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EXFOR Systems Manual

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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. The present version is identical to the report BNL-NCS-63330 (April 2000) except for very few minor corrections introduced by IAEA-NDS.

Preface to IAEA-NDS-207

This document contains the agreed coding rules and format definition for EXFOR, the exchange format for the transmission of experimental nuclear reaction data between national and international nuclear data centers, in its thoroughly revised version published in April 2000 as informal report BNL-NCS-63330. The present version within the IAEA-NDS-series is identical to the BNL report with the only exception of a few insignificant changes (some typographical corrections and very few brief additions of explanatory nature) made by IAEA-NDS, which are highlighted by <u>double underlining</u> and a vertical line at the right margin.

Other reports describing the EXFOR System:

- IAEA-NDS-1, "Short Guide to EXFOR" (1994)
- IAEA-NDS-2, "EXFOR/CINDA Dictionaries"
- IAEA-NDS-206 (BNL-NCS-63380), "EXFOR Basics" (Sept. 2000). Format description for data users
- "LEXFOR" - EXFOR Compiler's Manual, containing physical definitions and background information required for preparing high-quality EXFOR entries

Previous versions of the EXFOR Systems Manual are:

- IAEA-NDS-103 (1989), "EXFOR Manual Version 89-1"
- IAEA-NDS-3 (1985), "NDS EXFOR Manual"

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Nuclear Reaction Data
Exchange Format

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INTRODUCTION

EXFOR is an exchange format designed to allow transmission of nuclear reaction data between the members of the Nuclear Data Centers Network. This document has been written for use by the members of the Network and includes matters of procedure and protocol, as well as detailed rules for the compilation of data. Users may prefer to consult EXFOR Basics[1] for a brief description of the format.

History

The Nuclear Data Centers Network[2] (NDCN) 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.[3] The EXFOR System consists, primarily, of all experimental nuclear reaction data that has been exchanged between the members of the Network, 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.[4] 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.[5]

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 NDCN.

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[1] V. McLane, EXFOR Basics: A Short Guide to the Nuclear Reaction Data Exchange Format, Brookhaven National Laboratory report BNL-NDC-63380, Rev. 1999 (December 1999).

[2] See Appendix P for a list of the Nuclear Reaction Data Centers and their responsibilities.

[3] See H. D. Lemmel, The Nuclear Data Centers Network, IAEA report INDC(NDS)-401 Rev. (2000).

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

[5] 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
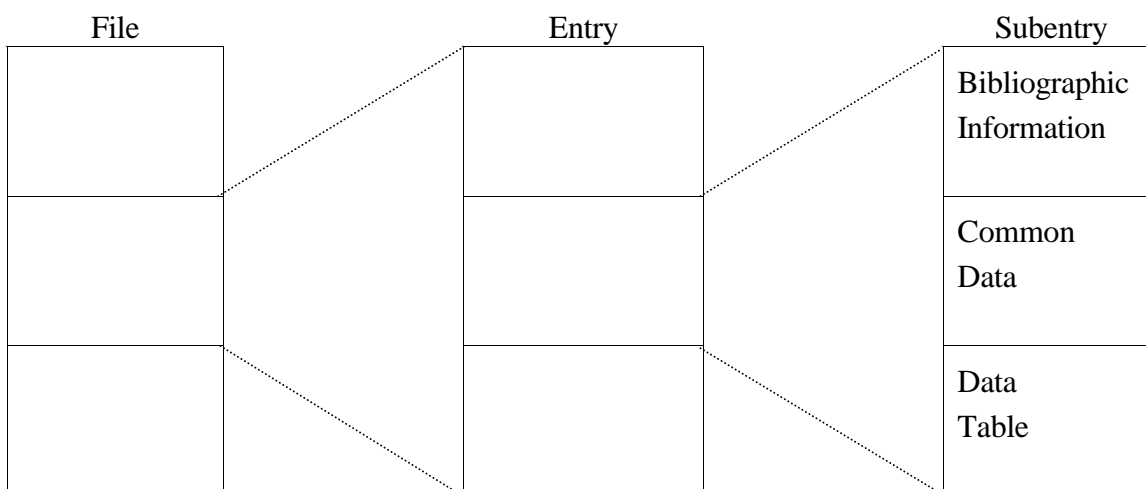
In order to avoid repetition of information that is common to all subentries within an entry or to all lines within a subentry, information may be associated with an entire entry or with an entire subentry. To accomplish this, the first subentry of each work contains only information which applies to 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
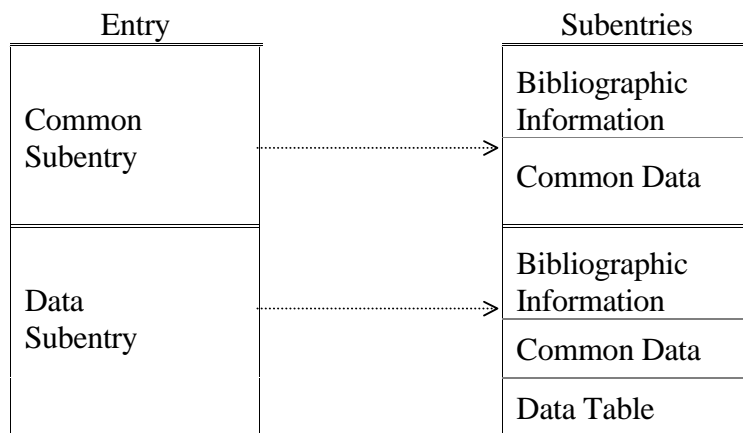
Definition of a subentry.

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, Appendix P.

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 Appendix P, Protocol, 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 data 2, 3, 4 series.
8	data from area 4	
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	VNIIEF (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
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.

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

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

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.[5] Column 67 is the file identification character (see page 1.4); columns 68-71 contain a center-assigned entry number,[6] allowing 9,998[7] 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 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.[8]

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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[5] Leading zeros should always be included on an exchange file.

[6] See Appendix P, Protocol, page P.4, for more information on the assignment of accession numbers.

[7] The integer 9999 is reserved for use in identifying the end of an exchange file (see Chapter 2).

[8] 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 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[9]

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.[10]

The first two fields (columns 67-74) are associated with a subentry throughout the life of the system; that is, if an 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 9 for the use of Alteration Flags.

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[9]   The integer 9999 is reserved for use in identifying the end of a subentry, entry, or file.

[10]   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 which 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, 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 zero's 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 ≥ 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)

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 EXFOR Dictionary 2. For detailed coding rules, see Chapter 8.

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 which 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.

<u>Use of codes</u>. 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 page 6.4 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 8 and the EXFOR Dictionaries (described in Chapter 6) for codes.

Embedded blanks. 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 8 for details on specific information-identifier keywords.

Examples 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 datum which has a constant value in all rows of the DATA section, e.g. a gamma ray energy or a relative cross-section error, can as well be entered as a constant parameter in the COMMON section. Vice versa, a parameter given in the COMMON section can as well be entered in a column of the DATA section with its value repeated in all rows.

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 EXFOR Dictionary 24.

  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 EXFOR Dictionary 25.

- 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 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, ...);
- dependent variables (DATA);
- associated quantities (EN-ERR, ANG-RSL, DATA-ERR, ...);
- additional information (MONIT, MISC, FLAG, HL, ...).

The division between different categories and families within categories is defined in EXFOR Dictionary 24 (Data Headings).[1] (See page 6.8).

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)
        + associated quantities      + associated quantities
                                      + additional information
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. **<u>Multiple Reaction Formalism.</u>**[1] In certain cases (see page 7.7 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   3
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. **<u>Vector Common Data</u>**. 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**.[2] Pointers may be used to link pieces of BIB information, all referring to the same reaction.

   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.[3] (See also **LEXFOR, Interdependent Data**).

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

---

[2] 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.

[3] From a processing point of view, this is the same concept as multiple reactions (described on page 7.7)

Chapter 6

DICTIONARIES

The EXFOR dictionaries contain the keywords and codes used by the EXFOR system. The dictionary transmission files have much the same format as an EXFOR exchange file. This section describes the structure of the dictionary exchange files, and the format of the dictionaries. Also included is more detailed information for specific dictionaries of special interest.

EXFOR Dictionary Transmissions

The EXFOR dictionaries contain explanations for all keywords and codes used in EXFOR. A **dictionary identification number** ranging between 001 and 099 is assigned to each dictionary. A dictionary transmission file will always include all dictionaries.

The first record on the dictionary transmission is a TRANS record; the last record is an ENDTRANS record (see page 2.2). The content of the N1 and N2 is as follows.
- For the TRANS record, N1 and N2 are the same as given on page 2.2. "9" is used as the center identification character, although in column 67 the center identification "3" is used (as it is throughout the file).
- For the ENDTRANS record, N1 contains the number of dictionaries transmitted and N2 is blank.

Dictionary Format

The format of the transmitted dictionaries is, in general, similar to that of the BIB section in EXFOR entries.

Keyword or code: the keyword or code to be defined is given, left adjusted, in the first field, starting in column 1. The field is usually contained in columns 1-11, but, for codes related to quantities, may be longer. The keywords have a maximum length of 10 characters; some codes are restricted to a length of 3 or 5 characters. (See page 6.4).

Explanation: The explanation field usually starts in column 12 (in column 23, in the case of quantity codes) and usually, but with some exceptions, ends in column 66 of the first record.

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

Flag: Column 80 is used

1. to flag the following conditions for the code given on the same record. These flags remain permanently attached to the respective codes or keywords..

    Obsolete flag (O) indicates that the keyword or code is not permitted on new transmissions, however, it may still exist in entries that were transmitted previously. An explanation as to why the code is obsolete and which code (if any) replaces it is given in free text. Obsolete codes remain in the dictionary until all cooperating centers have removed them from their data files.

    Extinct flag (X) indicates that the code given designates an extinct institute, journal, or report series. The code is still valid on transmissions, but will occur only in entries of old data.

2. as an indication that the record altered since the last dictionary transmission (*i.e.*, added, deleted, corrected). See page 9.3 for use of alteration flag.

The following two system-identifier records identify the beginning and the end of each dictionary (see page 2.2 for record format).

1. **DICTION** is the **first record** of each dictionary.
    N1 - Dictionary identification number (see above).
    N2 - Date of last alter (year, month, day - YYYYMMDD).
    Columns 34-66 describe the contents of the dictionary in free text.

    The record identification (columns 67-79) contains "30000" in columns 67-71, the dictionary number in columns 72-74, and the record sequence number "00001" in columns 75-79.

2. **ENDDICTION** is the **last record** of each dictionary.
    N1 - Number of records in the dictionary, excluding the DICTION and ENDDICTION records.
    N2 - Presently unused (may be blank or zero)

    The record identification is the same as in the DICTION record, except that the record sequence number is "99999".

Each dictionary contain the following items of information:

1. Keyword or code field.

    There are 4 keyword dictionaries:

Dict. 1	System identifiers (described in Chapter 2)
Dict. 2	Information identifiers (described in Chapter 7)
Dict. 24	Data headings
Dict. 25	Data units

    Dict. 24 Data headings / Dict. 25 Data units — used in COMMON and DATA sections (see Chapter 4)

Other dictionaries define codes used within the BIB section under specific information-identifier keywords (see the Table of Dictionaries, page 6.4).

2. <u>Explanation field</u>: The explanation may be given:
   - in free text,
   - or in an "expanded form"
   - or in an "expanded form" followed by free text.

3. <u>Expanded forms</u>,[1] which are self-explanatory, are provided in certain dictionaries (see page 6.4). The expanded form is enclosed in parentheses; the opening parenthesis is given in the first column of the explanation field (usually column 12). The expanded form is, in general, restricted to the length of the explanation field of one record, but, for certain dictionaries (see page 6.4), the expanded form may continue, within the explanation field, onto following records.

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

   <u>Other coded information</u> is included within this field for some of the dictionaries (*e.g.*, the country of origin for journal codes, certain flags for checking purposes in the case of data-heading keywords). For detail see the dictionaries themselves, and pages 6.5 and following.

The order of entries in each dictionary has been chosen for ease of use by compilers. It is the prerogative of each center to rearrange the dictionary for their own purposes, *e.g.*, for optimum computer use, if they wish.

An example of a dictionary is shown below; columns 67-80 are omitted.

```
DICTION             5|  19991102| Journals
AAA        (ASTRON.AND.ASTROPHYS.) ASTRONOMY AND ASTROPHYSICS      2GER
AAB        (AN.ACAD.BRASIL.CIENC.)ANAIS DA ACADEMIA BRASILEIRA DE  3BZL
            CIENCIAS
AAF        (ANN.ACAD.SCI.FENN.SER.A6) ANNALES ACADEMIAE            2SF
           SCIENTIARUM FENNICAE,SERIES A6:PHYSICA
ABS        (MEM.ACAD.ROY.BELG.CL.SCI.) MEMOIRES DE L'ACADEMIE ROYAL 2BLG
            DE BELGIQUE,CLASSE DE SCIENCES
AC         (ANAL.CHEM.) ANALYTICAL CHEMISTRY                       1USA
ACA        (ANAL.CHIM.ACTA) ANALITICA CHIMICA ACTA                 2NED
ACH        (ANGEWANDTE CHEMIE)                                     2GER
ACJ        (ACTA CHEM.SCAND.) ACTA CHEMICA SCANDINAVICA            2DEN
ACR        (ACTA CRYSTALLOGR.) ACTA CRYSTALLOGRAPHICA              2DEN
            CONTINUED 1970 IN PARTS A AND B
ACR/A      (ACTA CRYSTALLOGR.,PART A) ACTA CRYSTALLOGRAPHICA,      2DEN
            PART A, STARTED WITH VOL.26 IN 1970
ACR/B      (ACTA CRYSTALLOGR.,PART B) FROM VOL.26 (1970)           2DEN
ENDDICTION
```

---

[1] The expanded form may be used to replace the code in an output format, so that the EXFOR user may read the entries without having to consult the dictionaries to find the meaning of the codes.

Table of Dictionaries

Dict. #	Name	Add'l info[2]	Code length	Expansion provided	Status
*1	System Identifiers		≤10		
*2	Information Identifiers	T	≤10	yes	
3	Institutes	T	6 – 7	Yes[4]	
*4	Reference type	T	1	yes	
5	Journals	T	≤6	yes	
6	Reports	T	≤11		
7	Conferences and Books	T	≤10	Yes[4]	
8	Elements		≤6	yes	
*9	Chemical Compounds	T	7 – 10	yes	
10	Process/Parameter (*-QUANT formalism)		≤3		Obsolete
11	Function (*-QUANT formalism)		≤3		Obsolete
12	Modifier (*-QUANT formalism)		≤3		Obsolete
*13	Particle (PART-DET, RAD-DET, *etc*.)		≤3		
14	Quantity (*-QUANT formalism)		≤18	Yes[4]	Obsolete
15	History		1	yes	
16	Status		≤5	yes	
17	Related Reference		1	yes	
18	Facility		≤5	yes	
19	Incident Source		≤5	yes	
20	Additional Results		≤5	yes	
21	Method		≤5	yes	
22	Detectors		≤5	yes	
23	Analysis		≤5	yes	
*24	Data Headings	T	≤10		
25	Data Units	T	≤10		
27	Nuclides	T	≤10		
*28	Incident Particles (REACTION SF2)		≤3	yes	
*29	Product Particles (REACTION SF3)		≤3	yes	
*30	Process (REACTION SF3)		≤3		
*31	Branch (REACTION SF5)		≤5[3]		
*32	Parameter (REACTION SF6)		≤3		
*33	Particles Considered (REACTION SF7)		≤3	yes	
*34	Modifiers (REACTION SF8)	T	≤3		
*35	Data Type (REACTION SF9)		≤5	yes	
*36	Quantities (REACTION SF5-8)	T	≤44	yes[4]	
*37	Result		≤5	yes	
41	Conversion of Quantity (Dict. 14 to Dict.36)		≤18	yes	Obsolete
42	CINDA Quantities		≤3	yes	

* Additions to these dictionaries require NRDC approval.

---

[2] Additional information given on the following pages.

[3] Normally limited to a three-character code.

[4] Expansion may extend to follow-up records. In all other cases, expansion is restricted to the length of the explanation field of one record.

Additional information on specific dictionaries

Dictionary 2. Information-Identifier Keywords. The first record for each keyword has the following format:

Columns   12-33: Expansion
         34-44: Code designating whether keyword is obligatory
             REQ   required
             XREQ   required except where not relevant
             AREQ   one of these codes required
             BREQ   each of these keywords is obligatory when relevant, but at least one of them must be present
             OBS   keyword obsolete; may exist in older entries
         45-55: definition of coded information
             RCODE   code required
             OCODE   optional
             OCODE+ optional; if given, may be repeated in free text
         56-66: Pointer to dictionary used, '+' indicating additional coded information

Any following records contain free text information in columns 12-66.

Obsolete codes are marked by an O in column 66.

Dictionary 3. Institute. The 7-character code ABBBCCC is constructed as follows:

A   = service-area code, 1, 2, 3 or 4 as defined among neutron data centers (see page 1.4)
BBB   = country code
CCC   = lab code (may be less than 3 characters, left adjusted)[5]

The 3-character institute codes include all laboratory, university, institute, agency and commission codes in use in the EXFOR system, and must be unique.

Where the code identifies only a country, the information in the country-code field (columns 2-4) is repeated in the lab-code field (columns 5-7), as for example: 1CANCAN (Canada). For this reason, a lab code may not be identical to a country code.

Obsolete codes are marked with an O in column 80; extinct codes are marked by an X in column 80 (see page 6.2). The code that replaces it, if any, is given in all cases. The dictionary is sorted by the code, thus grouping together the institutes for each area and country.

---

[5] The 3-character lab code is also used by CINDA and, for this reason, must be unique.

Dictionary 4. Type of reference. This dictionary is in the standard format except that columns 56-61 of the explanation field are reserved for the term "DICT *n*" pointing to the dictionary number *n* which contains the reference codes to be used with the given reference type. Columns 56-61 are blank when no dictionary applies.

Dictionary 5. Journals[6]. The actual journal code is restricted to 4 characters or less. Where journals are subdivided into parts, the part is included in the dictionary with the journal code, and separated from it by a slash; the complete code is restricted to 6 characters, as for example:

ND/A = Nuclear Data, Part A.

The area code and country code (country of publication) are in columns 63 to 66.

The expanded form follows the commonly adopted style for journal titles, in particular, INIS.[7] However, some abbreviations have been expanded for clarity.

Obsolete codes are marked by an O in column 80; extinct codes are marked by an X in column 80 (see page 6.2). The dictionary is sorted by codes.

Dictionary 6. Reports[6]. Each code in the dictionary consists of the alphanumeric character string that precedes the actual report number. The final character of the codes given in the dictionary is always a hyphen (-), except in a few cases where the report codes are 11 character and the 12th character a hyphen. In such cases the hyphen is dropped in the dictionary. Since the code and the number may both contain hyphens, the separator is defined as the first hyphen which is followed by a digit or an opening parenthesis, for example:

$$\text{separator}$$
$$\underbrace{\text{AERE-C/R-}}_{\text{code}} \; \underbrace{\text{159-MS}}_{\texttt{number}}$$

Annual progress reports which do not have a report number given are assigned an EXFOR report code A-, followed by the 3-digit institute code; when coded, the code is followed by the year for which the report is given.

Examples: `A-ARK-84` or `A-COL-1999`

The 7-character institute code (as in Dictionary 3) of the institute at which the report was issued is given in columns 60 to 66.

Obsolete codes are marked by an O in column 80; extinct codes are marked by an X in column 80 (see page 6.2). The dictionary is sorted on the institute code and, within the institute code, by report code.

---

[6] In general, these codes are identical with those used in CINDA.

[7] Authority List for Journal Titles, IAEA-INIS-11

Dictionary 7. Conferences and Books.   Codes are up to 8 characters.[8]
<u>Conference</u> codes are composed of the year of the conference given in the first 2 digits of the code, followed by the place of the conference, which may have up to 6 characters.

> *Examples*:   66PARIS
> 82ANTWER

Two conferences at the same place in the same year may be distinguished as shown in the following examples:

　　　　66ANL   and 66ARGONNE
　　　　80BNL   and 80BNL-2
　　　　69WIEN and 69VIENNA

If the proceedings of a conference can be identified by a report code, then the report code should be used and the conference code will be marked in the dictionary as obsolete.

<u>Book</u> codes give a concise short title of the book, or the family name of the first author.

> *Examples:*   ABAGJAN -   Group Constants for Nuclear Reactor Calculations, Abagjan, et al., 1964
> NEJTRONFIZ -   Neytronnaya Fizika, P.Krupchitskiy, 1961

In the dictionary, books, sorted alphabetically by code, precede conferences, which are sorted alphabetically by code, within year.

In this dictionary, two expanded forms may be given: a short expansion, restricted in length to the explanation field of one record; this may be followed, starting on a new record, by a long expansion extending over more than one record.

Dictionary 9. Chemical Compounds.[9] The general compound code CMP can be combined with any element in the form (*Z*-*S*-CMP) without entry in this dictionary, which only lists special cases. The actual compound codes (*e.g.,* OXI for oxide) are restricted to three characters. The codes are sorted by atomic number of the principal element in the compound. See LEXFOR, "Chemical Compounds".

Dictionary 16. Status. This dictionary is in the standard format except that column 66 of the explanation field is reserved for a flag which indicates which codes may be followed by an accession number field:
>   S   indicates that an accession number field may follow the code;
>   R   indicates that an accession number field always follows the code.

Dictionary 19. Incident Source. This dictionary is in the standard format except that column 66 of the explanation field is reserved for a field delimiter which indicates that another code is expected following the code given, and separated from it by the delimiter given.

---

[8]   Some older codes may have a total length of 10 characters. The codes in this dictionary are also used by CINDA, which is restricted to 8-character codes.
[9]   Codes are also used in CINDA.

Dictionary 24. Data Headings. The data headings are used in the COMMON and DATA sections to define the contents of data fields. No expanded form of the codes is given.

Codes should be unique within Dictionary 24 and 25, *i.e.*, a data heading may not be identical to any data unit.

Obsolete codes are marked with an O in column 80.

Column 66 is reserved for a flag. This flag is used for checking purposes and defines the category and the family (or independent variable type) within each category, according to the scheme in the following table.

Family	Flags	
	Variables	**Associated Quantities[10]**
Independent variables		
Incident energy	A	B
Resonance energy	C	D
Secondary energy[11]	E	F
Angle of outgoing particle	G	H
Product charge	I	
Product mass	J	
Secondary linear momentum	L	
Linear momentum	M	
Coefficient number	N	
Neutrons out	O	
Protons out	P	
Secondary effective mass	S	
Additional information [12]		
Sample thickness	K	
Flag	Z	
Sample temperature	8	9
Half life	6	7
Spin J	4	
Momentum *l*	2	
Parity	0	

---

[10] Associated quantities are those data heading keywords which contain the characters ERR or RSL

[11] Except E-LVL-INI and E-LVL-FIN.

[12] In certain cases, these may act as an independent variable.

Dictionary 25. Data Units. The data units are entered in the COMMON and DATA section below the data heading to define the units for the contents of each field.

Codes are unique within Dictionary 24 and 25, *i.e.*, a data unit may not be identical to any data heading.

The format of the dictionary is as follows:

Column	1 - 10	code
	11	blank
	12 - 44	explanation of code (no expanded form given)
	45 - 48	dimension code
	49 - 55	blank
	56 - 66	conversion factor

The dimension code provides a cross-link with Dictionary 36, (Quantity Dictionary) where the dimension code is also given (see page 6.11). This facilitates computerized cross checks for consistency of quantities and units in a table.

The conversion factor is a floating-point number that may be used for transforming units with the same dimension to standard units, for example:

energies	to electron-volts;
angles	to degrees;
time	to seconds;
length	to meters;
cross sections	to barns.

Dictionary 27. Nuclides.[13] The format of the dictionary is:

Column	1 - 11	nuclide code
	12 - 26	flags in defined positions, enclosed in parentheses.

Free text may be given on successive records, starting in column 12.

The **nuclide code** has the format *Z-S-A*

where:	*Z* =	the charge number, up to 3 digits, no leading zeros;
	S =	the element symbol; 1 or 2 characters;
	A =	the mass number; up to 3 digits, no leading zeros; a single zero denotes natural isotopic composition.

---

[13] This dictionary is not intended as a Chart of the Nuclides. Rare or short-lived nuclides will be added only when the nuclide is entered into EXFOR or CINDA.

Columns 12-26 have the following structure:

Column   12   (Parenthesis

           13-23 Each column contains either a flag or blank:

               13   used for REACTION SF1 (SF2≠0)

                    1   indicates validity,

                    X   indicates a warning for unusual use.

               14   used for REACTION SF2.

                    2   indicates validity.

               15   used for REACTION SF3, SF4, and SF7, plus other keywords that allow nuclide codes.[11]

                    3   indicates validity,

                    V   virtual (not yet found)

                    Z   indicates validity, except for those cases where the particle codes are used instead of the corresponding nuclide codes.[14]

               16   used for REACTION SF1 (SF2=0).

                    4   indicates validity.

               17   used to indicate a fission product

                    F   indicates validity.

           (18-21 are presently unused)

               22   used for CINDA

                    C   indicates validity,

                    T   indicates validity for theoretical work only.

               23   used to indicate a stable isotope.

                    S   indicates stability.

           24-25 isomer field:

                  either blank, indicating that the nuclide has no isomeric states

                  or a number, right justified, indicating the maximum number of metastable states (*i.e.*, number of isomeric states not including the ground state).

                  or A, indicating one or more short-lived isomers (<1 sec.), but no long-lived isomers.

               26   ) parenthesis

The flags given in this dictionary cover the normal cases. A number of special rules as described in Chapter 8 under REACTION, DECAY-DATA, *etc.*, must also be considered.

Dictionary 34. Modifiers (REACTION). An expanded form is only given for those general-quantity modifiers (at the beginning of the transmission dictionary) which may be included in the REACTION code, but are not included in the quantity codes given in Dictionary 36.

---

[14] DECAY-DATA, DECAY-MON, EN-SEC, EMS-SEC, HALF-LIFE, MOM-SEC, PART-DET, RAD-DET

Dictionary 36. Quantities. The format of this dictionary is as follows:

Columns   1 - 18   quantity code (or 1-44, see below)
                 19 - 21   dimension code
                 22   flag
                 23 - 66   expanded form and free text.

1. The quantity code is composed of the codes for the REACTION subfields 5 to 8. All meaningful combinations of the codes that are in use are included. Note, however, that these quantity codes do not include the general-quantity modifiers from Dictionary 34 (see preceding page).

2. The dimension code provides a cross-link to Dictionary 25 (Data Units), where the dimension code is also given (see page 6.9). This facilitates computerized checks of whether quantities and units given in a table are consistent.

3. Resonance parameters are flagged with a "**.**" in column 22.

4. The expanded form is a short definition of the quantity. It may be used for edited output to users.

5. If the quantity code length is >18 characters, the code is continued on the same record and followed by blanks and "9" in column 66. The dimension code and the expansion follow on the next record in their assigned fields. Maximum code length = 44 characters.

6. Obsolete codes are marked with an O in column 80.

Particle Designator field. In order to keep the size of the dictionary to a minimum, specific particles are not always included in the particle designator field (REACTION SF7). Instead, this field may contain a code indicating that a particle designator (or designators) is legal for this quantity.

     *   All codes from Dictionary 33, and nuclides from Dictionary 27 which have a "3" or a "Z" in column 15 are allowed in this field.

     *FF   Any fission fragment particle codes is allowed, *i.e.*, FF, LF, HF.

If the particle designator is blank, only a blank field is allowed for that quantity[15].

If more than one particle designator must be given (*e.g.*, for correlations), the codes are given for each particle, separated by slashes.

Examples: `PAR,TTY,A`
                `DA/CRL,P/D`
                `,AKE,*FF`

---

[15] That is, there must be a separate dictionary entry for the quantity with codes in SF7..

Chapter 7

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:
    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)

Exceptions to this coding are noted on the pages for each keyword. (See also **LEXFOR, Elements**). Valid nuclide codes are given in Dictionary 27 (see page 6.9).

Compounds may in some cases replace the nuclide code. The general format for coding compounds is either the specific compound code, taken from Dictionary 9, 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 on page 7.2 with the following exceptions:
      A = 0 denotes natural isotopic mixture,
      X may not have the value G.
    Permitted nuclei are indicated in Dictionary 27 either by a '1' in column 13, or, if SF2 contains a zero, a '4' in column 16.
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 7.8. 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 28.

b) for particles heavier than an α, a code in the form *Z-S-A* (isomer field omitted), see page 7.2. Permitted nuclei are indicated in Dictionary 27 by a '2' in column 14.

SF3. Process. Contains one of the following:

a) a process code from Dictionary 30, *e.g.*, TOT.
   For use of the process codes XN and YP, see page 7.9, Variable Number of Emitted Nucleons.
   See also **LEXFOR, Particles**.

b) a particle code from Dictionary 29 which may be preceded by a multiplicity factor, whose
   value may be 2→99.[1]

   Examples: A
                  4A

c) for particles heavier than α, a code in the form *Z-S-A-X*, see page 7.2, (the mass number may
   not have the value zero). Permitted nuclei are indicated in Dictionary 27 by a '3' in column
   15. 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+8-0-16
                  A+XN+YP

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 7.5.

2) If SF5 contains the branch code UND[3] (undefined), the particle codes given in SF3 represent
    only the sum of emitted nucleons, implying that the product nucleus coded in SF4 has been
    formed via different reaction channels. The code (DEF) in SF5 denotes that it is not evident
    from the publication whether the reaction channel is undefined or defined. 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 6.7.

[2] Lowest Z, then lowest A.

[3] The code UND is presently used only for charged particle reaction data.

SF4. Reaction Product. 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), or if SF3 contains the process code TOT, ABS, or NON.

c) There is no reaction product given if the reaction specifies a resonance parameter (defined in Dictionary 36 by a period in column 22).

d) For certain reactions which 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.
   - 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 F, X, XN, or YP.

Coding: This subfield:
   either is blank, as in cases b, c, and d (see preceding); 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)

   or contains a code in the form *Z-S-A-X*, as described on page 7.2. Permitted nuclei are indicated in Dictionary 27 by a '3' in column 15.

   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 A, HE3, T, D, P, N, G 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 7.2). (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)`

or, if the reaction product is entered into the data table using the data headings ELEMENT, MASS, and/or ISOMER (see page 5.6, 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 5.6.

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 36 (see page 6.11).

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. Code(s) are taken from Dictionary 32.

SF7 Particle Considered. Provides particle code(s) indicating to which of several outgoing particles the quantity refers.[5] When more than one particle code is entered, *e.g.*, for a quantity describing the correlation between outgoing particles, all particles are entered, separated by a slash. Code(s) are taken from Dictionary 33. (See **LEXFOR, Particles**).

The particle considered <u>should</u> be omitted if there is no ambiguity. For integral data this subfield is generally 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)

---

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

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 following, Reaction Ratios, 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**).

<u>Reaction Ratios</u>. 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-NUM   EN-DUM-DN
MEV          EV
 1.0          0.0253
ENDCOMMON
DATA
ELEMENT      MASS           DATA
…
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. (See page 5.1 for general information on pointers). 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 which may be coded using the multiple reaction formalism, see **LEXFOR, Multiple Reaction Formalism**.

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 pages 8.7 (and 8.19), and **LEXFOR, Flags**).[6]

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

    XN   - variable number or neutrons (see following)

    YP   - variable number of protons (see following)

See also **LEXFOR, Reaction Products**.

---

[6] 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 Nucleons. In the case where mass and element distributions of product nuclei have been measured and the Z and/or A of the reaction product acts as an independent variable, the sum of outgoing neutrons and protons may be entered as variables in the data table. In this case SF3 of the REACTION keyword contains at least one of the following codes:

> XN - variable number of neutrons given in the data table.
> YP - variable number of protons given in the data table.

The numerical values of the multiplicity factors *X* and *Y* are entered in the data table under the data headings N-OUT and P-OUT, respectively. See also **LEXFOR, Particles**.

Example:

```
BIB
REACTION     (…(…,XN+YP)…)
…
ENDBIB
NOCOMMON
DATA
EN           N-OUT        P-OUT        DATA
MEV          NO-DIM       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 (see page 6.8) of independent variables. The family code for a given data heading is given in Dictionary 24, column 66.

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.

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 are used when the quantity field contains the modifier MXW, SPA, FST or FIS. See also page 8.13 (INC-SPECT).

   See also **LEXFOR, Incident-Projectile Energy and Spectrum Average**.

2. **Resonance Energy (Family C)** is specified for resonance parameters (flagged in Dictionary 36, see page 6.11). 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.

3. **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 8.9 (EN-SEC), and **LEXFOR, Secondary Particles**.

4. **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.**

5. **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**.

6. **Half life (Family 6)** is coded if SF4 of the REACTION code contains a product with a metastable state extension (see page 7.2), and the half life is not coded under DECAY-DATA. See also **LEXFOR, Half-Lives**.

7. **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.**

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

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

10. **Element** (family I) will be coded when REACTION SF1 or SF4 contains the code ELEM (see page 7.8).

11. **Mass** (family J) will be coded when REACTION SF1 or SF4 contains the code MASS (see page 7.8).

Cross References of Data Heading to Family Codes

Data heading	Family code[7]	Family
EN	A	Incident energy
EN-RES	C	Resonance energy
E	E	Secondary energy
EMS	S	Secondary effective mass
MOM-SEC	L	Secondary linear momentum
ANG	G	Angle of outgoing particle
ELEM	I	Element
MASS	J	Mass
MOM	M	Linear momentum
NUMBER	N	Coefficient number
HL	6	Half life
MOMENTUM L	2	Angular momentum

---

[7] As given by a flag in Column 66 of Dictionary 24.

Chapter 8

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 which 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 AUTHOR INSTITUTE EXP-YEAR	except when not relevent always always	
REFERENCE REL-REF MONIT-REF	always	
Data specification REACTION RESULT	always when a code exists	
Related data MONITOR ASSUMED	except when not relevant	MONIT, *etc.* ASSUM, *etc.*
DECAY-DATA DECAY-MON PART-DET RAD-DET HALF-LIFE		DECAY-FLAG HL1, *etc.*
EN-SEC EMS-SEC LEVEL-PROP MOM-SEC MISC-COL		E1, *etc.* EMS1, *etc.* LVL-FLAG M1, *etc.* MISC, *etc.*
Physics INC-SOURCE INC-SPECT SAMPLE		EN-DUMMY, *etc.*
METHOD FACILITY ANALYSIS DETECTOR	one of these is obligatory	
.CORRECTION COVARIANCE ERR-ANALYSIS	except when not relevant	ERR-*, *-ERR
Other ADD-RES COMMENT CRITIQUE FLAG		FLAG
Bookkeeping STATUS HISTORY	except when not relevant 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 7).

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-LOB0, JA.M.IVANOV,NGO-DINH-LONG,
             A.MORALES AMADO)
    AUTHOR   (R.W.MCNALLY JR)
    ```

COMMENT. Gives pertinent information which 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**.

1. 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-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.

    Flag. 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**.

    Nuclide field. 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 7.2. Permitted nuclei are indicated in Dictionary 27 by a "3" in column 15.

    Half-life field. 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.

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

    Radiation field. 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.

    SF1. Type-of-radiation. A code from Dictionary 13.

    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 and not under DECAY-DATA.

    <u>SF2. Energy</u>. 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**.)

    <u>SF3. Abundance</u>. 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 fields
        `DG,708.,0.27,DG,403.,0.03,B+,,0.006)` 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 not permitted.

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 to define 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 -MIN, -MAX or -APRX.

   Particle Field. This field contains the particle or nuclide to which the data heading refers. The code is:
   - either a particle code from Dictionary 13.
   - or a nuclide coded in the standard format as described on page 7.2.

   Permitted nuclei are indicated in Dictionary 27 by a "3" in column 15.

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 to define 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 or -APRX.

   Particle Field. Contains the particle or nuclide to which the data heading refers. The code is:
   - either a particle code from Dictionary 13.
   - or a nuclide coded in the standard format as described on page 7.2. Permitted nuclei are indicated in Dictionary 27 by a "3" in column 15.

   For two or more particle codes, they are separated by a slash, and ordered *lightest* to *heaviest* as for REACTION subfield 3 (see page 7.3).

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. 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 Repitition of data headings, page 4.3).

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)

   Heading field: Data heading to be defined.

   Nuclide field: General format of the code is *Z-S-A-X*, see page 7.2. 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.

    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 decay 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. Permitted nuclei are indicated in Dictionary 27 by a '3' in column 15.

    Level identification field. Identification of the level whose properties are specified, given as either a level energy or level number. If the field is not present, its separating comma is omitted. If there is no flag field, a level identification field must be present.

    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.

    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 *e.g.*, +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)
    ```

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 13.
    or   a nuclide coded in the standard format as described on 7.1. Permitted nuclei are indicated in Dictionary 27 by a "3" in column 15.

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 or -APRX.

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 8.5).

    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 8.21 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:

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

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

    Example:
    ```
    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 13,
    * or, for particles heavier than α particles, a code of the form *Z-S-A-X*, see page 7.2. Permitted nuclei are indicated in Dictionary 27 by a '3' in column 15.

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 7.6 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.

   Nuclide field. A code of the form *Z-S-A-X,* see page 7.2. Permitted nuclei are indicated in Dictionary 27 by a '3' in column 15.

   Radiation field: One or more codes from Dictionary 33, each separated by a comma.

   No embedded blanks are permitted in the code.

   See also **LEXFOR, Flags**.

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 7 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:
    a) of a parenthesized subfield,
    b) 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 = B or C; Books and Conferences. The reference field may contain up to 4 subfields: code, volume, part, page (paper number).

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

Code subfield: a code from Dictionary 7.

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,67KHAROV,,(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: Journals. The reference field may contain up to 4 subfields: code, volume, issue#, page.

General coding forms: (J,code,volume,(issue #),page,date)
(J,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 and may have any content, except commas or parentheses. Presence optional; if omitted, the following comma is also omitted.

Page (paper #) subfield: If present, contains 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
b) `(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: Thesis or Private Communication. 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.
b) `(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 page 6.6)..

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 8.21 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. 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,F)ELEM/MASS,CUM,FY)/
               (Z-S-A(N,F)MASS,CHN,FY))
    RESULT     (FRCUM)
    ```

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

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

<u>TITLE</u>. 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 9

UPDATING AND ALTERATIONS

Alterations to EXFOR entries

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

When an entry is altered, those subentries which 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 which 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 which 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, 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 which 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).

Appendix A

Example of an EXFOR Entry

Attached is an example of a complete entry in the EXFOR format.

```
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)          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
    ...           ...          ...           ...          ...
  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                    3                    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.

<u>Comment record format</u>

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

<u>Data record format</u>

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

<u>End record format</u>

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

See also **LEXFOR, Covariance**.

Appendix C

GLOSSARY

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

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.

Appendix D

Archive Dictionaries

The EXFOR/CINDA Dictionary Archive consists of a dictionary index file and a set of dictionary files, one for each dictionary, and contains all information necessary for the production of the DANIEL data base, and the EXFOR and CINDA dictionaries. The dictionary numbers <u>do not necessarily correspond to the EXFOR dictionary numbers</u>.

All dictionary updates are made on the Master Archive by the Nuclear Data Section and transmitted periodically to the other Nuclear Reaction Data Centers, either in the form of an EXFOR Dictionary transmission file or as a DANIEL update file.

The format and contents of the Archive Dictionary files are described on the following pages.

Table of Contents

General Format

Dictionary Index

The dictionary index contains a list of all the dictionary files stored, along with supplemental information.

The format of dictionary index line is:
Column(s)   1-3:   Dictionary number
                5-34:   Dictionary name
               36-37: # of DANIEL keys
               39-78: DANIEL record format

Dictionary Files

The dictionary files consist of two types of records: MASTER records and COMMENT records.

The general format of a MASTER record is:

Column(s)	1:	Alter flag
	2-4:	Status Code
	6-11:	Data of entry or last update
	13-32:	Key
	34-113:	Codes, expansions, *etc.* Format and contents given under each dictionary.

The general format of a COMMENT record is (exceptions are noted under each dictionary):

Columns	1-33:	blank
	34-88:	comment

Alteration Flags

Dictionary updates are recorded on the Master Archive files by adding an alteration flag and the date of alteration. When a new transmission is run the flags are used to process the records for the output files, and are deleted from the Master Archive files.

The following flags are used to indicate an alteration to a dictionary record.

    A   The record has been added
    D   The record is marked for deletion
    M   A modification has been made to the Code-expansion field
    S   The status has been changed

Status Codes

A list of legal status codes (for all dictionaries) follows.

CIN	CINDA	used only by CINDA
EXT	extinct	no longer applies, but valid for older data sets
INT	internal	used only by DANIEL System
OBS	obsolete	not to be used on EXFOR exchange files
PRE	preliminary	do not need approval or are approved
PRO	proposed	are not yet approved
TRA	transmitted	sent to all centers on Dictionary transmission file

List of Archive Dictionaries

1	EXFOR System Identifiers
2	EXFOR Information Identifiers
3	Institute Codes
4	Reference Type
5	Journal Codes
6	Report Codes
7	Book and Conference Codes
8	Elements
10	Standard Reactions (CSISRS)
11	Forbidden Reactions (CINDA)
12	CINDA Quantities
13	REACTION Type (for Dictionary 36)
14	REACTION Dimensions (for Dictionary 36)
15	History Codes
16	Status Codes
17	Related Reference Codes
18	Facility Codes
19	Incident Source
20	Additional Information
21	Method
22	Detector
23	Analysis
24	Data Headings
25	Data Units
26	Family Flags
27	Natural Elements, Nuclides and Compounds
30	Process Codes (for REACTION)
31	Branch Codes (for REACTION)
32	Parameter Codes (for REACTION)
33	Particles
34	Modifiers (for REACTION)
35	Data Type
36	Quantities
37	Result
43	NLIB for Evaluated Libraries
44	Data Libraries
50	List of Dictionaries

Contents of Dictionaries

The contents of the operating dictionaries are given on the following pages, along with the format of the MASTER records and any exceptions to the format of the COMMENT records.

For each MASTER record, the primary key is given first with the actual length of the key. (Note, however, that all primary keys are stored as 20-character strings.) Following the primary key, the secondary key (for the DANIEL database), if it exists, and the contents of the dictionary line fields are given. Note that the secondary key is also the first dictionary line field. The dictionary line is stored as an 80-character string.

Dictionary 1: SYSTEM IDENTIFIERS
MASTER RECORD:
    KEY: EXFOR CODE (A10)
            field 1: INTERNAL NUMERICAL EQUIVALENT (I9)
            field 2: EXPANSION (A55)

Dictionary 2: INFORMATION IDENTIFIERS
MASTER RECORD:
    KEY: EXFOR CODE (A10)
            field 1: EXPANSION (A25)
            field 2: KEYWORD REQUIRED (A1)
                R - required
                B - one required
                X - required when relevant
            field 3: INTERNAL NUMERICAL EQUIVALENT (I2)
            field 4: CODE REQUIRED OR OPTIONAL (A1)
                R - required code
                O - optional code
            field 5: blank (A1)
            field 6: EXFOR REQUIREMENT CODES (A22)
            field 7: EXFOR dictionary (A11)

Dictionary 3: INSTITUTE CODES
MASTER RECORD:
    KEY1: EXFOR CODE (A7)
    KEY2: field 1: 3-character CINDA CODE (A3)
            field 2: AREA, COUNTRY CODE (A4)
            field 3: EXPANSION (A53)
            field 4: COUNTRY, ORG. CODE FOR CINDA (A15)
COMMENTS:
    Column 34:   comment flag
                   =   CINDA comment
    Columns 35-88: comment

Dictionary 4: REFERENCE TYPE
MASTER RECORD:
    KEY: EXFOR CODE (A1)
           field 1: SHORT EXPANSION (A4)
           field 2: POINTER TO RELATED DICTIONARY (A3)
           field 3: LONG EXPANSION (A35)

Dictionary 5: JOURNAL CODES
MASTER RECORD
    KEY1: EXFOR CODE (A6)
    KEY2: field 1: CINDA CODE (A4)
           field 2: AREA-COUNTRY CODE (A4)
           field 3: ADDITIONAL AREA-COUNTRY OR ORGANIZATION CODE (A4)
                    1st character area code: 2nd country of origin
                                  T: country of original publication
                                blank: organization code (1st code = nZZZ)
           field 4: SHORT EXPANSION (A20)
           field 5: EXPANSION (A48)
COMMENTS:
    Column 34:   comment flag
               +   addition to title
               *   full title
               .   translation of title
               =   CINDA comment
    Columns 35-88: comment

Dictionary 6: REPORT CODES
MASTER RECORD:
    KEY: EXFOR CODE (A11) (CINDA key is 8-character truncation of code)
           field 1: INSTITUTE CODE (A7)
           field 2: EXPANSION (A48)
           field 3: CINDA FLAG (A1)
                 * Expansion not entered in CINDA book dictionary
COMMENTS:
    Column 34:   comment flag
                =   CINDA comment
    Columns 35-88: comment

Note: This dictionary contains CINDA codes flagged with the status code CIN, which are not simply truncations of the 10-character EXFOR code.

Dictionary 7: BOOK AND CONFERENCE CODES
MASTER RECORD:
    KEY: EXFOR CODE (A10) (CINDA key is 8-character truncation of code)
          field 1: EXPANSION (A53)
          field 2: AREA-COUNTRY CODE (A4)
          field 3: 2ND AREA-COUNTRY OR ORGANIZATION CODE (A4)
                1st character area code: 2nd country of origin
                            T: country of original publication
                            blank: organization code (1st code = nZZZ)
          field 4: CINDA SHORT CODE (A10)
COMMENTS:
    Column 34:   comment flag
                    (EXFOR long expansion
                    =   CINDA comment
    Columns 35-88: comment

Dictionary 8: ELEMENTS
MASTER RECORD:
    KEY1: Z-NUMBER OF ELEMENT (I3)
    KEY2: field 1: ELEMENT SYMBOL (A2)
            field 2: ELEMENT NAME (A20)

Dictionary 10: STANDARD REACTIONS (CSISRS)
MASTER RECORD:
    KEY: CSISRS CODE line format output (A2)
          field 1: EXPANSION (A24)
          field 2: INTERNAL NUMERICAL EQUIVALENT (A56)

Dictionary 11: FORBIDDEN REACTIONS (CINDA)
MASTER RECORD:
    KEY: EXFOR CODE (A8)
          field 1: EXFOR CODE (A50)

Dictionary 12: CINDA QUANTITIES
MASTER RECORD:
    KEY: CINDA CODE (A3)
          field 1: FISSION FLAG (A1)
          field 2: INTERNAL NUMERICAL EQUIVALENT (I4)
          field 3: CINDA SHORT EXPANSION (A14)
          field 3: EXPANSION (A50)

Dictionary 13: REACTION TYPE (for Dictionary 36)
MASTER RECORD:
    KEY: EXFOR CODE (A3)
          field 1: COMPUTATION FORMAT (A5)
          field 2: ONLINE SYSTEM CODE (A4)
          field 3: INDEPENDENT VARIABLE FAMILY CODE (I10)
          field 4: EXPANSION (A65)

Dictionary 14: REACTION DIMENSIONS (for Dictionary 36)
    MASTER RECORD:
    KEY: EXFOR CODE (A1)
          field 1: EXPANSION (A55)

Dictionary 15: HISTORY CODES
MASTER RECORD:
    KEY: EXFOR CODE (A1)
          field 1: SHORT EXPANSION (A15)
          field 2: LONG EXPANSION (A45)

Dictionary 16: STATUS CODES
MASTER RECORD:
    KEY: EXFOR CODE (A5)
          field 1: INTERNAL NUMERICAL EQUIVALENT (I5)
          field 2: EXPANSION (A55)
          field 3: SUBACCESSION # FIELD FLAG (A1):
                  R - code must be followed by subaccession #
                  S - code may be followed by subaccession #

Dictionary 17: RELATED REFERENCE CODES
MASTER RECORD:
    KEY: EXFOR CODE (A1)
          field 1: EXPANSION (A53)

Dictionary 18: FACILITY
MASTER RECORD:
    KEY: EXFOR CODE (A5)
          field 1: EXPANSION (A53)
          field 2: SPECIAL USE CODE (A4)
                  NEUT, PHOT

Dictionary 19: INCIDENT SOURCE
MASTER RECORD:
    KEY: EXFOR CODE (A5)
          field 1: EXPANSION (A53)
          field 2: SPECIAL USE CODE (A4)
               NEUT, PHOT
          field 3: DELIMITER CODE (A1)

Dictionary 20: ADDITIONAL INFORMATION
MASTER RECORD:
    KEY: EXFOR CODE (A5)
          field 1: EXPANSION (A53)

Dictionary 21: METHOD
MASTER RECORD:
    KEY: EXFOR CODE (A5)
          field 1: EXPANSION (A53)
          field 2: SPECIAL USE CODE (A4)
               FY, NEUT, PHOT

Dictionary 22: DETECTOR
MASTER RECORD:
    KEY: EXFOR CODE (A5)
          field 1: EXPANSION (A53)
          field 2: SPECIAL USE CODE (A3)
               FY, NEU, GAM

Dictionary 23: ANALYSIS
MASTER RECORD:
    KEY: EXFOR CODE (A5)
          field 1: EXPANSION (A53)
          field 2: SPECIAL USE CODE (A4)
               PHOT, RP

Dictionary 24: DATA HEADINGS
MASTER RECORD:
   KEY: EXFOR CODE (A10)
        field 1: DATA TYPE (2I1)
           1st integer 0: flags, *etc.*
                      2nd integer   1:flag
                                        2: decay flag
                                        3:level flag
                                        4: miscellaneous data
               1: assumed values
                     2nd integer   1: monitor
                                          5:assumed
               2: data
                     2nd integer   1:data
                                          3: ratio
               3: resonance parameter
                     2nd integer   1: quantum number
                                          2: energy
               4: incident energy
                     2nd integer   1: energy
                                          2: momentum
                                        3: spectrum energy
                                        4: spectrum temperature
               5: secondary energy
                     2nd integer   1: particle energy
                                          2: level energy
                                        3: excitation energy
                                        4: Q value
                                        5: energy degradation
                                        6: energy gain
                                        7: level number
                                        8:linear momentum
                                        9:polarity
               6: angle
                     2nd integer   1: angle
                                          2: cosine
                                        7: q (momentum transfer)
                                        8: wave number
               7: number
                     2nd integer   5: coefficient number
                                        6: kq

Dictionary 24: DATA HEADINGS (continued)

        8: other variable
           2nd integer   2: sample temperature
                        3: sample thickness
                        4: polarization
                        5: half-life
                        6: group number
                        7: decay constant
        9: isotope/particle identification
           2nd integer   1: element
                        2: mass
                        3: isomer
                        4: monitor element
                        5: monitor mass
                        9: emitted nucleons
    field 2: FAMILY CODE (A1)
    field 3: PLOTTING FLAGS (I7)
      col 1-3 - independent variable
      col 4-6 - dependent variable
        col 1 & 4: variable
             1 - value
             2 - minimum
             3 - maximum
             4 - approximate
             5 - one of multiple variables
             9 - uncertainty or resolution
        if col 1 = 1-5:
         col 2: 1 - numerator
                2 - denominator
        if col 1 or 4 = 9:
         col 2 & 5: +error; col 3 & 6: -error
             1 - error
             2 - resolution
             3 - half resolution
             4 - statistical error
             5 - partial error
      col 7 - reference frame flag
             1 - c.m. system
    field 4: UNIT CODE (A4)
    field 5: SPECIAL USE FLAG (A1)
        H = for relativistic heavy-ion data
    field 6: EXPANSION (A55)

Dictionary 25: DATA UNITS
MASTER RECORD:
    KEY: EXFOR CODE (A10)
           field 1: EXPANSION (A35)
           field 2: FAMILY CODE (A4)
           field 3: CONVERSION FACTOR (E11)
           field 4: SORTING CODE (A3)

Dictionary 26: UNIT FAMILY CODES
MASTER RECORD
    KEY: UNIT FAMILY CODE (A4)
           field 1: DICTIONARY 24 USE (I2)
           field 2: DICTIONARY 25 USE (I2)
           field 3: DICTIONARY 36 USE (I2)
           field 4: EXPLANATION (A50)

Dictionary 27: NATURAL ISOTOPIC MIXTURES, NUCLIDES AND COMPOUNDS
MASTER RECORD:
    KEY1: EXFOR CODE (A10)
    KEY2: field 1: CINDA CODE (A5)
           field 2: INTERNAL NUMERICAL EQUIVALENT (I6)
           field 3: NUCLIDE USES (A13)
                  (See EXFOR Chapter 7 for field contents)
           field 4: SPIN (E5)
           field 5: for isotopes, ISOTOPIC ABUNDANCE (E11)
                  for natural element, ATOMIC WEIGHT (E11)
           field 6: EXPANSION (A25)
           filed 7: COMPOUND FLAG (A1) = '*'
COMMENT RECORD
    Columns 34-35: OUTPUT DICTIONARY NUMBER FOR DANIEL (I2)
                  (blank after 1st MASTER Record).
    Columns 36-88: COMMENT

Dictionary 30: PROCESS CODES
MASTER RECORD:
    KEY: EXFOR CODE (A3)
           field 1: INTERNAL NUMERICAL EQUIVALENT (I10)
           field 2: EXPANSION (A55)

Dictionary 31: BRANCH CODES
MASTER RECORD:
    KEY: EXFOR CODE (A3)
           field 1: INTERNAL NUMERICAL EQUIVALENT (I10)
           field 2: EXPANSION (A55)

Dictionary 32: PARAMETER CODES
MASTER RECORD:
    KEY: EXFOR CODE (A3)
            field 1: INTERNAL NUMERICAL EQUIVALENT (I10)
            field 2: EXPANSION (A55)
            field 3: SPECIAL USE CODE (A4)

Dictionary 33: PARTICLES
MASTER RECORD:
    KEY: EXFOR CODE (A3)
            field 1: INTERNAL NUMERICAL EQUIV: Reaction SF2,3 (I6)
            field 2: INTERNAL NUMERICAL EQUIV: Reaction SF7 (I5)
            field 3: ALLOWED SUBFIELD FLAG (A4)
                    D - BIB keyword other than REACTION; 1st character
                    1 - REACTION SF2; 2nd character
                    2 - REACTION SF3; 3rd character
                    7 - REACTION SF7; 4th character
            field 4: EXPANSION (A40)
COMMENT RECORD
    Columns 34-35: OUTPUT DICTIONARY NUMBER FOR DANIEL (I2)
    Columns 36-88: COMMENT

Dictionary 34: MODIFIERS
MASTER RECORD:
    KEY: EXFOR CODE (A3)
            field 1: INTERNAL NUMERICAL EQUIVALENT (I10)
            field 2: GENERAL QUANTITY MODIFIER FLAG (A5)
            field 3: EXPANSION (A55)
COMMENT RECORD
    Column 1:   Flag
                    *   replaces EXFOR expansion
    Columns 35-89: Comment

Dictionary 35: DATA TYPE
MASTER RECORD:
    KEY: EXFOR CODE (A5)
            field 1: INTERNAL NUMERICAL EQUIVALENT (I10)
            field 2: EXPANSION (A40)

Dictionary 36: QUANTITIES
MASTER RECORD:
   KEY: EXFOR CODE (A18)
          field 1: INTERNAL NUMERICAL EQUIV. Reaction SF5 (I6)
          field 2: INTERNAL NUMERICAL EQUIV. Reaction SF6 (I6)
          field 3: INTERNAL NUMERICAL EQUIV. Reaction SF7 (I6)
          field 4: INTERNAL NUMERICAL EQUIV. Reaction SF8 (I6)
          field 5: REACTION TYPE (A3)
          field 6: REACTION DIMENSION (A1)
          field 7: FAMILY CODE (A4)
          field 8: EXPANSION (A48)
COMMENT RECORD
   Columns 34-77: COMMENT

Dictionary 37: RESULT
MASTER RECORD:
   KEY: EXFOR CODE (A5)
          field 1: EXPANSION (A53)

Dictionary 43: NLIB for Evaluated Libraries
MASTER RECORD:
   KEY: NLIB NUMBER (A2)
          field 1: LIBRARY NAME (A40)

Dictionary 44: Data Libraries
MASTER RECORD:
   KEY: LIBRARY NAME (A20)
          field 1: AREA-COUNTRY CODE (A4)
          field 2: AREA-COUNTRY, ORGANIZATION CODE (A4)
               1st character: area code; 2nd country of origin
                           blank; organization code (1st code = nZZZ)
          field 3: EXPANSION (A55)

Archive/EXFOR Dictionary Correspondence

EXFOR	Title	Archive Source
1	EXFOR System Identifiers	1
2	EXFOR Information Identifiers	2
3	Institute Codes	3
4	Reference Type	4
5	Journal Codes	5
6	Report Codes	6
7	Book and Conference Codes	7
8	Elements	8
9	Compounds	27
13	REACTION Type (for Dictionary 36)	33
15	History Codes	15
16	Status Codes	16
17	Related Reference Codes	17
18	Facility Codes	18
19	Incident Source	19
20	Additional Information	20
21	Method	21
22	Detector	22
23	Analysis	23
24	Data Headings	24
25	Data Units	25
27	Nuclides	27
28	Incident Particles (REACTION SF2)	33
29	Product Particles (REACTION SF3)	33
30	Process Codes (REACTION SF3)	30
31	Branch Codes (REACTION SF5)	31
32	Parameter Codes (REACTION SF6)	32
33	Particles Considered (REACTION SF7)	33
34	Modifiers (REACTION SF8)	34
35	Data Type (REACTION SF9)	35
36	Quantities (REACTION SF5-8)	36
37	Result	37
42	CINDA Quantities	12
43	NLIB for Evaluated Libraries	43

Appendix P

PROTOCOL FOR COOPERATION BETWEEN
THE NUCLEAR REACTION DATA CENTERS

The general scope of EXFOR data is all experimental microscopic nuclear reaction data.

Data tapes are exchanged regularly between the Nuclear Reaction Data Centers (NRDC) in the EXFOR format in accordance with the conventions laid down in the EXFOR Manual. Modifications to the general scope of EXFOR data can be adopted only as a result of an agreement between the NRDC.

The working language of EXFOR is English, and all free text comments within all EXFOR entries shall be in English.

All matters that affect EXFOR, in general, must be agreed to by the Nuclear Reaction Data Centers.

Table of Contents

Data Compilation Responsibility

The data centers are responsible for compiling nuclear reaction data as given in the following sections.

Neutron, charged-particle, and photonuclear reaction data must be compiled in separate entries, with appropriate identification, even if they are reported in the same publication.

<u>Neutron Reaction Data Compilation</u>. The responsibility for the collection, compilation and dissemination of neutron data information is shared among the four major neutron data compilation centers, each being responsible for a defined service area.

The four primary neutron data centers and their respective service areas are:

- The National Nuclear Data Center (NNDC) services the U.S.A. and Canada.

- Nuclear Energy Agency Data Bank (NEA-DB) services the non-American member Countries of the O.E.C.D.

- The Russian Nuclear Data Center (CJD), services the countries of the former U.S.S.R.

- The I.A.E.A. Nuclear Data Section (NDS) services I.A.E.A. Member States not included in the service areas of the above three centers.

Within the scope of this protocol each center is expected to compile the data measured in its service area as fast and as thoroughly as possible. If two institutions from different service areas are involved, the primary institution defines the responsible center. See **LEXFOR, Institutes** for definition of primary institution.

Where the primary institute is not clear, the centers concerned should consult each other before compiling the data in order to avoid duplicate entry of the same data.

All neutron reaction data published after 1 July, 1970, should be coded in EXFOR (where new is defined as data collected by the centers at the time of, or after, formal transmission of data was initiated). Earlier data will be compiled as time permits.

Although each center may compile data measured outside its service area, regular transmission of EXFOR data from any one center shall include data only from its own service area.

Each center shall keep an archival copy of the latest version of each of the EXFOR entries which it originated and shall be ready to provide the data to any center should it be required.

All matters concerning the exchange of neutron data must be agreed to by the four primary neutron data centers.

<u>Charged-Particle Reaction Data Compilation</u>. The following four nuclear reaction data centers have the responsibility for the collection, compilation, and dissemination of charged-particle data information from their respective countries from 1980 and later.

- National Nuclear Data Center (NNDC): for the United States and Canada,

- Japan Charged-Particle Reaction Group (JCPRG): for data from Japan,

- ATOMKI: for data from Hungary and Jülich,

- Russian Nuclear Structure and Reaction Data Center (CAJaD): for all countries not covered by other centers.

If two institutions from different service areas are involved, the primary institution defines the center responsible (see **LEXFOR, Institutes**, for definition of primary institution).

For other countries and for all charged-particle reaction data published until 1979, with the exception of data measured in Japan, CAJaD will be responsible for coordinating the compilation of the data. JCPRG will be responsible for all data measured in Japan.

The following procedures should be followed.

New Data (1980→): A center wishing to compile data (C1) will contact the center in whose area of responsibility the data were produced (C2) with a list of the data sets to be compiled. C2 will inform C1, as quickly as possible, whether the data either have been compiled or are in the process of being compiled by another center. If the data are not compiled or being compiled, C2 will either agree to compile them with priority, or ask that C1 compile the data and send them to C2 to be included in the next regular C2 transmission file.

Old Data (→1979): A center wishing to compile data (C1) will contact all other centers with a list of the data sets to be compiled. The center responsible for the data (JCPRG or CAJaD) will inform C1, as quickly as possible, whether the data either have been compiled or are in the process of being compiled by another center. If the data are not compiled or being compiled, C1 will compile the data and include it in the next regular C1 transmission file.

1) The center wishing to compile data should notify CAJaD of the data sets that they intend to compile.

2) CAJaD will check that the data set has not been compiled, and is not being compiled by another center, and will let the originating center know if they may go ahead with the compilation.

   CAJaD will be responsible for checking that the data sets transmitted do not duplicate existing data.

<u>Photonuclear Reaction Data Compilation</u>. The Center for Photonuclear Experimental Data (CDFE) will be responsible for coordinating the compilation of photonuclear reaction data.

For photonuclear data there is no requirement for completeness.

EXFOR Transmissions

Assignment of Accession Numbers. The methods of assigning accession numbers may be different at each center. That is to say, a center may assign them manually or automatically (by computer). A center may assign legal EXFOR accession numbers only to works within its agreed area of responsibility. Where the responsibility for compiling a given data set is not clear, the centers concerned should consult each other before compiling the data in order to avoid duplicate entry of the same data. (See **LEXFOR, Institute**).

Procedure for transmitting new exchange files. The originating center deposits new exchange files on the IAEA open area, subdirectory TRANS.EXCHANGE,[1] and notifies the other centers. The other centers will have one month to suggest modifications to the file.

As soon as possible after the month has passed, the originating center should:

1. Either make any suggested modifications to the file, or notify the other centers why the modifications have not been made.

2. Deposit the corrected file in the IAEA open area, subdirectory TRANS,[2] and notify the other centers.

3. Delete the preliminary version from the IAEA open area.

In general, it is the responibility of the individual centers to transfer the files from the IAEA open area.

Procedure for files received with errors. There are two cases to be considered for files received with errors.

1. If a file can not be physically read, in part or whole, then the originating center should be requested to send another identical file, which should be done with minimum delay.

2. If there are errors (format, structure, *etc*.) in one or more entries, then the originating center should be notified of the errors by 4C- or CP-Memos with the usual distribution.

Alterations to EXFOR entries. Alterations to EXFOR entries are, in general, transmitted only by the originating center and are included in the regular EXFOR transmissions. However, retransmission of entries belonging to a center that is no longer active in an area compilation may be done at another center by agreement of the cooperating centers.

Serious corrections (for example, those involving the COMMON or DATA sections, or essential BIB keywords such as REACTION, MONITOR, *etc*.) should be transmitted as quickly as possible. Less serious corrections can be made and transmitted as workloads permit.

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[1] Suggested naming convention: PRELIM.*nnnn*, where *nnnn* is the file identification number.

[2] Suggested naming convention: TRANS.*nnnn*, where *nnnn* is the file identification number.

Communication between Centers

Discussion among the cooperating centers on the subjects of data compilation, the EXFOR system and its further development, EXFOR Manual and Dictionaries, and EXFOR transmission files, are continued by means of memos, which are called:

- **CP Memos**: for the communication of proposals, programming details and other general considerations that touch upon the overall aspect of EXFOR. These memos are distributed to the cooperating centers. Other compiling groups are informed, as needed, by their center of contact. This series of memoranda is numbered as: Memo-CP-*n/m*.

- **Four-Center Memos**: for the communication of details dealing only with neutron data or other Four-Center (non-EXFOR) matters, *e.g.*, CINDA. This series is numbered as: Memo 4C-*n/m*.

  For both series of memos *n* is the center identification number, and *m* the chronological memo number within the center.

Such memos should conform to the following general format:

1. The memo shall be headed by the memo number, the date, originating staff member(s), and subject.

   For memos covering more than one topic, all subjects should be listed separately, and the contents of the memo should be summarized on a covering-page. Each subject should begin on a new page to facilitate distribution to the appropriate staff at each center for action. The memo number should appear on each page.

2. Items requiring agreement of the cooperating centers should be noted on the appropriate page.

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

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

EXFOR Dictionaries

Routine transmission of Dictionaries. The IAEA Nuclear Data Section (NDS) is responsible for the coordination and the updating of the EXFOR dictionaries. For this purpose, an archival dictionary file is maintained at NDS in the DANIEL format (see Appendix D).

About every three months, or whenever a major alteration is made, NDS will transmit the complete dictionary file to the cooperating centers, either in the EXFOR or DANIEL format, as each center prefers.

It is the responsibility of each center to verify that EXFOR information is compiled in accordance with the latest version of the dictionaries.

Addition of new codes. The cooperating centers may propose new codes or any other dictionary alteration by means of CP-Memos. A proposal for a new code should include any associated information needed for the dictionary, along with an explanation of its use, and, where appropriate, references to data sets for which it will be used.

The center responsible for updating the dictionaries is also responsible for checking the consistency of proposed alterations with other codes and with the manuals. Some latitude is allowed in the formulation of a final dictionary entry, but the meaning must not be changed without the approval of the originating center. In questionable cases, the other centers should be consulted. The cooperating centers are responsible within their respective areas for keeping the laboratory (Dictionary 3) and bibliographic reference code (Dictionaries 5-7) dictionaries up to date.

Consequential updates, in particular, changes to the codes in Dictionaries 1, 2, 4, 16, 24, 25, 28-37 will be entered into the dictionaries only after approval by the centers.[3] Also, alterations of EXFOR dictionary entries that entail changes to data already transmitted cannot be implemented without specific NRDC approval. A proposed dictionary alteration that appears to be trivial (inconsequential) will be added to the dictionaries as soon as possible after receipt.

If a center uses a new dictionary code in a data transmission prior to its inclusion in the relevant dictionary, the center must be prepared to correct the entry and retransmit it, if the new code is not approved.

In general, a dictionary alteration becomes effective upon its transmission to the cooperating centers.

Changes to Scope and Format of EXFOR

No changes in the structure of EXFOR will be allowed without NRDC agreement.

If any one of the NRDC initiates a proposal which would result in changes of the EXFOR structure and content, it will be the responsibility of the center originating such proposal to obtain NRDC agreement, following the procedure outlined, below.

The following procedure should be followed by each of the NRDC members in obtaining the agreement for changes or revisions;

1. The initial proposal should be disseminated to all centers. Wherever possible proposals affecting the content of the EXFOR Manual should contain proposals for specific wording to be inserted in the Manual. All communications with regard to such proposals shall be in the form of CP Memos.

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[3] See section on Changes to Scope and Format of EXFOR

2. In the case where there is discussion on a proposal, the initiating center shall then collect and digest all comments, suggestions and counter proposals.

3. In this review, the initiating center shall consider all facts would affect the EXFOR associated computer codes.

4. A change in EXFOR will not oblige centers to change existing entries (whether they have been transmitted or not) unless stated explicitly in the proposal and approved by the data centers.

5. The initiating center shall then distribute a technical evaluation of alternatives to the other centers.

6. After receiving the response to this technical evaluation:
   a) <u>In the case of positive agreement</u>, the initiating center shall submit a final proposal including all dictionary, EXFOR Manual, and LEXFOR updates and mention which computer programs will need to be updated.
   b) <u>If no positive agreement has been reached</u>, the proposal will be included in the agenda of the next NRDC meeting. In order to be adopted at an NRDC meeting, a proposal should be sent out at least one month prior to the meeting date.

Whenever decisions are made at an NRDC meeting which require Manual changes, the dictionary and manual updates should be prepared and sent out as soon as possible after the draft minutes are received. The minutes of the meeting should include either the proposed dictionary and manual updates or a reference to the CP-Memo(s) in which they are given.

1. Adequate explanation and documentation to help in preparing LEXFOR entries should accompany any suggestions for additions to LEXFOR.

2. Proposals for new dictionary quantity codes (Dictionaries 28-37) should be supported by an expansion, a full explanation of its use and limits, a list of corresponding Dictionary 36 entries, and, where appropriate, a reference to the data for which the code will be used.

Manuals

<u>Updating of Manual Pages</u>. The center responsible for the updating of the Manuals is the National Nuclear Data Center (NNDC).

The final proposed manual update, submitted in a CP-Memo or in the minutes of an NRDC meeting, is entered into the manuals substantially unchanged. However, the NNDC is free to introduce editorial changes to maintain a consistency of style. The NNDC is also responsible for maintaining the internal consistency of the manuals which means, *e.g.*, that they must check whether an agreed proposal entails changes (cross-references, *etc.*) in other parts of the manuals.

In general, a non-editorial change on a manual page, as compared to its previous version, is marked by a vertical line in the left-hand margin, and the date of the latest revision to that page is given at the bottom of each page.

Where there are different views on matters of minor importance, These may all be included in LEXFOR in so far as these views are in agreement with the agreed procedures and do not cause ambiguities in the definitions of codes.

Manual updates will be issued as soon as possible.

EXFOR Processing and Retrieval Codes.

Some EXFOR Processing and Retrieval programs are used by more than one data center. Each center using one of these programs is invited to contribute suggestions for updates to the program. The originating center will coordinate all program updates.

If another center wishes to update a code, that center should communicate their intention to the originating center before any updates are done in order to avoid duplication of programming effort. The updated code should be transmitted immediately to the originating center.

The originating center retains responsibility for the official version of the code and is free to reject unsanctioned updates. Only the originating center will transmit updated versions to the other centers.

Cooperating Centers and Groups

	Center address	**Electronic addresses**
NNDC	National Nuclear Data Center, Bldg. 197D Brookhaven National Laboratory Upton, NY, 11973-5000 U.S.A.	Email: nndc@bnl.gov or nndc*nn*@bnl.gov[4] www.nndc.bnl.gov
NEADB	NEA Data Bank 12, boulevard des Iles 92130 Issy-les-Moulineaux, FRANCE	Email:nea@nea.fr or *name*@nea.fr
NDS	IAEA Nuclear Data Section Wagramerstr. 5, P.O.Box 100 A-1400 Vienna, AUSTRIA	Email: *name*@iaeand.iaea.or.at
CJD	Federal Research Center IPPE Centr Yadernykh Dannykh Ploschad Bondarenko 249 020 Obninsk, Kaluga Region, RUSSIA	Email: *name*@cjd.obninsk.ru
CAJaD	National Scientific Research Center Kurchatov Institute Russia Nuclear Center 46 Ulitsa Kurchatova	Email: Chukreev@cajad.kiae.su

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[4] *nn* = first and last initial of person to be contacted, *e.g.*, NNDCCD@BNL.GOV.

	Center address	**Electronic addresses**
	123 182 Moscow, RUSSIA	
CDFE	Institute of Nuclear Physics Moskovskiy Gos. Universitet Vorob'evy Gory 119 899 Moscow, RUSSIA	Email: varlamov@cdfe.npi.msu.ru
CNDC	China Nuclear Data Center China Institute of Atomic Energy P.O. BOX 275 (41) Beijing 102413, CHINA	Email: cndc@mipsa.ciae.ac.cn
RIKEN	The Institute of Physical & Chemical Research (RIKEN) 2-1 Hirosawa, Wako-Shi Saitama-ken 351-01, JAPAN	Email: Tendow@postman.riken.go.jp
JCPRG	Japan Charged Particle Reaction Group Dept. of Physics Hokkaido University Kita-10 Nisha-8, Kita-ku Sapporo 060, JAPAN	Email: kato@nucl.phys.hokaido.ac.jp
ATOMKI	Dr. F. T. Tárkányi Cyclotron Application Department ATOMKI, Institute of Nuclear Research Bem Tér 18/c, P. O. Box 51 H-4001 Debrecen, HUNGARY	Email: tarkanyi@atomki.hu
RFNC	Russian Federal Center - VNIIEF Sarov, Nizhni Novgorod Region 607 190 pr. Mira 37, RUSSIA	Email: dunaeva@expd.vniif.ru
The following center has contributed in the past, but is no longer compiling data		
KaChaPaG	Charged Particle Nuclear Data Group Institute for Radiochemie Kernforschungszentrum Karlsruhe Postfach 3640 D-75 Karlsruhe, GERMANY	