …
ENDDATA
```

Chapter 5

POINTERS

Different pieces of EXFOR information may be linked together by pointers. A pointer is a numeric or alphabetic character (1,2...9,A,B,...Z) placed in the eleventh column of the information-identifier keyword field in the BIB section and in the field headings in the COMMON or DATA section.

Pointers may link, for example,

- one of several reactions with its data field;

- one of several reactions 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 field in the DATA section;

- a value in the COMMON section with any field in the DATA section.

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

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

See also **LEXFOR, Pointers**

The use of pointers is restricted to the five cases given on the following pages.

1. Multiple Reaction Formalism[1]

In certain cases (see page 6.7 and **LEXFOR, Multiple Reaction Formalism**) more than one code unit may be given under the REACTION keyword for a subentry, each unit having its own data field(s). Each data field is then linked to the appropriate code string by means of a pointer.

Example:

```
BIB
REACTION  1 (92-U-235(N,0),,EN)
          2 (92-U-235(N,0),,J)
          3 (92-U-235(N,TOT),,WID)
...
ENDBIB
COMMON
MOMENTUM L  DATA-ERR   1
NO-DIM      EV
 ...         ...
ENDCOMMON
DATA
DATA        1 DATA      2 DATA       3 DATA-ERR
EV            NO-DIM      MILLI-EV     MILLI-EV
...           ...         ...          ...
...           ...         ...          ...
ENDDATA
```

In the example above, the field headed MOMENTUM L in the COMMON section does not have a pointer and, therefore, relates to all fields of the DATA section. The field in the COMMON section headed DATA-ERR is linked, by means of a pointer, to fields of the DATA section and to a specific REACTION code in the BIB Section with the pointer 1. Each field in the DATA section is linked to the REACTION code in the BIB Section with the same pointer.

2. Vector Common Data

Multi-dimensional tables may be coded using pointers. (See page 4.6 for alternate coding of multi-dimensional tables).

The following rules apply to the use of vector common data:

- If a pointer links a set of independent-variable data headings, (*e.g.*, EN, ANG, E-LVL), one of which appears in the COMMON section, all other pointers will also link with the same set of independent-variable data headings, *i.e.*; the following is forbidden:

      E   1 E   1 E-MIN   2 E-MAX   2

- Units referring to a given independent variable will be the same for all pointers.

- For a given independent variable, the number of data headings repeated for each pointer will be the same.

- The *vector common formalism may not be combined with the multiple reaction formalism*.

---

[1] The multiple reaction formalism is used only for the specific cases listed in **LEXFOR, Multiple Reaction Formalism**.

Example:

```
COMMON
ANG          1 ANG          2 ANG          3
ADEG           ADEG           ADEG
...            ...            ...            ...
ENDCOMMON
DATA
EN             DATA         1 DATA-ERR   1 DATA         2 DATA-ERR   2 DATA         3
DATA-ERR     3
MEV            MB/SR          MB/SR          MB/SR          MB/SR          MB/SR
MB/SR
...            ...            ...            ...            ...
...
ENDDATA
```

3. BIB/DATA Links

Pointers used for multiple reactions or for vector common data may be also be used elsewhere in the BIB section in order to link certain information to one of the multiple reactions or vector common fields.

Example:

```
BIB
...
COMMENT      1
ENDBIB
COMMON
ANG          1 ANG          2 ANG          3
ADEG           ADEG           ADEG
...            ...            ...
ENDCOMMON
DATA
EN             DATA         1 DATA         2 DATA         3
MEV            MB/SR          MB/SR          MB/SR
...            ...            ...            ...            ...
...
ENDDATA
```

or

```
BIB
REACTION     1 (...)
             2 (...)
PART-DET     1 (...)
             2 (...)
ENDBIB
```

Forbidden:

```
BIB
REACTION       (...)
PART-DET     1 (...)
             2 (...)
ENDBIB
COMMON
MONIT        1 MONIT        2
...
```

4. BIB/BIB Links

Pointers may be used to link pieces of BIB information, all referring to the same reaction.
If the multiple-reaction or vector-common formalism is used, BIB/BIB links are used only to link to existing pointers, as in BIB/DATA Links.

Example:

```
BIB
REACTION      (…)
PART-DET    1 (…)
            2 (…)
DETECTOR    1 (…)
            2 (…)
ENDBIB
```

5. Alternative results

Different results for the same quantity in the same experiment, *e.g.*, by two different methods of analysis, may be entered in the same subentry, distinguished by the pointers. In this case, the code unit under the REACTION keyword is repeated.[2]   (See also **LEXFOR, Interdependent Data**).

Example:

```
BIB
REACTION    1 (…)
            2 (…)
ANALYSIS    1 (…)
            2 (…)
ENDBIB
```

---

[2] From a processing point of view, this is the same concept as multiple reactions (described on page 6.7)

Chapter 6

REACTION SPECIFICATION

The reaction and quantity for the data coded in the data table is specified using the information-identifier keyword REACTION, therefore, this keyword must always be present in a data set. Because of its importance, the use of this keyword will be given in detail in this chapter, along with information on its links to the data.

A REACTION unit consists of three major fields:

>   (reaction, quantity, data-type)

More than one reaction unit may be given as a ***Reaction Combination*** or in the ***Multiple-Reaction Formalism***.

Detailed coding rules are given on the following pages.

Coding of nuclides and compounds

Nuclides appear in the coding of many keywords. The general code format is *Z-S-A-X*, where:

- *Z* is the charge number; up to 3 digits, no leading zeros
- *S* is the element symbol; 1 or 2 characters (Dictionary 8)
- *A* is the mass number; up to 3 digits, no leading zeroes. A single zero denotes natural isotopic composition (limited to special cases as given under the specific keyword).
- *X* is an isomer code denoting the isomeric state (this subfield may be omitted)

  X may have the following values (see also **LEXFOR, Isomeric States**):
  - G   for ground state (of a nucleus which has a metastable state)
  - M   if only one metastable state is regarded
  - M1 for the first metastable state
  - M2 for the second, *etc.*
  - T   for sum of all isomers (limited to use within an isomeric ratio in SF4 of the reaction string)
  - L   if only one quasi-metastable state is regarded
  - L1   for the first quasi-metastable state, *etc*.

Exceptions to this coding are noted on the pages for each keyword. (See also **LEXFOR, Elements**). Valid nuclide codes are given in Dictionary 227 (see Part III, Dictionaries).

Compounds may in some cases replace the nuclide code. The general format for coding compounds is either the specific compound code, taken from Dictionary 209, the general form for an oxide *Z-S*-OXI, or the general code for a compound of the form *Z-S*-CMP. (See also **LEXFOR, Compounds**).

> ***Example***: 26-FE-CMP

Reaction field

The reaction field consists of four subfields, separated by commas or parentheses (not interchangeable):

> (SF1(SF2,SF3)SF4,quantity,data type)

SF1. Target nucleus. Contains one of the following:

a) *Z-S-A-X*, as described above, but with the following exceptions:
   - *A* = 0 denotes natural isotopic mixture,
   - *X* may not have the value G.
b) *Z-S*-CMP, see above.
c) the code ELEM/MASS when the target nucleus is entered into the data table using the heading codes ELEMENT, MASS, (ISOMER) (Variable Nucleus Formalism). Use of this formalism is restricted to the cases specified on page 6.8. See **LEXFOR, Target Nucleus** for details.

> ***Example***: (ELEM/MASS(0,B-),,PN)

SF2. Incident projectile. Contains one of the following:

a) a particle code from Dictionary 33 with an allowed SF flag 2 of 1.

b) for particles heavier than an α, a code in the form *Z-S-A* (isomer field omitted), as described above.

See also **LEXFOR, Incident Projectile.**

SF3. Process. Contains one of the following:

a) a process code from Dictionary 30, *e.g.*, TOT.

b) a particle code from Dictionary 33 with an allowed SF flag 3 of 2, which may be preceded by a multiplicity factor with a value of 2→99.[1]

> ***Examples***:   A
>   4A

c) for particles heavier than α, a code in the form *Z-S-A-X* (see page 6.2, but the mass number may not have the value zero). No multiplicity factor is allowed; instead the nuclide code is repeated, if necessary.

> ***Examples***:   8-O-16
>   8-O-16+8-O-16

d) combinations of a), b) and c), with the codes connected by '+'. Outgoing particles are ordered starting with the *lightest*[2] at the left of the subfield, followed by the *Z-S-A-X* formatted codes, in *Z, A* order, followed by process codes given in the same order as given in Dictionary 30.

> An exception to this order is when SF5 contains the code SEQ, which indicates that the particles and/or processes are ordered in the sequence in which the reaction proceeds (see **LEXFOR, Particles**).

> ***Examples***:   HE3+8-O-16
>   X+N

Notes on SF3

1) Gammas are coded only:
    * for a capture process, *e.g.*, (P,G).
    * when they are needed to define the partial reaction considered, *e.g.*, (N,G+F),SEQ.
    In all other cases, gammas are considered as self-evident and are, therefore, not coded, *e.g.*, (P,N) is coded, not (P,G+N). Compare SF7, Particle Considered, page 6.5.

2) If SF5 contains the branch code (DEF)[3] (it is not evident from the publication whether the reaction channel is undefined or defined), the particle codes given in SF3 may represent only the sum of emitted nucleons, implying that the product nucleus coded in SF4 has been formed via different reaction channels. For details see in **LEXFOR, Particles**.

3) For coding of SF3 in the case of scattering see **LEXFOR, Scattering**.

---

[1] In the few cases where the multiplicity factor may exceed 99, the ***Variable Number of Emitted Nucleons Formalism*** may be used, see page 6.9.
[2] Lowest Z, then lowest A.
[3] The code (DEF) is presently used only for charged particle reaction data.

SF4. <u>Reaction Product</u>. In general, the heaviest of the products is defined as the reaction product (also called residual nucleus). In the case of two reaction products with equal mass, the one with the larger *Z* is considered as the *heavier* product. Exceptions or special cases are:

a) If SF5 contains the code SEQ, indicating that the sequence of several outgoing particles and/or processes coded in SF3 is meaningful, the nuclide to be coded in SF4 is the heaviest of the final products.

> ***Example***: `5-B-10(N,A+T)2-HE-4,SEQ,SIG`

b) There is no reaction product if a nuclear quantity is given (*i.e.*, SF2 contains the code 0).
c) There is no reaction product given if the reaction specifies a resonance parameter (defined in Dictionary 236 by using the resonance flag '.').
d) For certain reactions that are implicit sums, the reaction product is not defined if no specific reaction product is considered. This may occur:

- for fission processes; SF3 contains the process code F.
- for total, absorption, or nonelastic processes; SF3 contains the process codes TOT, ABS, or NON
- if SF3 contains a combination of the process code X with a particle code, *e.g.*, (P,G+X),SEQ.
- if the reaction is measured for a target of natural isotopic composition.

e) Where emission cross sections, production cross sections, product yields, *etc*., are given for specified nuclides, particles, or gammas, the product considered is defined as the reaction product (even if it is not the heaviest of several reaction products).

- SF3 contains the process code X.

<u>Coding</u>: This subfield:

a.) either is blank, as in cases b, c, and d, above; the following comma is always present.

> ***Examples:*** `(26-FE-56(N,EL),,WID)`
> `(92-U-235(N,F),,SIG)`
> `(40-ZR-0(N,G),,SIG)`

b.) or   contains a code in the form *Z-S-A-X*, as described on page 6.2.

If light particles or gammas are defined as the reaction product, these are coded using the *Z-S-A* formalism (*i.e.*, the particle codes N, G, P, *etc*., are not used in SF4).

> ***Example***: `(28-NI-0(N,X)0-G-0,,SIG)` γ production cross section

For scattering on a target nucleus which is a natural isotopic mixture (A=0) (see **LEXFOR, Scattering**), A=0 is given for the product nucleus; otherwise, A=0 is not used in SF4.

In the case of isomeric ratios and sums, the isomer code may consist of a combination of codes separated by a slash or a plus sign.[4] The use of these separators is algebraic, *e.g.*, M1+M2/G. The code T is used in an isomeric ratio to denote the sum over all isomers (see page 6.2). (See **LEXFOR, Isomeric States**).

---

[4] The code RAT is always given in SF6 when the arithmetical / appears in the isomer extension in SF4.

Examples: `(92-U-235(N,F)54-XE-124,CUM,FY)`
                  `(51-SB-123(N,G)51-SB-124-M1+M2/T,,SIG/RAT)`

c.) or, if the reaction product is entered into the data table using the data headings ELEMENT, MASS, and/or ISOMER (see page 6.8, Variable Nucleus), it contains one of the following codes:

>   ELEM   if only the data heading ELEMENT is used in the data table,
>
>   MASS   if only the data heading MASS is used in the data table,
>
>   ELEM/MASS   if the data headings ELEMENT and MASS are used in the data table.

Example: `(92-U-235(N,F)ELEM/MASS,CUM,FY)`

Use of this formalism is restricted to those cases given on page 6.8.

d.) or, if the number of particles emitted is entered into the data table using the data heading PART-OUT, it contains the code NPART.

Example: `(79-AU-197(92-U-238,X)NPART,NUM,SIG,HF)` Cross section for a given number on heavy fragments emitted; the number of fragments is given in the DATA or COMMON section under the heading PART-OUT.

Quantity Field

The quantity field consists of four subfields, each separated by a comma. If a subfield is omitted, the separating comma is included, except that trailing commas are omitted.

>   (reaction,SF5,SF6,SF7,SF8,data-type)

Any subfield may contain a combination of codes from the same dictionary, separated by a slash. All combinations of codes allowed in the quantity field are given in Dictionary 236 (see Part III, Dictionaries).

SF5 Branch. Indicates a partial reaction, for example, only one of several energy levels or particle groups has been considered. Code(s) are taken from Dictionary 31.

SF6 Parameter. Contains information about the reaction parameter given, such as, integral or differential cross section. **This subfield must always be present.** Code(s) are taken from Dictionary 32.

SF7 Particle Considered. Provides particle or nuclide code(s) indicating to which of several outgoing particles or nuclides the quantity refers.[5] When more than one particle/nuclide is entered, *e.g.*, for a quantity describing the correlation between outgoing particles, all codes are entered, separated by a slash. For the case where a variable is given for a correlated pair, *e.g.*, the center-of-mass energy of two or more emitted particles, the codes are separated by a plus sign (+). Contains either a code from Dictionary 33 with an allowed SF flag 4 of 7 (see **LEXFOR, Particles**), or, for particles heavier than α, a code in the form *Z-S-A-X* (see page 6.2, but the mass number may not have the value zero).

Examples of SF7 entry:

>   `(....(...,P)4-BE-9,,DA,4-BE-9)`   angular distribution on [9]Be product.

---

[5] Note that the particle considered is not necessarily identical to the particle detected, *e.g.*, the angular distribution of an outgoing particle that has been deduced from a recoil particle detected.

```
(…..(…,N+P)…..,DA/DA/DE,N/P/N+P)
```
triple differential cross section as a function of the angle of the emitted neutron and proton and the center-of-mass energy of the emitted neutron-proton pair.

The particle considered should be omitted if there is no ambiguity. For integral data this subfield is in most cases not used.

SF8 Modifier. Contains information on the representation of the data, for example, relative data, fitting coefficients. Code(s) are taken from Dictionary 34. General quantity modifiers, as noted in Dictionary 34, should trail other modifiers.

Data Type Field
The data type field consists of one subfield.

(reaction,quantity,SF9)

SF9 Data type. Indicates whether the data are experimental, theoretical, evaluated, *etc*. If two or more data types are given, they are each separated by a slash. Code(s) are taken from Dictionary 35. (See **LEXFOR, Data Type**).

If this field is omitted, the data are experimental.

Reaction Combinations
In order to deal with experimental data sets referring to complex combinations of materials and reactions, the code units defined in this section can be connected into a single machine-retrievable field, with appropriate separators and properly balanced parentheses. In all cases of combined units, parentheses are used in exactly the same manner as in FORTRAN to define algebraic operations. The complete reaction combination must be enclosed in parentheses.

The permitted separators are:

+	`((------)+(-----))`	Sum of 2 or more quantities (see **LEXFOR, Sums**).
-	`((------)-(-----))`	Difference between 2 or more quantities.
*	`((------)*(-----))`	Product of 2 or more quantities (see **LEXFOR, Products**).
/	`((------)/(-----))`	Ratio of 2 or more quantities (see **LEXFOR, Ratios**).
//	`((------)//(-----))`	Ratio of 2 quantities, where the numerator and denominator refer to different values for one or more independent variables (see Reaction Ratios, page 6.7, and **LEXFOR, Ratios**).
=	`((------)=(-----))`	Tautologies (see **LEXFOR, Tautologies** for usage).
,	`((------),(-----))`	Obsolete, but may be found in older neutron entries. Used for multiple representations of the same quantity, which are now coded using pointers.

If a code string is continued onto the next record, a code unit must not be broken, *i.e.*, the separator appears last on the record, with the first parenthesis of the next code unit beginning in column 12 of the next record. Thus blanks may follow a separator if the reaction combination is continued on the next record.

Examples: ```((92-U-235(N,F),,SIG)/(79-AU-197(N,G)79-AU-198,,SIG))```
```(((28-NI-58(N,N+P)27-CO-57,,SIG)+(28-NI-58(N,D)27-CO-57,,SIG))/```
```(13-AL-27(N,A)11-NA-24,,SIG))```

Note that the reaction combination formalism is not used for certain frequently occurring sums, ratios, and products for which specific quantity codes have been introduced (see **LEXFOR, Ratios, Sums, Products**).

Reaction Ratios

If a reaction combination contains the separator "//", signifying that the numerator and denominator of a ratio have different values for one or more independent variables, then the data table will contain at least one independent variable pair with the data heading extensions -NM and -DN (see Dictionary 24).

Example:

```
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-DUM-NM   EN-DUM-DN
MEV         EV
 1.0         0.0253
ENDCOMMON
DATA
ELEMENT     MASS        DATA
NO-DIM      NO-DIM      NO-DIM
…
ENDDATA
```

Multiple Reaction Formalism.

If pointers are used with the REACTION keyword, the code fields associated with each pointer may be a reaction unit or a reaction combination[6]. The use of this formalism is restricted to specific classes of data that are subject to the following constraints (see page 5.2 for coding example).

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.

For the specific classes of data that may be coded using the multiple reaction formalism, see **LEXFOR, Multiple Reaction Formalism**.

---

[6] See page 5.1 for general information on pointers.

Variable Nucleus

In the case of the processes specified below, the data table may contain yields or production cross sections for several nuclei that are entered as variables in the data table. In this case, either SF1 or SF4 of the REACTION keyword contain one of the following codes:

ELEM - if the Z (charge number) of the nuclide is given in the data table.
MASS - if the A (mass number) of the nuclide is given in the data table.
ELEM/MASS - if the Z and A of the nuclide are given in the data table.

The nuclei are entered in the common data or data table as variables under the data headings ELEMENT and/or MASS with the units NO-DIM.

If the data headings ELEMENT and MASS are used, a third field with the data heading ISOMER is used when isomer states are specified:

0. = ground state (used only if nuclide has also an isomeric state),
1. = first metastable state (or the metastable state when only one is known),
2. = second metastable state, *etc*.

Decay data for each entry under ELEMENT/MASS(ISOMER) and their related parent or daughter nuclides may be given in the usual way under the information-identifier keyword DECAY-DATA. Entries under the data headings ELEMENT/MASS(ISOMER) are linked to entries under DECAY-DATA (and RAD-DET, if present) by means of a decay flag (see page 7.6 and **LEXFOR, Flags**).[7]

Example:

```
BIB
REACTION       (…(…,F)ELEM/MASS,…)
ENDBIB
NOCOMMON
DATA
EN             ELEMENT      MASS         ISOMER       DATA
MEV            NO-DIM       NO-DIM       NO-DIM       B
   …            61.          148.         0.           …
   …            61.          148.         1.           …
   …            61.          149.                      …
   …            62.          149.                      …
```

Restrictions of use. Only SF1 or SF4 may become variable by using this formalism.
The variable nucleus formalism may be used:

* for SF1, only when SF6 contains the code PN (delayed-neutron emission probability)
* for SF4, only when SF3 contains one of the process codes
    X - production of the product nuclei specified
    F - fission

See also **LEXFOR, Reaction Products**.

---

[7] If the half-life is the only decay data given, this may be entered in the data table under the data heading HL, *although this is not recommended*.

Variable Number of Emitted Particles

If the data table contains yields or production cross sections as a function of the number of secondary particles, and the number of particles is entered as a variable in the data table, SF4 of the REACTION keyword contains the code NPART and SF5 contains the code NUM:

See also **LEXFOR, Particles**.

Example:

```
BIB
REACTION        (…(…,X)NPART,NUM,…)
…
ENDBIB
NOCOMMON
DATA
EN              PART-OUT    DATA
MEV             NO-DIM      B
…
…
…
ENDDATA
```

Links between reaction quantity and data headings

The quantity given under the REACTION code string requires the presence, or absence, of certain families of independent variables. The family code for a given data heading is given in Dictionary 24 (see Part III, Nuclear Reaction Data Dictionaries).

The following shorthand is used throughout this section.
- particle is used to mean particle, nuclide or radiation.
- data headings as given are understood to include their derivatives (*e.g.*, for DATA, the headings DATA-CM, DATA-APRX, *etc.*, are also included).

The keyword REACTION defines the data coded in the DATA section under the dependent variable data heading DATA. The independent variables required for each quantity are given, below, according to family code[8].

1. **Incident Projectile Energy (Family A) or Incident Projectile Momentum (Family M)**
   is always present except in the following cases when it is forbidden:
   - if SF2 of REACTION contains 0 (zero);
   - if resonance energy is given (see below).
   KT, EN-DUMMY, or EN-MEAN is used when the quantity field contains a spectrum modifier MXW, SPA, FST, FIS, *etc*.

   See also page 7.13, (INC-SPECT), and **LEXFOR, Incident-Projectile Energy and Spectrum Average**.

---

[8] See Dictionary 24 for family codes.

Resonance Energy (Family C) is specified for resonance parameters[9]. It is coded either under the data heading EN-RES, or, if coded under REACTION (specified by the code EN given in REACTION SF6), under the heading DATA.

2. **Secondary Energy (Family E)** is coded when:
   - REACTION SF5 contains the modifier code PAR, or
   - REACTION SF6 contains the code DE or SPC.

   For specifying the secondary energies of more than one particle, see page 7.9 (EN-SEC), and **LEXFOR, Secondary Particles**.

3. **Angle of Outgoing Particle (Family G)** is coded when REACTION SF6 contains the code DA, except in the case of Legendre or cosine coefficients see below. (For angles in degrees and minutes see page 4.3)

   If more than one angle is specified, *e.g.*, double-differential data, DA/DA,N/P, the angles must be given under ANG1, ANG2, *etc.*, in the same order as the particles are specified in REACTION SF7. See also **LEXFOR, Angle.**

4. **Fitting Coefficient Number (Family N)** is coded when REACTION SF8 contains a code denoting a fitting coefficient, *e.g.*, LEG or COS. See also **LEXFOR, Fitting Coefficients**.

5. **Half life (Family 6)** is coded if SF4 of the REACTION code contains a product with a metastable state extension (see page 6.2), and the half-life is not coded under DECAY-DATA. See also **LEXFOR, Half-Lives**.

6. **Angular Momentum (*l*) (Family 2)** will be coded when:
   - REACTION SF6 contains the code RED.
   - REACTION SF6 contains the code STF.

   It is coded either under the data heading MOMENTUM L, or, if coded under REACTION (specified by the code L in REACTION SF6), under the heading DATA. See also **LEXFOR, Quantum Numbers.**

7. **Secondary Linear Momentum (Family L)** will be coded when REACTION SF6 contains the code MCO.

8. **Secondary Effective Mass (Family S)** will be coded when REACTION SF6 contains the code EMC.

9. **Element (Family I)** will be coded when REACTION SF1 or SF4 contains the code ELEM (see page6.8).

10. **Mass (Family J)** will be coded when REACTION SF1 or SF4 contains the code MASS (see page 6.8).

12. **Number of Particles (Family K)** will be coded when REACTION SF4 contains the code NPART (see page 6.9).

---

[9] Resonance parameters are indicated using a resonance flag of '.' (period) in Dictionary 36, see Part III, Nuclear Reaction Data Dictionaries).

Cross References of Data Heading to Family Codes

Data heading	Family code[10]	Family
EN	A	Incident energy
EN-RES	C	Resonance energy
E, E-LVL, *etc.*	E	Secondary energy
EMS	S	Secondary effective mass
MOM-SEC	L	Secondary linear momentum
ANG	G	Angle of outgoing particle
ELEMENT	I	Element
MASS	J	Mass
PART-OUT	K	Number of particles
MOM	M	Incident beam linear momentum
NUMBER	N	Coefficient number
HL	6	Half life
MOMENTUM L	2	Angular momentum of resonance

---

[10] As given by the family flag in Dictionary 24.

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Chapter 7

INFORMATION-IDENTIFIER KEYWORDS AND CODING RULES

This section gives detailed rules for the use of the information-identifier keywords and the structure of the codes associated with them. It does not, in general, give any information about specific codes from any dictionary, nor does it go into details of the physics content or additional free text explanations that may be required. For such information, the user should refer to LEXFOR.

The keywords are ordered alphabetically.

The information given under each keyword includes use, plus the following;

1. Requirements
2. Code format
3. Format for 2 or more codes or code strings
4. Additional information

See also Chapter 3 for a discussion of codes and free text.

Information identifier categories

Detailed coding rules for each information identifier are given on the following pages. The keywords can be grouped in certain categories, which are shown in the table on the following page.

The second and third columns of the table show that some of the keywords are:

- obligatory: these must be present in either subentry 001 or in all other subentries.

- obligatory, except when not relevant: these must usually be present, however, occasionally they are not relevant and may be absent; see the detailed coding rules.

- obligatory for specific data headings: these must be present when certain data headings are present in the COMMON or DATA section (see the detailed coding rules), otherwise, they are optional.

All other keywords are optional.

Keyword	Presence of keyword is obligatory	Obligatory with data heading
Bibliography		
TITLE	except when not relevent	
AUTHOR	always	
INSTITUTE	always	
EXP-YEAR		
REFERENCE	Always	
REL-REF		
MONIT-REF		
Data specification		
REACTION	always	
RESULT	when a code exists	
Related data		
MONITOR	except when not relevant	MONIT, *etc.*
ASSUMED		ASSUM, *etc.*
DECAY-DATA		DECAY-FLAG
DECAY-MON		
PART-DET		
RAD-DET		
HALF-LIFE		HL1, *etc.*
EN-SEC		E1, *etc.*
EMS-SEC		EMS1, *etc.*
LEVEL-PROP		LVL-FLAG
MOM-SEC		M1, *etc.*
MISC-COL		MISC, *etc.*
Physics		
INC-SOURCE		
INC-SPECT		EN-DUMMY, *etc.*
SAMPLE		
METHOD	↑	
FACILITY	one of these is obligatory	
ANALYSIS	│	
DETECTOR	↓	
.CORRECTION		
COVARIANCE	except when not relevant	
ERR-ANALYS		ERR-*, *-ERR
Other		
ADD-RES		
COMMENT		
CRITIQUE		
FLAG		FLAG
Bookkeeping		
STATUS	except when not relevant	
HISTORY	always	

ADD-RES. Gives information about any additional results obtained in the experiment, but which are not compiled in the data tables.

1. Presence is optional. May contain free text or coded information and free text.

2. If coded information is given, it may be in either of the general forms with code(s) from Dictionary 20.

ANALYSIS. Gives information as to how the experimental results have been analyzed to obtain the values given under the heading DATA, which actually represent the results of the analysis. See also **LEXFOR, Analysis**.

1. At least one of the keywords METHOD, FACILITY, DETECTOR, or ANALYSIS must be present with coded information. If an existing code applies, it should be given, otherwise coded information is optional.

2. Coded information, if given, may be in either of the general forms with code(s) from Dictionary 23.

ASSUMED Gives information about values assumed in the analysis of the data, and about COMMON or DATA fields containing assumed values. See also **LEXFOR, Assumed values**.

1. Presence is obligatory when assumed values are given in the data under the heading ASSUM or its derivatives and coded information is required, with or without free text. Otherwise, free text information may be given..

2. The format of the code is: (heading,reaction,quantity)

    Heading field: data heading to be defined.

    Reaction field and quantity field: coded as under the keyword REACTION (see Chapter 6).

3. In the case of more than one assumed data heading (ASSUM1, ASSUM2, *etc.*) to be defined, each must be coded on a separate record, starting in column 12.

    Example:
    ```
    ASSUMED    (ASSUM1,AAAAA)
               (ASSUM2,BBBBB)
    …
    DATA
    EN         DATA       ASSUM1     ASSUM2
    …
    ```

AUTHOR. Gives the authors of the work reported. See also **LEXFOR, Author**.

1. Presence is obligatory. Must have coded information.

2. Authors' names are entered in the normal way of writing a name, *i.e.*, A.B.Name, each name separated by a comma. Hyphenated family names, 2-character initials (as in the transliteration of some Cyrillic characters), and any other deviations from the normal name structure are permitted. For a family name modified by 'Junior', JR is entered following the family name and separated from it by a blank.

   All names are entered between one set of parenthesis. Blanks are permitted between authors' names (*i.e.*, after a comma), but are not permitted following initials. (For transliteration of authors' names given in Cyrillic characters, see **LEXFOR, Author**).

   Authors' names may be continued on the next record, but names should not be broken, *i.e.*, the last character on the line to be continued should be a comma.

   Examples:

   ```
   AUTHOR    (A.B.Jones, L.Poza-Lobo, JA.M.Ivanov,Ngo-Dinh-Long,
             A.Morales Amado)
   AUTHOR    (R.W.McNally Jr)
   ```

COMMENT. Gives pertinent information that cannot logically be entered under any other of the keywords available. See also **LEXFOR, Comment**.

1. Presence is optional. Contains only free text.

CORRECTION. Gives information about corrections applied to the data in order to obtain the values given under DATA. See also **LEXFOR, Correction**.

1. Presence is optional. Contains only free text.

COVARIANCE. Gives covariance information provided by the experimentalist, or to flag the existence of a covariance data file. See also **LEXFOR, Covariance**.

1. Presence is optional. Contains either free text only or the code COVAR, which indicates the existence of a covariance file, followed by free text.

2. See Appendix B for the Covariance Data File format.

CRITIQUE. Gives comments on the quality of the data presented in the data table. See also **LEXFOR, Comments**.

Presence is optional. Contains only free text.

DECAY-DATA. Gives the decay data for any nuclide occurring in the reaction measured as assumed or measured by the author for obtaining the data given[1]. See also **LEXFOR, Decay Data**.

1. If the keyword RAD-DET is used, an entry should also be made for DECAY-DATA. Also, if decay flags appear in the data section, they must be linked to an entry under DECAY-DATA, see below. Otherwise, its presence is optional, and free text or coded information, with or without free text, may be given.

    If the keyword DECAY-DATA is present, the keyword HALF-LIFE may not be used. See also **LEXFOR, Half-Lives**.

2. The general format of the coding string consists of three major fields which may be preceded by a decay flag:

    $$((flag)nuclide,half\text{-}life,radiation).$$

    Embedded blanks are permitted in the code only at the beginning of a field or subfield. A code string may be broken for continuation onto the next record, but the break must come at the end of a field or subfield, *i.e.*, the comma separating the subfields should be the last character on the line.

    <u>Flag</u>. The general format of the code is (*n*.), where *n* has a numerical value that also appears in the data section under the data heading DECAY-FLAG. The flag may be omitted, in which case its parentheses are also omitted. See also **LEXFOR, Flags**.

    <u>Nuclide field</u>. The general format of the code is *Z-S-A-X*, except that when the ground state of a nuclide is given, the use of the extension G is optional, see page 6.2.

    <u>Half-life field</u>. Contains the actual half-life of the nuclide specified, coded as a number, readable in an E11.4 format (see page 4.2, no blanks are allowed), followed by a unit which consists of a code from Dictionary 25 with the dimension TIME; no embedded blanks are allowed.

    This field may be omitted, in which case the following comma must be included, unless the radiation field is also omitted, in which case the closing parenthesis immediately follows the nuclide.

    Examples: `2.45MIN`
    `3.6E+03YR`

    <u>Radiation field</u>. Consists of three subfields. This field may be omitted, in which case the closing parenthesis immediately follows the half-life. This field may also be repeated, each radiation field being separated by a comma. The absence of any subfield must be indicated by including the separating comma; trailing commas are not included.

    <u>SF1. Type-of-radiation</u>. A code from Dictionary 33 with a D in the 1st position of the allowed subfields flags.

    Where two or more different decay modes are possible and are not distinguished in the measurement, two or more codes may be given; each separated by a slash (see Example b, following).

---

[1] Decay data relevant to the monitor reaction are coded under the keyword DECAY-MON, not under DECAY-DATA.

SF2. Energy. The energy of the radiation in keV, coded as a floating-point number (see page 4.2, no blanks permitted); no units are given in the code.

In the case of two or more unresolved decays, two or more energies, or a lower and upper energy limit, are given, each separated by a slash. (See Example f and **LEXFOR, Decay Data**.)

SF3. Abundance. The abundance of the observed radiation per decay, coded as a floating-point number (see page 4.2, no blanks permitted).

3. If decay data is given in coded form for more than one nuclide, each is coded on a separate record, starting in column 12.

Examples of coding for DECAY-DATA

a) `DECAY-DATA  (40-ZR-89-M)` (half-life and radiation omitted) in this case, information on the decay data for the nucleus specified is given in free text)

b) `DECAY-DATA  (60-ND-140,3.3D)`   (radiation field omitted)
   `(59-PR-140,,B+/EC,,0.500)`   (half-life and radiation SF2 omitted)

c) `DECAY-DATA  (25-MN-50-G,0.286SEC,B+,6610.)`   (radiation SF3 omitted)

d) `DECAY-DATA  (25-MN-50-M,1.76MIN,DG,785.,,B+)` (two radiation fields, the 2nd with SF2 and SF3 omitted)

e) `DECAY-DATA  ((1.)60-ND-138,5.04HR,DG,328.,0.065)` (decay flag, all fields and subfields present)

f) `DECAY-DATA  (60-ND-139-M,5.5HR,DG,708./738.,0.64)` (the abundance given is the total abundance of both γ rays)

g) `DECAY-DATA  (60-ND-139-G,30.0MIN,B+,,0.257,DG,405.,0.055)` (two radiation fields)
   `(60-ND-139-M,5.5HR,DG,738.,0.37,DG,982.,0.29,` (five radiation
   `DG,708.,0.27,DG,403.,0.03,B+,,0.006)`   fields extending over 2 records)

This last example could be entered in the following way for improved readability:

```
DECAY-DATA  (60-ND-139-G,30.0MIN,B+,,0.257,
                         DG,405.,0.055)
            (60-ND-139-M,5.5HR, DG,738.,0.37,
                         DG,982.,0.29,
                         DG,708.,0.27,
                         DG,403.,0.03,
                         B+,,0.006)
```

DECAY-MON. Gives the decay data assumed by the author for any nuclide occurring in the monitor reaction used.

1. Presence is optional; may only be used if the keyword MONITOR is present. Coded information is obligatory, with or without free text.

2. The coding rules for DECAY-MON are exactly the same as those for DECAY-DATA (see preceding), except that the flag field is replaced with a heading field:

> ((heading)nuclide,half-life,radiation).

Heading field. Contains the data heading of the field in which the monitor value is given. The heading may be omitted, in which case its parenthesis is omitted.

3. For more than one monitor decay, each is coded on a separate record, starting in column 12. Entries under DECAY-MON and MONITOR may be linked:

a) using pointers (see page 5.4, BIB/BIB links)

b) using the data headings MONIT1, MONIT2, *etc.*

> *Example*:
> ```
> DECAY-MON   ((MONIT1)26-SC-46-G,83.81D,DG,889.3,0.99984
>                                  DG,1120.5,0.99870)
>             ((MONIT2)26-SC-47,3.345D,DG,159.4,0.683)
> ```

DETECTOR. Gives information about the detector(s) used in the experiment. See also **LEXFOR, Measurement Techniques**.

1. At least one of the keywords METHOD, FACILITY, DETECTOR, or ANALYSIS must be present with coded information. If an existing code applies, it should be given, otherwise coded information is optional.

2. If coded information is given it may be in either of the general forms with code(s) from Dictionary 22, but see exception below.

3. If the code COINC or TELES is used, then the codes for the detectors used in coincidence or in the telescope follow within the same parenthesis;

> *Example*:   `DETECTOR   (COINC,NAICR,NAICR)`

In this case any other detectors used are coded on a separate record, starting in column 12.

EMS-SEC. Gives information about secondary squared effective mass of a particle or particle system, and defines secondary-mass fields given in the data table. See **LEXFOR, Secondary Particles**.

1. Must be present when the data headings EMS1, EMS2, *etc.*, are used in the data set. Otherwise its use is optional and free text or coded information, with or without free text, may be given.

2. The format of the coded information is: (heading, particle)

    Heading Field. This field contains the data heading or the root of the data heading to be defined. Root means that the data heading given will also define the same heading followed by the extensions -MIN, -MAX, -APRX, -NM, or -DN.

    Particle Field. This field contains the particle or nuclide to which the data heading refers. The code is:
    > either a particle code from Dictionary 33 with a D in the 1st position of the allowed subfields flags.
    > or   a nuclide coded in the standard format as described on page 6.2.

3. If more than one effective mass data heading is defined, each is coded on a separate record, starting in column 12.

    > *Example:* EMS-SEC   (EMS1,N)
    >   (EMS2,P+D)

EN-SEC. Gives information about secondary energies, and defines secondary-energy fields given in the data table. See **LEXFOR, Secondary Particles**.

1. Must be present when the data headings E1, E2, *etc.*, are used in the data set. Otherwise its presence is optional and free text or coded information, with or without free text, may be given.

2. The format of the coded information is: (heading,particle)

    Heading Field. Contains the data heading or the root of the data heading to be defined. Root means that the data heading given also defines the heading followed by -MIN, -MAX, -APRX, -NM, or -DN.

    Particle Field. Contains the particle or nuclide to which the data heading refers. The code is:
    > either a particle code from Dictionary 33 with a D in the 1st position of the allowed subfields flags.
    > or   a nuclide coded in the standard format as described on page 6.2.

3. For two or more particle codes, they are separated by a slash, and ordered *lightest* to *heaviest* as for REACTION subfield 3 (see page 6.3).

    If more than one secondary-energy data heading is defined, each is coded on a separate record, starting in column 12.

    > *Example*: EN-SEC   (E1,G)
    >   (E2,N)
    >   (E-EXC,3-LI-7)

ERR-ANALYS.   Explains the sources of uncertainties and the values given in the COMMON or DATA sections under data headings of the type ERR- or -ERR. See also **LEXFOR, Errors**.

1. Presence is obligatory, except when not relevant.   May contain free text or coded information with free text.   However, coded information is obligatory when more than one error field is given in the data set.

2. The coded information is of the form: (heading,correlation factor) free text

    Heading Field. Contains the data heading or the root of the data heading to be defined. Root means that the data heading given also defines the heading preceded by + or -.

    Correlation Factor Field.   Contains the correlation factor, coded as a floating point number. This field is optional and is used only with systematic data uncertainty headings of the form ERR-1, *etc*. If this field is not given, the trailing comma is omitted.

3. If two or more error fields are given, then the data headings are given as codes under this keyword, each on a separate record, starting in column 12, and followed by free text explanation.

    Example:
```
BIB
…
ERR-ANALYS  (EN-ERR) followed by explanation of energy error
            (ERR-T)  followed by explanation of total uncertainty
            (ERR-S)  followed by explanation of statistical uncertainty
ENDBIB
NOCOMMON
DATA
EN          EN-ERR      DATA        ERR-T       ERR-S
MEV         MEV         MB          MB          PER-CENT
...         ...         ...         ...         ...
```

EXP-YEAR.   Defines the year in which the experiment was performed when it differs significantly from the date of the references given (*e.g.*, classified data published years later).

1. Presence is optional, but if present, it must have coded information.

2. The format of the code is (YYYY) where YYYY is the year.
Example: EXP-YEAR   (1965)

FACILITY. Defines the main apparatus used in the experiment. See also **LEXFOR, Measurement Techniques**.

1. Keyword must be present except when not relevant. At least one of the keywords METHOD, FACILITY, DETECTOR, or ANALYSIS must be present with coded information. Within this restriction, coded information for FACILITY is optional.

2. If coded information is given it may be given:
   - in either of the general forms (see page 3.2) with code(s) from Dictionary 18,
   - or a facility code from Dictionary 18 may be followed by an institute code from Dictionary 3, which specifies the location of the facility. When two or more institutes are given under the keyword INSTITUTE, then a facility code is always followed by the appropriate institute code.

3. When the second form of coding is used and more than one facility is given, then each is coded on a separate record, starting in column 12.

   Example: ```
   FACILITY   (CHOPF,1USACOL)
                (SPECC,1USABNL)
   ```

**FLAG**.  Provides information to specific lines in a data table.  See also **LEXFOR, Flags**.

1. Must be present if the data heading FLAG is used in the data table.  Otherwise presence is optional (but not meaningful).  If present, it must have coded information.

2. The format of the code is a fixed-point number (*n*.) that appears in the data section under the data heading FLAG.  The code must be followed by free text containing the comment attached to the flag.

3. If two or more codes are given, each is coded on a separate record, starting in column 12, followed by a free text explanation of the meaning of the flag.

   *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
   ```

More than one FLAG field may be coded (see Repetition of data headings, page 4.2).

**HALF-LIFE**.  Gives information about half-life values and defines half-life fields given in the data table. See also **LEXFOR, Half-lives**.

1.  Must be present with coded information when the data headings, HL1, HL2, *etc.*, are given in the data set. Otherwise presence is optional.  If present may have free text or coded information with or without free text.

2.  The general coding format is:  (heading,nuclide)

    <u>Heading field</u>:      Data heading to be defined.

    <u>Nuclide field</u>:      General format of the code is *Z-S-A-X*, see page 6.2.  Permitted nuclei are indicated in Dictionary 27 by a "3" in column 15.

3.  If two or more half-lives are given, each is coded on a separate record starting in column 12.  See LEXFOR Half-lives for a coding example.

    ***Example***:    HALF-LIFE    (HL1,41-NB-94-G)
    (HL2,41-NB-94-M)

*Note*:  Decay data, including the half-life, is preferably coded under the keyword DECAY-DATA or DECAY-MON, as appropriate.

**HISTORY**.  Documents the handling of an entry or subentry.  See also **LEXFOR, History**.

1.  Presence is obligatory with coded information and with or without free text.

2.  The general format of the code is:  (YYYYMMDDX),
    where:   YYYYMMDD: date (year,month,day) on which some action was taken on the entry  or subentry;
    X:    a code from Dictionary 15 indicating what action was taken.  *X* may be omitted.

3.  Each item of coded information is coded on a separate record, starting in column 12.

    ***Example***:    HISTORY    (19940312C)
    (19960711A) Data units corrected.

**INC-SOURCE**. Gives information on the source of the incident particle beam used in the experiment. See also **LEXFOR, Measurement Techniques** and **Incident-Particle Energy**.

1. Presence is optional. May contain either free text, or coded information and free text.

2. Coded information, if given, may be in either of the general forms, see page 3.2, with code(s) from Dictionary 19, but see exceptions below.

3. a) If the code POLNS is used, the code for the polarized source, if given, must follow within the same set of parenthesis.

   *Example*:   `INC-SOURCE  (POLNS,D-T)`

   b.) If the code MPH, followed by the separator = is present, the next field contains a reaction string coded as under the keyword REACTION, SF1-4.

   *Example*:   `INC-SOURCE  (MPH=(13-AL-27(N,A)11-NA-24))`

   In both these cases, other sources are coded on a separate record, starting in column 12.


**INC-SPECT**. Provides information on the characteristics and resolution of the incident-projectile beam. See also **LEXFOR, Incident-Projectile Energy**.

1. Must be present when a spectrum average modifier (*e.g.*, MXW, SPA, or FIS) is present in REACTION SF8. See also **LEXFOR, Spectrum Average**. Otherwise its use is optional. No coded information.


**INSTITUTE**. Designates the laboratory, institute, or university at which the experiment was performed, or with which the authors are affiliated. See also **LEXFOR, Institute**.

1. Presence is obligatory with coded information.

2. The coded information is given in either of the general forms, see page 3.2, with code(s) from Dictionary 3.

   Where the institute code is less than 7 characters, trailing blanks may be omitted, however, embedded blanks must be included, as they are considered part of the code.

   Institute codes may be continued onto the next record(s), but codes should not be broken, *i.e.*, the last character on the line to be continued must be a comma.

   *Examples:*   `INSTITUTE   (1USAGA, 1USALAS)`
                 `INSTITUTE   (2FR SAC)`

**LEVEL-PROP**.   Gives information on the spin and parity of excited states.   See also **LEXFOR, Flags.**

1.  If a level flag is given in the data set, it must be defined under LEVEL-PROP, see following. Otherwise presence is optional, but, if present, coded information must be given.

2.  The code string consists of three fields which may be preceded by a level flag:

    ((flag) nuclide, level identification, level properties)

Embedded blanks are permitted only at the beginning of a field or subfield.  If a code string is continued onto the next record, the break must come at the end of a field or subfield, *i.e.*, the comma separating the fields should be the last character on the line.

Flag.  Coded as (*n*.), where *n* will have a numerical value that appears in the data section under the data heading LVL-FLAG.  See also **LEXFOR, Flags**.

The flag may be omitted, in which case its parentheses are also omitted.  If the flag is omitted, a level identification field must be present.

Nuclide field.  Coded is *Z-S-A-X*, except that for the ground state of a nuclide, the use of the extension G is optional, see page 7.2.  This field must be present.

Level identification field.  Identifies the level for which properties are specified.  If the field is not present, its separating comma is omitted.  If there is no flag field, a level identification field must be present.  The following level identifiers are permitted.

> Level Energy.  The field identifier E-LVL= followed by the excited state energy in MeV, coded as a floating-point number (see page 4.2, no blanks permitted), which also appears in the data section under the data heading E-LVL.  No units are given in the code.

> Level Number.  The field identifier LVL-NUMB= followed by the level number of the excited state, *n*, where *n* has a numerical value which also appears in the data section under the data heading LVL-NUMB.

> Isobaric analog state number.  The level identifier IAS-NUMB= followed by the level number of the isobaric analog state, *n*, where *n* has a numerical value which also appears in the data section under the data heading IAS-NUMB.  See also **LEXFOR, Isobaric Analog States**.

Level properties field.  One or more properties for the excited state, each preceded by a subfield identification.  At least one of the fields must be present.  If the field is not present, its separating comma is omitted.

> Spin.  The field identifier SPIN=, followed by the level spin coded as a floating point number (see page 4.2, but no blanks).  For an uncertain spin assignment, two or more spins may be given, each separated by a slash.

> Parity.  The field identifier PARITY=, followed by the level parity, coded as +1. or -1.

3. If information on 2 or more levels is given, each is entered in a separate code string, starting in column 12.

   *Examples:*

   ```
   LEVEL-PROP  (82-PB-206,E-LVL=0.,SPIN=0./1.,PARITY=+1.)
               (82-PB-206,E-LVL=1.34,SPIN=3.,PARITY=+1.)

   LEVEL-PROP  ((1.)82-PB-206,,SPIN=0./1.,PARITY=+1.)
               ((2.)82-PB-206,,SPIN=3.,PARITY=+1.)

   LEVEL-PROP  (82-PB-207,LVL-NUMB=2.,SPIN=1.5,PARITY=-1.)

   LEVEL-PROP  (23-V-46,IAS-NUMB=0.,SPIN=0.,PARITY=+1.)
   ```

METHOD. Describes the experimental technique(s) employed in the experiment. See also **LEXFOR, Measurement Techniques**.

1. At least one of the keywords METHOD, FACILITY, DETECTOR, or ANALYSIS must be present with coded information. If an existing method code applies, it should be given, otherwise coded information is optional.

2. Coded information may be in either of the general forms, see page 3.2, with code(s) from Dictionary 21.

MISC-COL. Defines fields in the COMMON or DATA sections headed by MISC and its derivatives. See also **LEXFOR, Miscellaneous**.

1. Must be present if miscellaneous fields are given in the data table. Otherwise presence is optional. Free text may be given, or coded information plus free text.

2. The code is a miscellaneous data heading from Dictionary 24, *e.g.*, MISC.

3. If more than one miscellaneous field is given, then the data headings must be given as codes, enclosed in parentheses starting in column 12, followed by free text explanation.

   Example: MISC-COL   (MISC1)   Free text describing 1st miscellaneous field

   (MISC2)   Free text describing 2nd miscellaneous field

MOM-SEC. Gives information about secondary linear momentum, and defines secondary-momentum fields given in the data table. See also **LEXFOR, Secondary Particles**.

1. Must be present with coded information when the data headings MOM-SEC1, MOM-SEC2, *etc*., are used in the data. Otherwise its presence is optional and free text or coded information, with or without free text, may be given.

2. The format of the coded information is: (heading,particle)

   Heading Field: the data heading or root[2] of the data heading to be defined.

   Particle Field: the particle or nuclide to which the data heading refers. The code is:

   either   a particle code from Dictionary 33 with a D in the 1st position of the allowed subfields flags,

   or   a nuclide coded in the standard format as described on 6.2.

3. When more than one linear-momentum data heading is to be defined, each must be coded on a separate record, starting in column 12.

   Example: MOM-SEC   (MOM-SEC1,26-FE-56)

   (MOM-SEC2,26-FE-57)

---

[2] Root means that the data heading given will also define the same heading followed by -MIN, -MAX, -APRX, -DN, or -NM.

MONITOR. Gives information about the standard reference data (standard, monitor) used in the experiment and defines information coded in the COMMON and DATA sections under the data heading MONIT, *etc*. See also **LEXFOR, Standards**.

1. Presence is obligatory, except when not relevant. Information is entered either as free text, or in coded form with or without free text. However, coded information must be included when the corresponding data is given in the COMMON or DATA sections.

2. The general coding format is a REACTION string which may be preceded by a field containing a data heading: ((heading) reaction)

    Heading Field. Contains the data heading of the field in which the monitor value is given. The heading may be omitted, in which case its parenthesis is omitted.

    Reaction Field.   The coding rules are identical to those for REACTION, except that subfields 5 to 9 may be omitted when only the reaction is known. (In this case, no monitor information will be given in the COMMON or DATA section).

3. In the case of two or more monitors, each is coded on a separate record, starting in column 12. The respective monitor values coded are linked to the monitor codes:

    a) using pointers (see page 5.3, BIB/DATA Links)

    Example:
    ```
    REACTION    1 (AAAAA)
                2 (BBBBB)
    MONITOR     1 (CCCCC)
                2 (DDDDD)
    ...
    DATA
    EN            DATA          1 DATA          2 MONIT         1 MONIT         2
    ...
    ```

    b) using the data headings MONIT1, MONIT2, *etc*. This formalism is used when two or more monitors are given for one reaction[3].

    Example:
    ```
    REACTION      (AAAAA)
    MONITOR       ((MONIT1)CCCCC)
                  ((MONIT2)DDDDD)
    ...
    DATA
    EN            DATA          MONIT1        MONIT2

    ...
    ```

---

[3] On EXFOR entries compiled before 1985, the heading field was not included in the monitor code string.

MONIT-REF. Gives information about the source reference for the standard (or monitor) data used in the experiment.

1. Presence is optional, but, if present, includes coded information. Used only when the keyword MONITOR is present.

2. The code contains 3 main fields which may be preceded by a heading field:

    ((heading)subaccession#,author,reference)

    Embedded blanks are not permitted within the code, except within an author's name (see coding rules under AUTHOR, page 7.4).

    Heading Field: Data heading of the field in which the standard value is given. The heading may be omitted, in which case, its parentheses is also omitted.

    Subaccession Number Field: Subaccession number for the monitor data, if the data is given in an EXFOR entry. C$nnnn$001 refers to the entire entry C$nnnn$. C$nnnn$000 refers to a yet unknown subentry within the entry C$nnnn$. This field may be omitted, but the following comma is always included.

    Author Field. The first author (coded as under AUTHOR), followed by "+" when more than one author exists. This field may be omitted, but the following comma is always included.

    Reference Field. Must be present. May contain up to 6 subfields, coded exactly as under REFERENCE. (See page 7.22 and following).

3. For more than one monitor reference, each is coded on a separate record, starting in column 12. Entries under MONIT-REF and MONITOR may be linked:

    c) using pointers (see page 5.4, BIB/BIB links)

    d) using the data headings MONIT1, MONIT2, *etc.*

    Examples:
    ```
    MONIT-REF   ((MONIT1)BOO17005,J.GOSHAL,J,PR,80,939,1950)
                ((MONIT2),A.G.PANONTIN+,J,JIN,30,2017,1968)

    MONIT-REF   (,A.G.PANONTIN+,J,JIN,30,2017,1968)

    MONIT-REF   (B0016005,J.GOSHAL,J,PR,80939,1950)
    ```

PART-DET. Gives information about the particles (not decay radiations) detected directly in the experiment. Particles detected in a standard/monitor reaction are not coded under this keyword. See also **LEXFOR, Particles**.

1. Presence is optional, but, if the particle is not evident from the REACTION code, it must be given, either under this keyword, or under RAD-DET or DECAY-DATA. If the keyword is present, coded information is obligatory.

2. The code is:
    - either a code from Dictionary 33 with a D in the 1st position of the allowed subfields flags,
    - or, for particles heavier than α particles, a code of the form *Z-S-A-X* (see page 6.2).

3. If two or more particles detected, their codes are given in either of the general forms, see page 3.2. Particles detected pertaining to different reaction units within a reaction combination are coded on separate records in the same order as the corresponding reaction units. (See page 6.6 for examples of reaction combinations.)

RAD-DET. Gives information about the decay radiation (or particles) and nuclides observed in the reaction measured. See also **LEXFOR, Particles**.

1. *If the decay radiation detected is not evident from the* DECAY-DATA *code*, it must be specified either under this keyword, otherwise presence of this keyword is optional. If the keyword is present, it must have coded information, with or without free text.

   If this keyword is present the keyword DECAY-DATA must also be present.

2. The general format of the code is: ((flag)nuclide, radiation)

   Flag Field: a code of the form (*n*.), where *n* has the numerical value which appears in the data section under the data heading DECAY-FLAG. This field may be omitted, in which case its' parentheses are also omitted. See also **LEXFOR, Flags**.

   Nuclide field. A code of the form *Z-S-A-X,* see page 7.2.

   Radiation field: One or more codes from Dictionary 33 with a D in the 1st position of the allowed subfields flags, each separated by a comma.

   No embedded blanks are permitted in the code.

3. To specify information about two or more nuclides, the information for each nuclide is coded on a separate record, each code starting in column 12. Pointers may be used to link the RAD-DET codes with variable product nuclei coded in the Data Table and with DECAY-DATA codes.

   Examples:
   ```
   a.)   RAD-DET      (96-CM-240,A)
   b.)   RAD-DET      (25-MN-52-G,DG)
   c.)   RAD-DET      (25-MN-52-M,DG,B+)
   d.)   RAD-DET      (48-CD-115-G,B-)
                      (49-IN-115-M,DG)
   e.)   RAD-DET     1(94-PU-237-M2,SF)
                     2(94-PU-237-M2,SF)
   f.)   RAD-DET      ((1.)48-CD-115-G,B-)
                      ((2.)49-IN-115-M,DG)
   ```

REACTION. Specifies the data presented in the DATA section in fields headed by DATA[4].

1. Presence is obligatory with coded information; use of free text is optional.

2. See Chapter 6 for detailed coding rules and use.

---

[4] And similar headings such as DATA-MIN, DATA-MAX, *etc*.

REFERENCE.   Gives information on references that contain information about the data coded. Other related references are not coded under this keyword (see REL-REF, MONIT-REF). See **LEXFOR, Reference**.

1. Presence is compulsory with coded information, with or without free text.

2. The general coding format consists of 3 main fields: (reference type, reference, date). No embedded blanks are allowed

   Reference Type: a code from Dictionary 4. Field must always be present.

   Reference: up to four subfields depending on reference type; the first subfield is always present. The order of the subfields in the code is fixed, although some subfields may be omitted. If a subfield is omitted, the separating comma is included, except in the case:

   - of a parenthesized subfield,

   - for certain reference types, when the omitted subfield is the page number.

   See reference types on following pages for specific coding rules for each subfield.

   Date: code of the form *yyyymmdd* (year, month, day); the month and day may be omitted. Field must always be present.

3. Where there is more than one reference, each reference is coded on a separate record, starting in column 12. The main reference is given first.

4. If a document has more than one identification, each may be coded within one set of parenthesis, each code being in parentheses and separated from the other codes by '=' (an equal sign). The primary code is given first. (see **LEXFOR, Reference** for the definition of primary reference.)

   Example: `((R,USNDC-7,143,197306)=(R,EANDC(US)-181,143,197306))`

   If a code string is continued onto the next record, a code unit must not be broken, *i.e.*, the separator appears last on the record, with the first parenthesis of the next code unit beginning in column 12 of the next record.

5. The free text on the record following the closing parenthesis of the code string is reserved for a "mini-comment" giving further information about the reference.

   Examples: `(R,ANL-4567,196605)  Graph only`
   `(C,66PARIS,196605)  Abstract`

6. In the few cases (particularly with abstracts), when two works are referenced which appear on the same page of a journal or report, the following practice is followed:
   a) If a paper number or paragraph number is available it is enclosed in parentheses following the page number.
   Example: `(J,XYZ,9,999(1122),196912)`
   `(J,XYZ,9,999(1573),196912)`
   b) If this is not possible then the order in which they appear on the page is used.
   Example: `(J,XYZ,8,888(1),196911)`
   `(J,XYZ,8,888(2),196911)`

Following are the specific coding rules for each reference type.

Type of Reference = A or B or C; Conference Abstracts, Books, or Conferences. The reference field may contain up to 4 subfields: code, volume, part, page (paper number).

General coding forms: (A or B or C,code,volume,(part),page(paper #),date)
                                (A or B or C,code,volume,page(paper #),date)
                                (A or B or C,code,,page(paper #),date)
                                (A or B or C,code,,date)

Code subfield: a code from Dictionary 7 (Conferences) or Dictionary 207 (Books).

Volume subfield: may have any content, except commas or parentheses.

Part subfield: if present, it is enclosed in parentheses and may have any content, except commas or parentheses. If omitted, the following comma is also omitted.

Page (paper number) subfield, if present, contains the page number, which must be numeric and/or the paper number, enclosed in parentheses, which may have any content, except commas or parentheses. If omitted, the following comma is omitted.

Examples:
a) `(C,67KHARKOV,,(56),196702)` = 1967 Kharkov Conference Proceedings, paper number 56, February 1967.
b) `(C,66WASH,1,456,196603)` = 1966 Washington Conference Proceedings Volume No. 1, page 456, March 1966
c) `(B,ABAGJAN,,123,1964)` = Book by Abagjan, page 123, published in 1964.
d) `(B,MARION,4,(1),157,1960)` = Book by Marion, Volume 4, part 1, page 157, published in 1960.
e) `(C,77KIEV,,197704)` = 1977 Kiev Conference, page and paper number unknown.

Type of Reference = J or K: Journals or Journal Abstracts. The reference field may contain up to 4 subfields: code, volume, issue#, page.

General coding forms: (J or K,code,volume,(issue #),page,date)
                                (J or K,code,volume,page(paper #),date)

Code subfield: a code from Dictionary 5.

Volume subfield: the volume number; may have any content, except commas or parentheses.

Issue # subfield: the issue number enclosed in parentheses; may have any content, except commas or parentheses. Presence optional; if omitted, the following comma is also omitted.

Page (paper #) subfield: the page number, which must be numeric, and/or the paper #, enclosed in parentheses, which may have any content except commas or parentheses. If omitted, the following comma is also omitted.

Examples:
a) `(J,PR,104,1319,195612)` = Phys. Rev. Volume 104, page 1319, December 1956
   `(J,XYZ,5,(2),89,196602)` = Journal XYZ, Volume 5, issue#2, page 89, February 1966

Type of Reference = P or R or S: Reports. The reference field for reports may contain up to 3 subfields: code number, volume/part, page.

General coding forms: (P or R or S,code-number,date)
(P or R or S,code-number, page,date)
(P or R or S,code-number,(volume/part),page,date)

Code-number subfield: contains a code taken from Dictionary 6, and the number, which may have any format, but may not contain a comma (for example: 3058-39, 4648-MS, 66-12-9, 630-1X-A/PR). The separator between the code and the number is a hyphen[5].

Volume or part subfield: may have any content, except commas or parentheses, and is enclosed in parentheses; if omitted, the following comma is also omitted.

Page subfield: numeric field; if omitted, the following comma is also omitted. If there are two works on a page they may be distinguished as described on preceding page; for example: 123(1) and 123(2).

Examples:
a) `(R,UCRL-5341,195806)`   = UCRL report number 5351, published in June 1958.
b) `(R,JINR-P-2713,196605)`   = Dubna report, series P, number 2713, published in May 1966.
c) `(P,WASH-1068,185,196603)` = WASH progress report number 1068, page 185, published in March 1966.
d) `(R,BNL-325,(2A),1966)`   = a well-known, example for the Volume or Part field

Type of Reference = T or W or X: Thesis or Private Communication or Preprint. The reference field may contain up to 2 subfields: author, page

General coding forms: (W or T,author,date)
(W or T,author,page,date)

Author subfield: family name of the first author.

Page subfield: numeric field; if omitted, the following comma is also omitted.

Examples:
a) `(W,BENZI,19661104)` = private communication from Benzi received on November 4, 1966.
`(T,ANONYMOUS,58,196802)` = thesis by Anonymous, page 58, published in February 1968.

---

[5] The hyphen acting as separator is included in Dictionary 6, except when the code itself is 11 characters long (see Part III, Nuclear Reaction Data Dictionaries).

REL-REF. Used to give information on references related to, but not directly pertaining to, the work coded. See also **LEXFOR, Reference**.

1. Presence is optional, but, if present, will have coded information, with or without free text.

2. The general format of the code contains four main fields:

> (code,subaccession#,author,reference).

Embedded blanks are not permitted within the code.

Code field: code from Dictionary 17. This field must be present.

Subaccession# field: EXFOR subaccession number for the reference given, if it exists. C*nnnn*001 refers to the entire entry C*nnnn*. C*nnnn*000 refers to a yet unassigned subentry within the entry C*nnnn*. This field is optional; if omitted, the following comma is always included.

Author field: first author, coded as under AUTHOR, followed by + when more than one author exists. This field is optional; if omitted, the following comma is always included.

Reference field: up to 8 subfields, coded as under the keyword REFERENCE. (See page 7.22 and following). This field must always be present.

> ***Example:*** `(C,B9999001,A.B.NAME+,J,XYZ,5,(2),90,197701)` = Critical remarks by A.B.Name, *et al*., in journal XYZ, volume 5, issue #2, p. 90, January 1977.

RESULT. Describes commonly used quantities that are coded as REACTION combinations.

1. Presence is obligatory when relevant, and must contain coded information.

2. Contains a code from Dictionary 37, with or without free text. Only one code is entered for each Reaction Combination.

> ***Example:***
> ```
> REACTION    (((Z-S-A(N,EL),,WID,,G)*(Z-S-A(N,G),,WID))/
>             (Z-S-A(N,TOT),,WID))
> RESULT      (CAPTA)
> ```

3. If more than one code is entered, each will be on a separate record, preceded by the relevant pointer.

> ***Example:***
> ```
> REACTION    1((Z-S-A(N,F)ELEM/MASS,CUM,FY)/
>              (Z-S-A(N,F)MASS,CHN,FY))
>             2((Z-S-A(N,F)ELEM/MASS,IND,FY)/
>              (Z-S-A(N,F)MASS,CHN,FY))
> RESULT      1(FRCUM)
>             2(FRIND)
> ```

SAMPLE.   Used to give information on the structure, composition, shape, *etc.*, of the measurement sample.

1. Presence is optional. Contains only free text information.

STATUS. For use of this keyword see **LEXFOR, Status**.

1. Presence is obligatory when relevant. May contain coded information and/or free text.

2. The coded information is entered in:

    a) either of the general forms with codes from Dictionary 16.

    b) or as coded information with two fields: (code,subaccession#)

        Code Field: code from Dictionary 16.

        Subaccession# Field: cross-reference to an EXFOR subaccession number. C*nnnn*001 refers to the entire entry C*nnnn*. C*nnnn*000 refers to a yet unassigned subentry within the entry C*nnnn*. This field is only permitted for the codes COREL, DEP, OUTDT, RNORM, and SPSDD.

        The subaccession number field is always included for these codes, with the following exceptions:

        *   the codes SPSDD and OUTDT, where, in some cases, no cross-reference may exist.

        *   older subentries for which this field was not entered.

        Example:

        ```
        STATUS    (SPSDD,10048009)    - this subentry is superseded by subentry 10048009.
        ```

3. For case 2.b, if more than one status code or a cross-reference to more than one subaccession number is given, each is coded on a separate record, starting in column 12.

    Examples:

    ```
    STATUS    (DEP,12345002)
              (DEP,12345004)
    STATUS    (DEP,34567004)
              (APRVD)
    ```

4. For use of the following codes see the corresponding **LEXFOR** entries:

COREL	Interdependent Data
DEP	Dependent Data
Others	Status

TITLE. Used to enter a title for the work referenced. See **LEXFOR, Title**.

1. Presence is obligatory except when not relevant. Information is given in free   text only.

Chapter 8

UPDATING AND ALTERATIONS

Alterations to EXFOR entries

Alterations to EXFOR entries are transmitted only by the center responsible for those entries. (See Part IV, Protocol, page 3).

When an entry is altered, those subentries that have been altered will be retransmitted, accompanied by the retransmission of the first subentry (SAN=1). The minimum unit transmitted is a subentry (not just the altered records). Those subentries that are not altered need not be included on the transmission file. The appropriate ENTRY and ENDENTRY records are included.

Serious corrections (*e.g.*, those involving changes to the data or to the essential information-identifier keywords, such as REACTION, MONITOR) will be transmitted as quickly as possible.

Subentries added to a previously transmitted entry are transmitted accompanied only by the first subentry; other unchanged subentries need not be transmitted.

All corrections will be properly marked with alteration flags. The alteration flag is used to inform other centers when an alteration procedure has been performed on an entry.

Alteration flags are not accumulated over a number of transmissions (*i.e.*, alter flags are set only to indicate those records which have been altered since the last time the work was transmitted). Therefore, all flags are considered, at least conceptually, reset to blank after the work has been transmitted. The procedure that is actually carried out at each center of course depends upon the use that the center intends to make of the information conveyed by the alteration flag.

All corrections will be documented with an appropriate entry under HISTORY. (See **LEXFOR, History**).

Deletion of entries and subentries

If an entire entry is to be deleted, at least NOSUBENT records must be included for each subentry that has been previously transmitted. Column 80 alteration flags are used throughout the "deleted" entry or subentry as usual.

In general, the following information-identifier keywords must be included (left) in the BIB section for an entry or subentry to be deleted: REFERENCE, TITLE, AUTHOR, INSTITUTE, REACTION, and HISTORY. The ENDBIB record is usually followed by NOCOMMON and NODATA records.

An entry is made under HISTORY, with the date of deletion and the code D. Free text information giving the reason for the deletion must be included.

The accession number/subaccession number of a deleted entry/subentry may never be used for another data set.

Retransmission of subentries that have been combined into one entry

In the case where a series of subentries (*X* through *Y*) have been combined into one subentry (*X*), the following simplified flagging system may be used.

An entry should be made under HISTORY in the combined subentry.

For subentries *X+1* through *Y*, NOSUBENT records are entered, with a deleted subentry flag in Column 80.

Example:

```
ENTRY               00000    19991110                                       C
...
SUBENT           00000023    19991110                                       C
BIB
...
HISTORY     (19991110A) Subentries 00000023-00000025 combined              I
ENDBIB
NOCOMMON
DATA
...                                                                         R
...
ENDSUBENT
NOSUBENT         00000024    19991110                                       *
NOSUBENT         00000025    19991110                                       *
...
ENDENTRY
```

Alteration flags

The following alter flags are used in column 80 to indicate an alteration:

C The record flagged has been corrected. When a subentry is updated, the flag C is also added to the ENTRY and SUBENT records and the date of last updated is changed (N2 field, see pages 2.2 and 2.3).

D A record or records has been deleted following the record flagged.

I The record flagged has been inserted. When an entire subentry is inserted, the flag I is attached to the SUBENT record, and only the SUBENT.

T Two updates have occurred as follows:

   a) the record flagged has been inserted or corrected and

   b) a record or records has been deleted following the record flagged.

R The record flagged is a replacement. This is used when a large block of records is revised, *e.g.*, the complete BIB section or a section of the data table. The flag R appears in each replacement record or in the first record of a series of replacement records. An entry is made under the information identifier HISTORY explaining the alteration.

   Examples:

   ```
   HISTORY    (19710608A) Between 1.0 eV and 700 eV data replaced by a new
                          set calculated from the old one averaging over
                          five data points
              (19710709A) BIB section rewritten, full paper published.
   ```

* The entry or subentry has been deleted (used only on an ENTRY or SUBENT record).

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Appendix A

Example of an EXFOR Entry

This appendix contains an example of a complete entry in the EXFOR format

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```
TRANS              X023  20000424                              X005500000000
ENTRY             X0055  20000424                              X005500000001
SUBENT          X0055001  20000424                             X005500100001
BIB               11        20                                 X005500100002
INSTITUTE   (1USAPEN,4RUSKUR)                                  X005500100003
REFERENCE   (J,PR/C,49,2549,199405)                            X005500100004
AUTHOR      (R.W.Zurmuhle, Z.Liu, D.R.Benton, S.Barrow, N.Wimer, X005500100005
            Y.Miao, C.Lee, J.T.Murgatroyd, X.Li, V.Z.Goldberg,  X005500100006
            M.S.Golovkov)                                     X005500100007
TITLE       Observation of 12C cluster transfer by angular    X005500100008
            correlation measurements                          X005500100009
FACILITY    (VDGT,1USAPEN)                                     X005500100010
SAMPLE      A 30 microg/cm**2 self-supporting 12C target used. X005500100011
METHOD      (BCINT,SITA)                                       X005500100012
DETECTOR    (MAGSP) Deuterons were momentum analyzed in a double X005500100013
            focusing magnetic spectrometer.                   X005500100014
            (PSSSD) Deuterons were detected in the focal plane X005500100015
            with double-sided position sensitive silicon      X005500100016
            detector covered with a Ta foil to stop beam       X005500100017
            particles that otherwise might strike the detector. X005500100018
ADD-RES     (COMP).Distorted Wave Born Approximation and Hauser X005500100019
            Feshbach Formalism.                               X005500100020
STATUS      (APRVD) Approved by author, 5 April 2000.          X005500100021
HISTORY     (20000327C)                                        X005500100022
ENDBIB            22         0                                 X005500100023
NOCOMMON           0         0                                 X005500100024
ENDSUBENT         23         0                                 X005500199999
SUBENT          X0055002  20000424                             X005500200001
BIB                6        15                                 X005500200002
REACTION    (6-C-12(7-N-14,D+A)10-NE-20,PAR,DA/CRL,D/D+A)      X005500200003
EN-SEC      (E-EXC1,12-MG-24)                                  X005500200004
            (E-EXC2,10-NE-20)                                 X005500200005
            ANG1 is angle between incident beam and deuterons. X005500200006
            ANG2 is angle between deuterons and alpha particles. X005500200007
DETECTOR    An annular detector subdivided into ten segments,  X005500200008
            also used at small angles. Each annulus had a width X005500200009
            of 12 mm and was separated from adjacent segments  X005500200010
            with 1-mm wide inactive masks.                    X005500200011
ERR-ANALYS  (DATA-ERR) Uncertainty read from figures.          X005500200012
            (ANG2-ERR) Data-point reader uncertainty.          X005500200013
FLAG        (1.) Data taken with the annular detector.         X005500200014
            (2.) Data taken with position sensitive strip      X005500200015
            detectors.                                        X005500200016
STATUS      (CURVE) Data scanned from Fig.3 in reference.       X005500200017
ENDBIB            15         0                                 X005500200018
COMMON             4         3                                 X005500200019
ANG1        E-EXC1     E-EXC2     ANG2-ERR                     X005500200020
ADEG        MEV        MEV        ADEG                         X005500200021
  0.        13.45       0.        0.4                          X005500200022
ENDCOMMON          3         0                                 X005500200023
DATA               5        95                                 X005500200024
EN          ANG2-CM    DATA       DATA-ERR   FLAG              X005500200025
MEV         ADEG       ARB-UNITS  ARB-UNITS  NO-DIM            X005500200026
 33.         8.0        71.        16.        1.               X005500200027
 33.        11.3        34.        8.         1.               X005500200028
 33.        14.5        35.        7.         1.               X005500200029
 33.        16.7        30.        4.         2.               X005500200030
 33.        17.3        26.        5.         1.               X005500200031
   ...         ...        ...        ...        ...
 33.        108.0       11.0       4.0        2.               X005500200075
```

```
   42.       11.4      28.0      4.        1.                     X005500200076
   42.       15.9      17.7      2.        1.                     X005500200077
   42.       17.7      18.7      2.5       2.                     X005500200078
   42.       19.9      16.7      1.8       1.                     X005500200079
    ...       ...       ...       ...       ...                  X005500200122
   42.      112.7       5.9      1.5       2.                     X005500200122
ENDDATA            97         0                                  X005500200123
ENDSUBENT         122         0                                  X005500299999
SUBENT       X0055003  20000424                                  X005500300001
BIB                 3         3                                  X005500300002
REACTION   (6-C-12(7-N-14,D+A)10-NE-20,PAR,DA,D)                 X005500300003
ERR-ANALYS (DATA-ERR) Relative uncertainty given.               X005500300004
STATUS     Data taken from Table III in reference.              X005500300005
ENDBIB              3                                            X005500300006
COMMON              1         3                                  X005500300007
EN         E-EXC                                                 X005500300008
MEV        MEV                                                   X005500300009
   33.       13.45                                               X005500300010
ENDCOMMON           3                                            X005500300011
DATA                3         5                                  X005500300012
ANG        DATA      DATA-ERR                                    X005500300013
ADEG       MB/SR     PER-CENT                                    X005500300014
    6.01    0.39      10.                                        X005500300015
   12.3     0.40      10.                                        X005500300016
   18.3     0.27      11.                                        X005500300017
   30.4     0.28      11.                                        X005500300018
   36.5     0.27      11.                                        X005500300019
ENDDATA             7                                            X005500300020
ENDSUBENT          19                                            X005500399999
SUBENT       X0055004  20000424                                  X005500400001
BIB                 3         3                                  X005500400002
REACTION   (6-C-12(7-N-14,D+A)10-NE-20,PAR,SIG)                 X005500400003
ANALYSIS   (INTAD)                                               X005500400004
ERR-ANALYS (DATA-ERR) Absolute uncertainty given.               X005500400005
STATUS     (DEP,X0055003) Data taken from text in reference.     X005500400006
ENDBIB              3                                            X005500400007
NOCOMMON            0         0                                  X005500400008
DATA                4         1                                  X005500400009
EN         E-LVL     DATA      DATA-ERR                          X005500400010
MEV        MEV       MB        MB                                X005500400011
   33.       13.45      3.6       0.5                            X005500400012
ENDDATA             3                                            X005500400013
ENDSUBENT          12                                            X005500499999
ENDENTRY            3                                            X005599999999
ENDTRANS            1                                            Z999999999999
```

Appendix B

COVARIANCE DATA FILE FORMAT

Covariance data may be stored on a separate covariance file. There are three record types in the covariance file:

- comment records,
- data records,
- end records.

Comment record format

Column	1	C
	2 – 9	Data set number (subaccession number)
	10	(blank)
	11 - 80	Comment which includes covariance type and format

Data record format

Column	1	D
	2 - 9	Data set number (subaccession number)
	10	(blank)
	11 - 80	Data in format given on comment record

End record format

Column	1	E
	2 - 9	Data set number (subaccession number)
	10 - 80	(blank)

See also **LEXFOR, Covariance**.

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Appendix C

GLOSSARY

This glossary includes definitions of terms used in this manual, listed alphabetically.

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BIB information: the information presented in the BIB section which includes bibliographic, descriptive and administrative information.

Center identification character: A character which identifies the originating center and type of data; used as the first character in the exchange file identification and in the accession number (and subaccession number).

Common data: data common to a whole work or sub-work, which is presented in the COMMON section of a subentry.

Data heading: a keyword defining the content of a data field in the COMMON or DATA section.

Data set: the data for a given subentry (sub-work); includes the common data and data table for the subentry along with the common data for subentry 001.

Data table: the information given in the DATA section of a subentry.

Data unit: a keyword defining the units for the data presented in a data field in the COMMON or DATA section.

Exchange file: a file used to transmit data exchanged in the EXFOR format among.

Exchange format: format used for the exchange of nuclear reaction data; *i.e.*, the EXFOR format.

Field heading: the 11-column heading to a data field which contains the data heading plus, perhaps, pointer.

General quantity modifier: modifier codes which may be added to any REACTION string given in Dictionary 36, *e.g.*, MXW, REL.

Information identifier: a keyword defining the content of a record in the BIB section.

Record identification: information given in columns 67-79 on every record in a transmission file which uniquely identifies the record.

System identifier: a keyword defining a unit (section) of an transmission file, *e.g.*, ENTRY, BIB, NODATA.

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