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Nuclear Reaction Data Centers
Exchange Formats Manual

Part I

CINDA2001
Exchange Format Manual

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INTRODUCTION

CINDA2001 is an exchange format designed to allow transmission of references to information on nuclear reactions among the members of the Nuclear Reaction Data Center Network (NRDC)[1]. The "CINDA System" contains all references that have been exchanged among these centers. Included are references to measured and evaluated data; references to the databases containing the data are also included. References to theory, calculations, compilations, and reviews may be found in the database for entries exchanged before September 2003.

The information in the CINDA system is obtained from scanning the available literature, both published and unpublished. Coverage is "complete" for neutron data from 1935 to the present. Coverage for charged-particle data is fairly complete *from* 1980 to the present, and less complete before 1980. Coverage for photon-induced data is mainly taken from Photonuclear Data[2], which covers the period 1976 to the present.

This manual is intended to be a complete guide to the indexing of information in the CINDA2001 format.

HISTORY

CINDA was originally designed in 1958[3] as a Card Index to Neutron Data. It was adopted in the 1970's by the four Neutron Data Centers[4] as an international index to the neutron data and a format was designed to facilitate the exchange of information between these centers. The Card Index format was retained as method of communication between "CINDA readers" and the Neutron Data Centers[5]. The compilation scheme remained essentially unchanged until 2003.

In the meantime, the Nuclear Reaction Data Network had evolved from the original four centers to a group of thirteen centers involved in the compilation of nuclear reaction data for incident charged particles and photons, in addition to neutrons. The need for an index that would allow the inclusion of all reaction data lead to a complete redesign of the bibliographic system.

[1] See NRDC Manual introduction for a list of the cooperating data centers.

[2] V. V. Varlamov, V. V. Sapuchenko, M. E. Stepanov, **Photonuclear Data 1976-1995**, Photonuclear Experimental Data Center, Moscow University (1996).

[3] CINDA was designed by Herbert Goldstein, a professor in the Department Of Applied Physics and Engineering at Columbia University, see Nuclear Development Corporation of America report NDA 2-80 (1958).

[4] These centers are: the US National Nuclear Data Center, the NEA Data Bank, the IAEA Nuclear Data Section, and the Russian Nuclear Data Center at Obninsk.

[5] S. Webster, Editor, CINDA Reader's Manual, unpublished, NEA Data Bank, February 1990.

The new system is more compatible with the EXFOR format[6], and has adopted many of the same the codes, thereby eliminating the need for users of nuclear reaction data to learn different sets of notation when accessing the bibliographic and data files.

CINDA2001 EXCHANGE FORMAT

The CINDA2001 exchange format consists of a series of 132-character records plus a header record that gives information about the attached file. The format of the header record is:

Columns	Content	Use
1-5	ID	CINDA
6	*(blank)*	
7-15	Type of file	READER or EXCHANGE; left-adjusted
16-22	Exchange number	Area code, number of exchange for area; right-adjusted.
23-33	Date of exchange	8-digit right-adjusted integer: year, month, day (YYYYMMDD)
34-44	Number of records on file	Right-adjusted integer

Files transmitted will be either exchange files or reader files. The format of these files is the same, but the content will differ slightly; the differences are noted under the sections on the appropriate fields.

Exchange files consist of records produced for transmitting entries from a center's own area of responsibility.

Reader files contain records produced by the transmitting center for an area outside its responsibility and transmitted to the responsible center for addition to its database. After the update of its database, the records will be transmitted by the responsible center to all other centers.

[6] See NRDC Manual, Part II, EXFOR Formats Manual

The fields given in the CINDA2001 exchange format are as follows.

Columns	Contents	Formats	Comment
1	Operation code	A1	Operation to be performed on database.
2-8	Target Nucleus	2I3,A1	Target Z, A, isomeric state (ZZZAAAm)
9-23	Reaction	A15	Generally, EXFOR REACTION SF2-SF4
24-26	Quantity	A3	From Dictionary 47.
27-33	Institute	A6	From Dictionary 3.
34-38	Block #	A5	Center assigned block #
39-40	Sequence #	I2	Sequence within block
41	Work type	A1	From Dictionary ??.
42	Reader code	A1	At discretion of center (blanks allowed)[7]
43-56	Energy range	2(E7.1)	Minimum, maximum energy (±n.n±ee)
57	Hierarchy code	I1	Hierarchy for references.
58-80	Reference	A23	Type (A1), Reference code (A22),
81-86	Date of reference	I6	Date: year and month, right-adjusted (YYYYMM)
87-132	Comment	A46	

Any codes to be used in CINDA2001 are included in dictionaries contained in the Archive Dictionaries. Updates to the dictionaries must be submitted before any code not given in these dictionaries may be used on a CINDA2001 exchange file.

Details for the coding and content of each of the above fields are given on the following pages.

OPERATION CODE (Column 1)

The operation code is a signal to the database update code as to what operation must be performed. The following list contains the legal operation code and their use.

Code	Meaning	Exchange Use	Reader Use
A	Add record	Block number and sequence number must be specified	Block number may be specified; sequence number must be blank.
D	Delete record	Block number and sequence number must be specified	Block number and sequence number must be specified.
M	Modify record	Block number and sequence number must be specified	Block number and sequence number must be specified

The remainder of the record must be complete for both reader and exchange format.

[7] That is, centers may choose not to use a reader code.

TARGET NUCLEUS (Columns 2-8)

The target nucleus is given as 2 three-digit integers (Z and A) , both right-adjusted in their field, plus an isomeric state code. All legal Z, A codes are found in Dictionary 227. The isomeric state code is blank for a nucleus in the ground state, and consists of the metastable state number for metastable states.

For compound nucleus properties, *e.g.*, resonance parameters, the nucleus entered is the target for the reaction(s) analyzed.

For a theoretical work giving systematic trends over many nuclei[8], the code MNY may occur in the A field with Z equal to 999. The code MNY is used either in place of, or in addition to, separate entries for the individual nuclei.

Naturally occurring elements

For naturally occurring elements that contain a mixture of isotopes, a zero is entered in the A-number field. For monoisotopic elements, the Z and A of the isotope are given. For nearly monisotopic elements, *i.e.*, for elements where the principal isotope is more than 99% of the natural isotopic mixture, the Z,A of that isotope may be given if the contribution from other isotopes to the reaction given is negligible.

Compounds and Mixtures

For compounds and mixtures, a 3-character compound code is given instead of the A number and is left adjusted in the field. Single element compounds, *e.g.*, molecular hydrogen, should not be coded as compounds. If information is deduced for a constituent element of a compound or mixture, it should be entered under that element.

The general code zzzCMP, where zzz is the major component of the compound, may be used if the compound is not given specifically in the dictionary. The name of the compound should be given in the comment. If more than one element may be considered a major component, choose the element with the highest Z number.

For data given for lumped fission products, *i.e.*, an aggregate of those fission products produced in a given fission reaction, the code FPR is given in place of the A value; use Z equal to 999.

REACTION (Columns 9-23)

The code for reaction is given as two fields: incident and outgoing. However, in some cases, information from EXFOR SF4 will be included in the outgoing field, or the outgoing field many contain a special code.

The incident field contains one of the following:

1. A particle code from Dictionary 33 that contains a non-blank character in the second position of the Allowed Subfield Flag, *e.g.*, P or HE3;
2. A chemical symbol and A-number (SSAAAM) from Dictionary 227; for a nucleus in a metastable state the code is followed by an M, *e.g.*, CL 35 or AM242M.

[8] Theoretical entries contained in the system result from the translation of older CINDA entries; no new theoretical works should be included in CINDA exchanges.

The outgoing field contains one of the following.

1. A particle code from Dictionary 33 that contains a non-blank character in the third position of the Allowed Subfield Flag, *e.g.*, P or HE3;
2. A nuclide code, *i.e.*, chemical symbol and A-number (SSAAA) taken from Dictionary 209; for a nucleus in a metastable state the code is followed by an M, *e.g.*, CL 35 or AM242M.
3. A process code taken from Dictionary 30, *e.g.*, TOT or EL;
4. A combination of the above with the codes separated by a "+".

   The order of codes is: particles ordered from lightest to heaviest,[9] followed by nuclide codes ordered from lightest to heaviest, followed by process codes in alphabetical order. The exception to this rule is: when the order in which the reaction proceeds is given explicitly, the codes are given in that order.
5. For complex reactions with many outgoing particles, the code CMPLX may be used in this field in place of all other codes.

QUANTITY (Columns 24-26)

The legal quantity codes are given in Dictionary 47.

For complete evaluations, covering many reactions and quantities, this field contains the code EVL.

INSTITUTE (Columns 27-33)

The institute is given as a seven-character code consisting of an area/country code followed by an institute code. These codes are found in Dictionary 3.

If more than one institute is involved in the work, the main institute is given. The main institute is defined as the institute at which the principal investigator resides, or the institute at which the work was done. Links to the other institutes are given on Institute Cross Reference Records (work type 9, see Work Type, page 6). An entry is made for each institute containing at least one reference.

BLOCK NUMBER (Columns 34-38)

References relating to the same work are grouped into blocks using a block number. Block numbers are unique within a given target, reaction, quantity, institute.

The block number consists of the area code for the responsible center, followed by a four-digit block number, *e.g.*, L0198. The area codes to be used are those assigned for EXFOR.

The block number is assigned ***only*** by the center responsible for the entry.

[9] Lightest to heaviest is defined as in order of lightest Z, then in order of A.

SEQUENCE NUMBER (Columns 39-40)

The Sequence Number is a 2-digit, right-adjusted integer denoting the sequence within a block. It is assigned ***only*** by the center responsible for the entry.

WORK TYPE (Column 41)

The one-character Work Type code gives the type of work referenced, *e.g.*, experimental, evaluated. For a reference containing more than one type of work, a separate block should be entered for each type.

READER CODE (Column 42)

A one-character Reader Code may be used, at the discretion of the entering center, to identify the compiler of the entry. This field may be left blank. A list of current and formerly used Reader Codes is given in Dictionary 52.

ENERGY RANGE (Columns 43-56)

The energy range field consists of two floating-point numbers (2E7.1) which give the minimum and maximum energies for the data referenced. If the data are presented at one energy only, that energy is given in the first field; the second field is blank. If only an upper limit is known, that is given in the second field; the first field is blank.

If only the approximate range is known, only the exponents are entered (*e.g.*, `+03 +05`)..

A four-character code is used to define the energy for spectrum-averaged values. A list of all legal codes is given in Dictionary 48.

If the reference covers two or more distinct energy ranges that may be viewed a separate experiments or calculations, separate entries should be made. *Example*: a measurement at thermal energy of Maxwellian-averaged cross section and a separate measurement over the energy range 5 eV to 6 keV.

If no information on the energy is given, the code NDG (no data given) is used.

For quantities for which an incident energy is meaningless, *i.e.*, nuclear quantities, ***spontaneous fission et al.*** both fields are left blank.

HIERARCHY CODE (Column 57)

The one-digit Hierarchy code is used to distinguish between different types of records, or to denote the importance of a reference. Valid hierarchy codes are defined in the following table.

Code	Use
1	Main publication. Assigned only to a publication known to be the definitive publication.
2	Published reference (journal or conference proceeding).
3	Other major reference, such as, complete laboratory report or a thesis.
4	Translation for reference with hierarchy 1-3.
5	Minor reference, such as, a progress report, a meeting abstract, or a private communication.
6	Data index entry. A reference to an entry in a data library which gives the numerical data referenced in the block.
8	A reaction product record. Gives, in the Comments field, a list of the reaction products measured in a nuclide production or fission product yield measurement. The energy and reference fields are blank (see Comment).
9	An institute cross-reference record. Gives, in the Reference field, a cross-reference for other institutes involved in the producing the data. The energy and comment fields are blank (see Reference, following).

REFERENCE (Columns 58-86)

The reference consists of three fields: reference type, reference code, and reference date. The format of the reference field depends on the reference type. The exceptions are:

1. For Hierarchy 8 records, the entire reference field is blank.
2. For Hierarchy 9 records, the reference type is blank; the reference code field contains a 7-character institute code, a space, and a 5-character block number, *e.g.*, 1USAC0196.

Reference type (Column 58)

The Reference Type consists of a one-character code taken from DANIEL Dictionary 4.

Reference Code (Column 59-80)

In general, references are coded as for EXFOR and use the same dictionaries and codes. See the EXFOR Manual for coding rules, and Dictionaries 5-7, 207 for document codes.

1. Reference codes 0 and 4:
   - columns 59-63 EXFOR
   - columns 64-68 EXFOR Accession number (or 00000, if unassigned)
   - column 69 full stop (.)
   - column 70-72 EXFOR Subaccession number

2. Reference code 3:

columns 59-64 evaluated file name (see Dictionary 44)
columns 65-80 version number, data set number.

Reference Date (Column 81-86)

The reference date is given as a 6-digit integer: 4-digit year, 2-digit month (YYYYMM). If the month is not known, it may be omitted.

COMMENTS (Columns 87-132)

Comments for reference records should start with the first author's last name, terminated with a full stop (.) for a single author or a plus sign (+) for multiple authors. If no author is known, column 87 should contain a full stop.

The author's name is followed by additional, abbreviated information about the work.

The comment should contain information on whether and how the data is presented in the reference.

Examples: NDG (no data given)
GRPH (graphs)
TBL (table)

For allowable character set and translation of Cyrillic characters, see Part II, EXFOR Formats Manual, Chapter 1.

Comments for the data index lines should contain:
- for EXFOR, the number of data lines, and type of data;
- for evaluations, the evaluator.