Nuclear Structure Data File A Manual for Preparation of Data Sets

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Nuclear Data Project

**NUCLEAR STRUCTURE DATA FILE .
A Manual for Preparation of Data Sets**

**W. B. Ewbank M. R. Schmorak F. E. Bertrand
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CONTENTS

I.	INTRODUCTION	1
II.	GENERAL STRUCTURE OF THE DATA FILE	2
	A. Introduction	
	B. Summary of Data Set Structure	
III.	STANDARD ONE-CARD RECORD FORMATS	3
	A. Introduction	
	B. The Standard One-Card Record Formats	
	C. Summary	
IV.	PREPARING FORMAT RECORDS	13
	A. Introduction	
	B. Organization of the Format Record	
	C. Allowed Data Types	
V.	RECORDS CONTAINING MORE THAN ONE CARD	16
	A. Card Enumeration	
	B. Formats for Continuation Cards	
VI.	DETAILED FIELD DESCRIPTIONS	18
	A. NUCID	
	B. DSID	
	C. DSREF	
	D. RTYPE	
VII.	UNCERTAINTIES	21
	A. Standard Numeric Uncertainties	
	B. Non-numeric Uncertainties	
VIII.	EXPECTED AND ALLOWED UNITS	22
IX.	FREE-FORM FIELDS	22
	APPENDIX	25

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I. INTRODUCTION

The Nuclear Data Project at ORNL is building a computer-based file of nuclear structure data, which is intended for use by both basic and applied users. For every nucleus, the Nuclear Structure Data File (NSDF) contains evaluated nuclear structure information taken from the Nuclear Data Sheets as well as from other published data evaluations. In addition, the file will incorporate such important new data as may have become available since the most recent published evaluation. It is hoped that nuclear structure research workers will participate in building the Data File by preparing their new data in such a form that it can easily be included. It is desired that the Data File represent the best currently available nuclear structure data.

This manual describes a standard input format for nuclear structure data. The format is sufficiently structured that bulk data can be entered efficiently. At the same time, the structure is open-ended and can accommodate most measured or deduced quantities that yield nuclear structure information.

The Data File will be used by both basic and applied scientists and engineers. The Nuclear Data Project is using the Data File to prepare Nuclear Data Sheets, collections of specific nuclear properties and of particular types of experimental information. Computer programs have been developed at the Data Project to perform consistency checking and routine calculations. Programs are also used for preparing level scheme drawings and for reformatting the nuclear structure data for special tabular presentation. Data extracted from the Nuclear Structure Data File will also be used by the Data Project to respond to specific requests from the nuclear community for current nuclear structure information.

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II. GENERAL STRUCTURE OF THE DATA FILE

A. Introduction

The Nuclear Structure Data File (NSDF) is made up from a collection of "data sets", each of which describes the results of a single experiment or the combined evaluated results of a number of experiments of the same type. The appearance of these data sets within the computer file is of less concern here than is the appearance of the data sets either before they enter the computer or after they have been retrieved. The Nuclear Data Project has designed a card-based (or card-image-based) external representation of results of a nuclear structure experiment, which may be used for preparing input to the computer file and for exchange of information retrieved from the computer file. In the remainder of this manual, we shall refer to the group of cards or card images as a data set, even though it is understood to be only an external version of the internal data set which makes up part of the data file. Several sample data sets are listed in the Appendix.

B. Summary of Data Set Structure

A data set is composed of records; each record is made up of one or more card images.

A data set must begin with an IDENTIFICATION record (with label information) and must end with an END record (a blank card). Between these two records, there will be as many additional records as are needed to describe fully the experiment or the evaluated data set.

Immediately following the IDENTIFICATION record is a group of records which contain information about the entire data set. The NORMALIZATION (N), Q-VALUE (Q), FORMAT (F), and PARENT (P) records are of this type.

The body of a data set is composed of numeric data records which describe the measured or deduced properties of levels, γ -rays, α -particles, etc. These records are associated with the level which decays (for GAMMA records) or the level which is populated (for B⁺, B⁻, EC, or ALPHA records). Thus, each LEVEL record is followed by a group of records describing charged-particle decay into the level and γ -ray decay out of the level.

If a GAMMA record (or ALPHA or B⁺ or B⁻) properly belongs in a data set, but it cannot be associated with any particular level, then the record may be placed in the data set before any LEVEL records.

COMMENT records (C) may appear in the data set wherever they seem most appropriate. General remarks will usually follow the IDENTIFICATION record, while comments about a specific number should follow the record which contains that number.

III. STANDARD ONE-CARD RECORD FORMATS

A. Introduction

In most cases, all information for a record can be placed on a single 80-column card. A "standard" format has been defined for each one-card record, such that the most commonly used quantities can be placed on a single card. The standard formats are described in this section for each record. If a needed quantity is not included in the standard format or if a value will not fit within the field defined for the value by the standard format, then a FORMAT record will be required (see Section IV). If a record cannot be contained on a single card, then additional cards can be prepared as described in Section V.

B. The Standard One-Card Record Formats

Record formats are given below in the same order in which they would normally be encountered in a data set. Conditions under which each record may appear or be required are given in parentheses. The format descriptions give the fields (in inclusive card-column numbers), the field names (the formal "name" of the quantity that goes into the field), and a brief field description. Card columns not explicitly included in the fields are expected to be blank. Additional information about each field can be found in the reference section noted.

1. THE IDENTIFICATION RECORD

(Required for all data sets)

<u>Field</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
Col. 1-5	NUCID	Nucleus identification	VI.A
8		Must be blank	
10-39	DSID	Data set identification	VI.B
40-74	DSREF	Data set references	VI.C
75-80	DATE	The date (year/month/day) when the data set was placed in the data file	

2. THE FORMAT RECORD

(Required only if the standard format is not used. See Section IV)

<u>Field</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
Col. 1-5	NUCID	Nucleus identification	VI.A
7	F	Letter "F" is required	
8	RTYPE	Record type being formatted	VI.D
10-80	FORMATS	A complete description of the format for records of type RTYPE; e.g., E = 10, DE = 19, J = 24, ...SYM = COL, where SYM is any data type (DTYPE) allowed for RTYPE records and COL is the column on RTYPE cards where the value of SYM begins	

3. THE COMMENT RECORD

(Optional with any data set)

<u>Field</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
Col. 1-5	NUCID	Nucleus identification	VI.A
7	C	Letter "C" is required	
8	RTYPE	Record type being commented upon	VI.D

10-19	SYM (FLAG)	<p>SYM = type of data being commented upon, or a special word (e.g., BAND) describing some common feature of a group of records</p> <p>FLAG = character in col. 77 of all level or gamma records to which the comment applies</p> <p>If FLAG is omitted, then the comment is understood to apply to all records of type RTYPE</p>	IV.C
20-80	CTEXT	<p>TEXT of the comment</p> <p>Comment records may also be used to give numeric data which is not included elsewhere in the data set, e.g., X-rays, annihilation radiation</p>	

4. THE NORMALIZATION RECORD

(Required if an absolute normalization is possible; used mainly with decay data sets)

<u>Field</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
Col. 1-5	NUCID	Nucleus identification	VI.A
8	N	Letter "N" is required	
10-19	NR	Multiplier for converting relative <u>photon</u> intensity to <u>photons</u> per 100 decays of the parent through the decay branch. <u>Required</u> if absolute photon intensity can be calculated	
20-21	DNR	Standard uncertainty in NR	VII
22-29	NT	Multiplier for converting relative <u>transition</u> intensity (including conversion electrons) to <u>transitions</u> per 100 decays of the parent through this decay branch.	
30-31	DNT	Standard uncertainty in NT	VII
32-39	BR	Branching ratio multiplier for converting intensity per 100 decays through this decay branch to intensity per 100 decays of the parent nucleus. <u>Required if known</u>	
40-41	DBR	Standard uncertainty in BR	VII

5. THE PARENT RECORD

(Optional, but desirable for decay data sets)

<u>Field</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
Col. 1-5	NUCID	Nucleus identification for <u>parent</u> nucleus	VI.A
8	P	Letter "P" is required	
10-19	E	Energy of the decaying level in keV	
20-21	DE	Standard uncertainty in E	VII
22-39	J	Spin or parity or both	
40-49	T	Half-life; units must be given	VIII
50-55	DT	Standard uncertainty in T	VII
65-74	QP	Ground-state Q-value in keV (total energy available for g.s. $\rightarrow$ g.s. transition); will always be a positive number	
75-76	DQP	Standard uncertainty in QP	VII

6. THE Q-VALUE RECORD

(Optional in most data sets)

<u>Field</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
Col. 1-5	NUCID	Nucleus identification	VI.A
8	Q	Letter "Q" is required	
10-19	Q^-	Total energy (keV) available for β^- -decay of the ground state. $Q^- > 0$ if β^- -decay is energetically possible	
20-21	DQ^-	Standard uncertainty in Q^-	VII
22-29	SN	Neutron separation energy in keV	
30-31	DSN	Standard uncertainty in SN	VII
32-39	SP	Proton separation energy in keV	
40-41	DSP	Standard uncertainty in SP	VII
42-49	QA	Total energy (keV) available for α -decay of the ground state	
50-55	DQA	Standard uncertainty in QA	VII
56-80	REF	Reference citation(s) for the Q-values	

7. THE LEVEL RECORD

(Optional, although a data set usually has at least one)

<u>Field</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
Col. 1-5	NUCID	Nucleus identification	VI. A
8	L	Letter "L" is required	
10-19	E	Level energy in keV	
20-21	DE	Standard uncertainty in E	VII
22-39	J	Spin or parity or both	
40-49	T	Half-life of the level; units must be given	VIII. A
50-55	DT	Standard uncertainty in T	VII
56-64	L	Angular momentum transfer in the reaction determining the data set. Whether it is l_n , l_p , $0l$, etc., is determined from the DSID field of the IDENTIFICATION record	
65-74	S	Spectroscopic factor for this level as determined from the reaction in the IDENTIFICATION record	
75-76	DS	Standard uncertainty in S	VII
77	C	Comment FLAG (see Section III. B.3) used to refer to a particular comment record	
78-79	MS	Metastable state is denoted by M or M1 for the first isomer; M2, for the second, etc.	
80	Q	The character "?" denotes an uncertain or questionable level Letter "S" denotes neutron or proton separation energy	

8. THE GAMMA RECORD

(Optional. Must follow the LEVEL record for the level from which the γ -ray decays. Records for γ -rays which are unassigned in a level scheme should precede the first level of the data set.)

<u>Field</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
Col. 1-5	NUCID	Nucleus identification	VI.A
8	G	Letter "G" is required	
10-19	E	Energy of the γ -ray photon in keV	
20-21	DE	Standard uncertainty in E	VII
22-29	RI	Relative <u>photon</u> intensity	
30-31	DRI	Standard uncertainty in RI	VII
32-41	M	Multipolarity of transition	
42-49	MR	Mixing ratio δ . (Sign must be shown explicitly if known. If no sign is given, then the number given is an absolute value.)	
50-55	DMR	Standard uncertainty in MR	VII
56-62	CC	Total conversion coefficient	
63-64	DCC	Standard uncertainty in CC	VII
65-74	TI	Relative total transition intensity	
75-76	ITI	Standard uncertainty in TI	VII
77	C	Comment FLAG (see Section III.B.3) used to refer to a particular comment record	
78	ORG	Letter "C" denotes coincidence with a preceding radiation	
79	END	Letter "C" denotes coincidence with a following radiation	
80	Q	The character "?" denotes an uncertain or questionable line or an uncertain placement of the transition Letter "S" denotes an expected, but as yet unobserved, transition	

9. THE β^- -RECORD(Optional. Must follow the LEVEL record for the level which is fed by the β^- .)

<u>Field</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
Col. 1-5	NUCID	Nucleus identification	VI. A
8	B	Letter "B" is required	
10-19	E	Endpoint energy of the β^- in keV <u>only</u> if measured	
20-21	DE	Standard uncertainty in E	VII
22-29	IB	Intensity of the β^- -decay branch in percent of the total β^- -decay	
30-31	DIB	Standard uncertainty in IB	VII
42-49	LOGFT	Log ft for the β^- -transition	
50-55	DFT	Standard uncertainty in LOGFT	VII
77	COIN	Letter "C" denotes coincidence with a following radiation	
78-79	UN	Uniqueness classification for the β^- - decay, e.g., 1U, 2U; a blank signi- fies an allowed transition	
80	Q	The character "?" denotes an uncertain or questionable β^- -decay Letter "S" denotes an expected or pre- dicted transition	

10. THE EC (or EC + β^+) RECORD

(Optional. Must follow the LEVEL record for the level being populated in the decay.)

<u>Field</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
Col. 1-5	NUCID	Nucleus identification	VI. A
8	E	Letter "E" is required	
10-19	E	Energy for <u>electron capture</u> to the level <u>only if measured</u>	
20-21	DE	Standard uncertainty in E	VII
22-29	IB	Intensity of β^+ -decay branch in <u>per-</u> <u>cent</u> of the total ($\epsilon + \beta^+$)-decay	
30-31	DIB	Standard uncertainty in IB	VII

32-39	IE	Intensity of elec. tron capture branch in <u>percent</u> of total ($\epsilon + \beta^+$)-decay	
40-41	DIE	Standard uncertainty in IE	VII
42-49	LOGFT	Log ft for ($\epsilon + \beta^+$)-transition	
50-55	DPT	Standard uncertainty in LOGFT	VII
65-74	TI	Total ($\epsilon + \beta^+$)-decay intensity in percent	
75-76	DTI	Standard uncertainty in TI	VII
77	COIN	Letter "C" denotes coincidence between β^+ and a following radiation	
78-79	UN	Uniqueness classification for ϵ , β^+ - decay, e.g., 1U, 2U; blank signi- fies an allowed transition	
80	Q	The character "?" denotes an uncertain or questionable ϵ -, β^+ -branch Letter "S" denotes an expected or pre- dicted transition	

11. THE ALPHA RECORD

(Optional. Must follow the LEVEL record for the level being populated in the decay.)

<u>Field</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
Col. 1-5	NUCID	Nucleus identification	VI.A
8	A	Letter "A" is required	
10-19	E	Alpha energy in keV	
20-21	DE	Standard uncertainty in E	VII
22-29	IA	Intensity of α -decay branch in <u>percent</u> of the total α -decay	
30-31	DIA	Standard uncertainty in IA	VII
32-39	HF	Hindrance factor for α -decay	
40-41	DHF	Standard uncertainty in HF	VII
77	COIN	Letter "C" denotes coincidence with following radiation	
80	Q	The character "?" denotes uncertain or questionable α -branch Letter "S" denotes an expected or pre- dicted α -branch	

12. THE END RECORD
(Required for all data sets)

<u>Field</u>	<u>Description</u>
Col. 1-80	All columns are blank

C. Summary

The following figure summarizes the standard one-card formats for all allowed record types.

NUCLEAR DATA SET-ORNL NUCLEAR DATA PROJECT STANDARD FORMATS

IF	PUNCH
S	LE
C	LY
S	DE
S	DT
M	AP
SYST	SY

nucleus	L	E	DE	J	T	DT	L	S	DSCMSIO			
nucleus	G	E	DE	RI	DR1	M	MR	DMR	CC	DCC	TI	DTIC
nucleus	B	E	DE	IB	DIB		LOGFT	DFT				UNQ
nucleus	E	E	DE	IB	DIB	IE	DIE	LOGFT	DFT		TI	DTI
nucleus	A	E	DE	IA	DIA	HF	DHF					Q
nucleus	Q	Q	DO	SN	DSN	SP	DSF	QA	DQA		key number and date	
nucleus	N	NR	DNR	NT	DNT	BR	DBR					
nucleus	C	identification					comment in free form					
nucleus	F						symbol+column					
nucleus			type of data set				reference key number(s)					
nucleus	P	E	DE	J	T	DT		Q	DO			

IV. PREPARING FORMAT RECORDS

A. Introduction

If the standard one-card formats described in Section III.B are used, then there is no need to include a FORMAT record. A FORMAT record is required if the data items in a one-card record are too wide for the standard fields or if the data appear in an order different from the standard record or if data of a nonstandard type are to be included on the one-card record. (Use of the FORMAT record should be avoided whenever possible.) Only the first card of a record may have its organization described by a FORMAT record. Continuation cards for the record will always contain their own format information (see Section V). A FORMAT record may not be used for the IDENTIFICATION record, a COMMENT record, the NORMALIZATION record, the Q-RECORD, the END record, or another FORMAT record.

B. Organization of the FORMAT Record

The FORMAT record will always contain the letter "F" in col. 7 and a character RTYPE (see Section VI.D) in col. 8 to identify the type of record the format of which is being specified by the FORMAT record. The FORMAT record consists of a single card for each record type for which a format is described. Continuation cards are not allowed. The text of the FORMAT record is contained in cols. 10-80. The text consists of a series of equalities separated by commas or blanks; e.g., $E = 10, DE = 20, J = 23, L = 40$. In general, the form $DTYPE = COL$ in a FORMAT record implies that the data of type DTYPE are always contained in a field beginning in column COL of the RTYPE record. By implication, the field width includes all space up to the next larger value of COL given for some other data type DTYPE.

If a FORMAT record is used, care must be taken to avoid conflicting format specifications. The same data type may not be identified with more than one location on the data record; i.e., $E = 10, E = 25$ is in error.

Since each field width is assumed to be the maximum available for the particular data type, it is important to specify the complete format of the record RTYPE. If the text of the FORMAT record for level records is $E = 15, J = 25, T = 40$, then ten card columns are allowed for E, 15 for J, and 41 columns are allowed for T. If any level record contains other information, e.g., the letter "C" for "unresolved doublet" in col. 77, then a strange value for the half-life (T) will be inferred since the information is within the field defined for "T" type information.

C. Allowed Data Types

Each record type is permitted to contain only a limited (but extendable) set of data types. For example, a GAMMA record is not allowed to contain information of data type DTYPE = J (nuclear spin). Neither may a level record contain LOGFT information. For each record type, the following table lists the data types permitted as of April 15, 1975.

1. The PARENT Record
2. The Q-VALUE Record

All allowed data types are included in the standard format description in Sections III.B.5 and III.B.6.

3. The LEVEL Record

Allowed data types, E, DE, J, T, DT, L, S, DS, C, MS, Q, are described with the standard formats in Section III.B.7. Additional allowed data types are:

<u>DTYPE</u>	<u>Description</u>
MV	Level energy in MeV
DMV	"Standard" uncertainty in MV (Section VII)
UEV, UKV, UMV	Uncertainty in level energy, expressed in eV, keV, and MeV, respectively
PE	Percent uncertainty in level energy
UE	Uncertainty in level energy, given in same units as the level energy itself
A	Percent isotopic abundance
SIGNG	Thermal-neutron capture cross section
SIGNA	Total thermal-neutron absorption cross section
%EC, %SF, %IT, %B-, %B+, %A, %P, %N	Percent decay of the level by electron capture, spontaneous fission, isomeric transitions, or emission of a β^- , β^+ , α , proton, neutron
G	g-factor of the level
MOME1, MOME2, ...	Electric moments: dipole, quadrupole, ...
MOMM1, MOMM2, ...	Magnetic moments: dipole, quadrupole, ...
CONF	Nuclear configuration of the level
F	A "free-form" field (see Section IX)
BE1, BE2, ...	Reduced electric transition probability (upward) given in units $e^2 \times (\text{barns})^L$, where $L = 1, 2, \dots$ for the transition from the ground state to this level

4. The GAMMA Record

Allowed data types, E, DE, RI, DRI, M, MR, DMR, CC, DCC, TI, DTI, C, ORG, END, Q, are described with the standard formats in Section III.B.8. Additional allowed data types are:

<u>DTYPE</u>	<u>Description</u>
MV	Gamma energy in MeV
DMV	"Standard" uncertainty in MV (Section VII)
UEV, UKV, UMV	Uncertainty in γ -energy, expressed in eV, keV, and MeV, respectively
PE	Percent uncertainty in γ -energy
UE	Uncertainty in γ -energy, given in same units as the γ -energy itself
BE1, BE2, ...	Reduced electric transition probability (downward) given in units of $e^2 \times (\text{barns})^L$, where $L = 1, 2, \dots$
BM1, BM2, ...	Reduced magnetic transition probability (downward) given in units of $\mu_N^2 \times (\text{barns})^L$, where $L = 1, 2, \dots$
CEK, CEL, CEL1, ...	ce-intensity for K, L, $L_1, \dots$ conversion
KC, LC, L1C, ...	Theoretical K-, L-, L_1 -conversion coefficient
EKC, ELC, EL1C, ...	Measured K-, L-, L_1 -conversion coefficient
K/L, M/L, L1/L2, ...	ce-intensity ratios
K/T, L/T, ...	Ratio of K, L, ... ce-intensity to total ($\gamma + \text{ce}$) intensity
PRI, PTI	Percentage uncertainty in RI, TI
URI, UTI	Uncertainty in RI, TI, given in same units as RI, TI
F	A "free-form" field (see Section IX)

5. The B⁻ Record

Allowed data types, E, DE, IB, DIB, LOGFT, DFT, COIN, UN, Q, are described with the standard formats in Section III.B.9. Additional allowed data types are:

<u>DTYPE</u>	<u>Description</u>
MV	Beta energy in MeV
DMV	"Standard" uncertainty in MV (Section VII)
UEV, UKV, UMV	Uncertainty in β -energy, given in eV, keV, MeV, respectively
UE	Uncertainty in β -energy, given in same units as energy

PE	Percentage uncertainty in β -energy
EAV	Average energy of the β -spectrum
F	A "free-form" field (see Section IX)

6. The EC Record

Allowed data types, E, DE, IB, DIB, IE, DIE, LOGFT, DFT, TI, DTI, COIN, UN, Q, are described with the standard formats in Section III.B.10. Additional allowed data types are:

<u>DTYPE</u>	<u>Description</u>
MV	Energy for <u>electron capture</u> to a level, given in MeV
DMV	"Standard" uncertainty in MV (Section VII)
UEV, UKV, UMV	Uncertainty in capture energy, given in eV, keV, MeV, respectively
UE	Uncertainty in capture energy, given in same units as the energy itself
PE	Percentage uncertainty in capture energy
EAV	Average energy of the β^+ -spectrum
K, L, M, N+	Fraction of decay by electron capture from the K, L, M, N+O+... shells
F	A "free-form" field (see Section IX)

7. The ALPHA Record

All allowed data types are included in the standard format description in Section III.B.11.

V. RECORDS CONTAINING MORE THAN ONE CARD

A. Card Enumeration

If all the information for a given record type cannot be contained on a single card, then it is possible to use additional cards to describe the record fully. The first card of a record will have the number 1 or a blank in col. 6. Subsequent cards will have running numbers: 2, 3, ... up to 9. It is not allowed to have continuation cards for the IDENTIFICATION record, the FORMAT record, the Q-VALUE record, the NORMALIZATION record, or the END record since these records consist of a single card. (The FORMAT record consists of a single card for each record type for which a special format is described.)

B. Formats for Continuation Cards

The second, third, etc., cards of a record do not have a standard format. The data must be presented in free-field format (Section IX). For example:

```

138BA2 L B(E2)=0.249 13
138BA2 L B(E3)=0.195 12
138BA2 L B(E2)=0.221 9  NONE2=-0.07 15
238PU2 G L/T=0.729 5$ M/T=0.203 7$ W+/T=0.068 2$
238U 2 G L/T=0.731 6$ M/T=0.201 6$ W+/T=0.067 2$
240PU2 G L/T=0.730 6$ M/T=0.202 6$ W+/T=0.068 2$
232U 2 G L/T=0.730 6$ M/T=0.201 6$ W+/T=0.066 2$
228TH2 G L/T=0.729 5$ M/T=0.199 6$ W+/T=0.066 2$
237WP2 W K=0.490 12$ L=0.363 8$ M+=0.150 1$
237WP2 E K=0.39 2$ L=0.431 14$ M+=0.180 6$
237WP2 G L/T=0.75 $ M/T=0.19 $ W+/T=0.06 $
237WP2 W K=0.26 3$ L=0.52 2$ M+=0.223 10$
237WP2 G L/T=0.60 $
237WP2 G L/T=0.38 $ M/T=0.10 $

```

The data types given on continuation cards are limited to the set of names listed under columns DTYPE for each record type in Section IV. The data type and the data value may be connected by a relational operator from the following list.

EQ or =	equal to
LE	less than or equal to ($\leq$)
LT or <	less than
GT or >	greater than
GE	greater than or equal to ($\geq$)
AP	approximately equal to ($\approx$)
SY	obtained from systematics
CA	calculated value

The alphabetic representations must contain a blank on either side, i.e., "_GT_", "_AP_".

VI. DETAILED FIELD DESCRIPTIONS

A. NUCID

The standard nucleus identification consists of two to five characters giving the A-value and the chemical symbol of a nucleus, e.g., 9B, 20F, 98RU, 177HF. The nucleus identification must be contained within the field defined for it (cols. 1-5 on most cards). It is recommended that the nucleus identification always begin in col. 1; i.e., it is left-adjusted. The nucleus identification must be included on every IDENTIFICATION record. It is strongly recommended that it also be included on every card of a data set except the END record. (This is done automatically when the data set is filed onto the data cell.) The data set will be handled correctly if all cards except the IDENTIFICATION record contain blanks in the NUCID field, but such decks are very difficult to edit.

B. DSID

The content of a data set is described in a standard way in the DSID field of the IDENTIFICATION record. The standards may be described under three general headings: 1) decay data sets, 2) reaction data sets, 3) "adopted" data sets.

1. For a data set describing the results of a measurement of radioactive decay, the DSID field contains three parts separated by one or more blanks — the decaying nucleus, the type of decay, and the word "DECAY", e.g.,

22NA	B+	DECAY	
64Y	B-	DECAY	
134I	IT	DECAY	(3.7 M)
134I	B-	DECAY	(3.7 M)
134I	B-	DECAY	(52.6 M)
133BA	EC	DECAY	
214AT	A	DECAY	
252CF	SF	DECAY	

A half-life (in parentheses) may be added to specify the decay completely. The decaying nucleus is identified by its standard NUCID (Section VI.A).

Five decay types are recognized in the DSID field:

B-	β -decay
EC } B+ }	electron capture and/or β^+ -decay (EC is preferred)
A	α -decay
IT	isomeric state decay (γ -radiation only)
SF	spontaneous fission

2. For a data set describing results of a nuclear reaction study, the DSID field contains the target and the incoming and outgoing particles such as:

20NE(P,D)
 48CA(A,A') for (α , α')
 109AG(40AR, 40AR')
 90ZR(A, 4NG)
 use 45SC(N, G), E = TH; never 45SC(TH N, G)

The target nucleus and the reacting particle may be given in the standard form (see NUCID, Section VI.A). A reaction energy may be given when desired or needed. The reacting particles may alternatively be taken from the list of abbreviations:

P	proton (1H)
N	neutron
A	α -particle (4HE)
D	deuteron (2H)
T	triton (3HE)
G	γ -ray
M+	} μ -meson
M-	
P+	} π -meson
P0	
P-	
NU	neutrino
E	electron

3. An "ADOPTED" data set contains the best representation of the present experimental knowledge about the levels of a nucleus. The data set will be named
ADOPTED LEVELS.

If all level information for a nucleus is contained in a data set for a single experiment, it is not necessary to make an additional ADOPTED data set as well. However, if more than one experimental data set contains level information about the nucleus, then a separate ADOPTED data set MUST be made, even if the ADOPTED data set contains only the Q-VALUE record and a simple ground-state LEVEL record.

An ADOPTED data set always contains (in its IDENTIFICATION record) a reference to the Nuclear Data Sheets or similar evaluation where the supporting data have been compared.

An ADOPTED data set contains a Q-VALUE record (e.g., as produced by the Atomic Mass Adjustment Program), which includes at least Q_β , S_n , S_p , if available.

An ADOPTED data set contains a LEVEL record for every level that has been reliably observed. GAMMA records may also be included in an ADOPTED data set.

C. DSREF

References to supporting publications or analyses are placed in this field by means of standard Nuclear Data Project reference key numbers. If the data set describes a single measurement, then the key number of the published report of the measurement is sufficient. The DSREF field may include more than one key number, each of which refers to a particular publication. If different experimental results have been combined or modified to form the data set, then the DSREF field should also refer to the source of the combination or modification, e.g., the Nuclear Data Sheets as 73NDS, 74NDS. The program that places the data sets in computer files can be used to add a reference to a group of data sets.

The DSREF field will be used mostly by the Nuclear Data Project to keep records of which data have superseded or been modified by others. The DSREF field will be so assigned that distinct data sets will also have distinct DSREF fields. If so many reference keys are needed that the DSREF overflows, it would be better to put reference keys in a comment record and use only the NDS reference in the DSREF field.

D. RTYPE

A single-letter code that gives a name to the RECORD type.

<u>RTYPE</u>	<u>Description</u>
Blank	May be IDENTIFICATION record or END record
N	NORMALIZATION record
P	PARENT record
Q	Q-VALUE record
L	LEVEL record
G	GAMMA record
B	B- record
E	EC (or EC + B ⁺) record
A	ALPHA record

VII. UNCERTAINTIES

Every experimental number entered into the data file should have an uncertainty associated with it if at all possible. Uncertainties may be numeric or non-numeric. Numeric uncertainties may be symmetric or asymmetric.

A. Standard Numeric Uncertainty

The "standard form" for expressing numeric uncertainties is as an integer uncertainty in the least significant digit(s) of the experimental number, i.e., $448.7 \pm 0.7 \rightarrow 448.7 \text{ 7}$; $0.3721 \pm 0.0014 \rightarrow 0.3721 \text{ 14}$. The RTYPE for a standard uncertainty is usually formed by adding the prefix D to the RTYPE of the datum, e.g., E, DE; RI, DRI; MV, DMV.

An asymmetric uncertainty may be written in the standard form by including signs; $0.84^{+0.10}_{-0.03} \rightarrow 0.84 \text{ +10-3}$. The convention on asymmetric uncertainties is that they combine algebraically with the datum, such that -3^{+1}_{-4} describes a range from -7 to -2.

B. Non-numeric Uncertainties

The non-numeric uncertainties include the symbols for approximate, calculated, systematics, and also the relational operators such as greater-than, less-than-or-equal-to, etc. The non-numeric uncertainty may be given either as a symbol or as a two-letter code in the uncertainty field:

<u>Symbol</u>	<u>Letter code</u>	<u>Meaning</u>
$\approx$	AP	approximately equal to
$>$	GT	greater than
$\geq$ or $\geq\approx$	GE	greater than or equal to
$<$	LT	less than
$\leq$ or $\leq\approx$	LE	less than or equal to
	SY	systematics
	CA	calculated
	TH	theoretical

VIII. EXPECTED AND ALLOWED UNITS

A. Half-lives must include units. Use

FS	=	10^{-15} s
PS	=	10^{-12} s
NS	=	10^{-9} s
US	=	$\mu\text{s} = 10^{-6}$ s
MS	=	10^{-3} s
S	=	second
M	=	minute
H	=	hour
D	=	day
Y	=	year
KY	=	10^3 year
MY	=	10^6 y
GY	=	10^9 y

Computer-standard exponential format may be used. Examples:

$$3.7 \text{ PS} = 3.7 \text{ E } -12 \text{ S}$$

$$4.21 \text{ GY} = 4.21 \text{ E } 9 \text{ Y}$$

B. Signs of certain experimental quantities (nuclear moments, γ -ray mixing ratios) are as important as the numbers, themselves. If the sign is known, it should be given explicitly. If the sign is not known, then the absence of any sign is just as descriptive as the $+$ - (or $\pm$). If a value is known to be > 0 , it must have a sign.

IX. FREE-FORM FIELDS

A free-form field on any card is a region on the card where the input data values are self-descriptive; i.e., the field contains character strings such as $\text{EKC} = 0.104 \text{ 5}$ or $\text{BE2} < 0.5$. The second, third, etc., cards for any record (when permitted) contain one free-form field between cols. 10-80 (see Section V.B).

A free-form field contains character strings of the form:

(data type)(operator)(data value).

The "data types" are restricted to the permitted names given under DTYPE in Section IV for the appropriate record type. The "data value" is a numerical or character-string value. A numerical data value may have an associated uncertainty (Section VII). The "operator" may be a mathematical symbol or its alphabetic representation.

EQ or =	equal to
LE	less than or equal to
LT or <	less than
GE	greater than or equal to
GT or >	greater than
AP	approximately equal to

(The alphabetic representation must include at least one blank on each side, e.g., CEK_LT_27.4, but not CEK_LT27.4.) The character strings (data type + operator + data value) may be separated from each other by one or more blanks.

APPENDIX

Sample Data Sets

7502	7502(B,P)	B=6.5 MEV	601110 75005	750015
7502	PL	B=10, BB=20, T=40, BT=50, L=62, C=77, BS=70, Q=00		
7502	L	0.	35	
7502	L	730	35	
7502	L	1130	35	?
7502	L	1360	35	?
7502	L	1500	35	
7502	L	1670	35	0 0.00
7502	L	1890	35	?
7502	L	2000	35	0 0.51
7502	L	2240	35	
7502	L	2620	35	
7502	L	2800	35	?
7502	L	3020	35	
7502	L	3190	35	0 0.37
7502	L	3500	35	
7502	L	3700	35	?
7502	L	4300	35	
7502	L	4520	35	
7502	L	4660	35	

7502	7502 B+ DECAY	75005	750006
7502 C	DECAY SCHEME		
7502 C	THE 7502 DECAY SCHEME IS BASED ON 72C006.		
7502 C	COMPILERS HAVE MODIFIED IN CORRELATING WITH OTHER DATA.		
7502 C	NORMALIZATION ASSUMES NO DIRECT DECAY TO 7502 G.S.,		
7502 C	SINCE NO CORRESPONDING B+ HAS BEEN OBSERVED. INTENSITY		
7502 C	OF B+ DERIVED FROM DECAY SCHEME AGREES WELL WITH		
7502 C	MEASURED 511.00.		
7502 CB	PHOTON PLACED THICE		
7502	B 0.92	10	1.0
7502	P 0	(3/2)-	90 B 3 3000 30
7502	Q -3000	30	
7502 CB	Q-	COMPILERS USE B+ DATA FROM 691A07, 69BA20 TO REDUCE	
7502 CB	Q-	$Q(B+) = 2BC2 + B(207 \text{ LEVEL}) = (1730 \text{ 30}) + 1022 + 206.6$	
7502	G 579.0	3 0.10	2
7502	G 511.0	167	10
7502	G 652.2	3 0.16	3
7502	G 906.2	3 0.16	3
7502	G 1515.0	3 0.13	2
7502	L 0	5/2+	
7502	L 112.1	107/2+	
7502	G 112.1	101.90	20B1+E2 0.13 C
7502	L 206.5	103/2-	
7502	CL T	1.23 BS 15(69BA20)	
7502	G 206.5	2 100. 10B1	
7502	CB CB	0.0020 4(72C006)	
7502	L 293.2	(7/2)-	
7502	CL T	29.6 BS 32(72C002)	
7502	G 6.5		
7502	B 2707	30 67.3	
7502	CB B0+	1720 20(691A07), 1700 20(69BA20) TO 206+293 LEVELS	
7502	CB B0+	OTHERS: 527004, 610A03	
7502	L 027.7	205/2-	
7502	G 101.19	107.5	6 B1+E2 0.05 CC
7502	G 315.61	150.69	7 (B1) CC
7502	G 027.79	130.9	5 B1 C
7502	B 2612	30 6.5	
7502	CB B0+	1590 20(69BA20)	
7502	L 506.0	2 (3/2)-	
7502	G 292.05	103.03	15B1+E2
7502	G 299.0	2 0.27	0 B1+E2
7502	G 506.1	2 0.21	3
7502	B 2050	30 1.0	

7548 7548 EC DECAY 7548 7548 15
 7548 C THE DECAY SCHEME IS BASED ON DATA FROM 600003, 618002, 640013, 680001,
 7548 C 690012, 700025, 710007, 710020, 710007, 737007, 740020.
 7548 C OTHERS: 500050, 510000, 550009, 560002, 590076, 590030, 600006,
 7548 C 600005, 620002, 650019, 660009, 660001, 670003, 670002,
 7548 C 670010, 680010, 700010, 700006, 710006, 710000, 737006
 7548 C 737006
 7548 C NORMALIZATION WAS BASED ON THE ADOPTED LEVEL SCHEME AND THE
 7548 C ADOPTED PHOTON AND E-RAY INTENSITIES.
 7548 C R (E-RAY) 92.3 20 (700020); OTHERS: 90.3 26 (700025), 90.0 20 (600009)
 7548 C G (E-RAY) 600007, 600002, 670023, 690012, 710036, 720004, 730010
 7548 C G (E-RAY) OTHERS: 590000, 560075, 500002, 600002
 7548 C G (E-RAY) 600002, 600002, 690023, 700010
 7548 C G-E-RAY 500002
 7548 B 0.502 10
 7548 P 0.0 5/2+ 120.0 0 2 000.0 10
 7548 Q -000.0 10
 7548 R 002.25 13 0.0000 1
 7548 S 563.32 0.0001 1
 7548 L 0.0 3/2- STABLE
 7548 B 000.0 10 <5
 7548 L 190.596 7 1/2-
 7548 CL T 0.93 05 3 (673001)
 7548 CL T 0.07 05 3 (690023)
 7548 CL T OTHERS: 700021
 7548 G 190.596 7 2.00 5 01+02 0.00 0 0.010
 7548 C0 00 FROM 2 (190.6 LEVEL) -0.07 05 3
 7548 C0 00 000 0 (E2) -0.0 05 1 10
 7548 B 646.2 10 0.11 6 9.57 20 10
 7548 L 260.651 0 3/2-
 7548 G 66.05 1 1.69 0 01+02 +0.19 2 0.01 1
 7548 C0 00 FROM A2 -0.017 3, A4 -0.005 10
 7548 G 260.651 0 100 01+02 -0.005 6 0.0072 2
 7548 C0 00 FROM A2 -0.010 3, A4 -0.000 6; 730010 QUOTE A2 -0.013 6
 7548 B 600.2 10 2.2 3 7.96 6
 7548 L 279.520 0 5/2-
 7548 CL T 0.366 05 20 (600001)
 7548 CL T 0.20 05 2 (690023)
 7548 CL T 0.209 05 10 (710011)
 7548 CL T 0.277 05 31 (730003)
 7548 CL T OTHERS: 620002, 600002, 730005
 7548 G 10.0 5 0.030 6 000 22.0
 7548 G 00.0 1 0.010 2 02 1.76
 7548 G 279.520 0 02.2 0 01+02 -0.02 0 0.007
 7548 C0 00 FROM A2 -0.01 1, A4 -0.000 0
 7548 C0 00 FROM CIRC. POL. 000 10027
 7548 B 505.3 10 2.5 57.09 9
 7548 L 303.916 12 9/2+
 7548 CL T 17.0 05 7 (573011)
 7548 CL T 15.0 05 6 (660025)
 7548 CL T OTHERS: 690013, 690015
 7548 G 20.0 2 0.05 1 02 206 6
 7548 G 303.916 12 2.2 0 03 0.055
 7548 B 560.9 10 1.7 12 0.0 02
 7548 L 000.606 9 5/2+
 7548 CL T 1.67 05 5 (673001)

7505 ADOPTED LEVELS 75005 750015
 7505 Q -065.0 9 10201 1 6096.3 20 -5312 0 70000
 7505 L 0.0 1/2-
 7505 CL 00001.0370, 00000.20 (697000)
 7505 L 190.596 7 1/2- 0.07 55 3
 7505 CL T FROM 7500, 7502 DECAT
 7505 CL J FROM COUL EX 000 00000 0000 0000 0000 0000
 7505 L 260.051 0 1/2- 11.0 55 7
 7505 CL 0000.70 22 (710000); SEE ALSO 710005
 7505 CL T FROM 7505 (6, 6°)
 7505 CL J 000000 12 IN 0000000 000000 SCATTERING
 7505 L 270.520 0 1/2- 0.20 55 1
 7505 CL 0000.36 5 (710000); SEE ALSO 710005
 7505 CL T FROM 7500 DECAT, 7505 (6, 6°)
 7505 CL J COUL EX (670010)
 7505 L 303.916 12 1/2- 17.53 55 0
 7505 CL T FROM 720053
 7505 CL T 000000: 11 000000000000 1957-1972
 7505 L 000.606 0 1/2- 1.7 55 1
 7505 CL T FROM 7500 DECAT, 7500 (6, 6°)
 7505 CL J 00000 DECAT
 7505 L 060.7 0 1/2, 1/2-
 7505 L 572.3 1 1/2-
 7505 CL J COUL EX (670010)
 7505 L 305 7
 7505 L 617.60 15
 7505 L 021.05 2 1/2-
 7505 CL J COUL EX (670010)
 7505 L 060.6 7
 7505 L 065.3 7
 7505 L 006.3 0
 7505 L 1003.0 5
 7505 L 1000.0 5
 7505 L 1075.5 5

101PT ADOPTED LEVELS 70005 701122
 101PT Q -1720 ST 1000 ST 3000 ST 0039 17 710000, 630000, 665100
 101PT L 0.0 6.6 9
 101PT-2 L 0000.0011

10JNC ADOPTED LEVELS 70005 701122
 10JNC Q 0000 ST 2000 ST 1000 ST 710000
 10JNC L 0.0 1/2- 0.0 5 5

1030P 1030P (A,20C) 60001, 7000S 701122
 1030P C6 RI RELATIVE PROTON INTENSITY AT P=20 MEV
 1030P C6 R ADOPTED MULTIPLICITY IS 5000
 1030P CL 2 E(LEVEL): ADOPTED ENERGY FROM 7000S
 1030P C6 E,PI,N,MP DATA OF 60001
 1030P L 0.0 (5/2)+ 70.0 D 11
 1030P L 110.42 3 (7/2)+
 1030P L 110.40 7 60.5 00 (N1)
 1030P L 250.83 0 (9/2)+
 1030P G 145.25 10 36.9 35 N1+22 +0.12 +5 -12
 1030P G 250.4 7 5.2 17 (E2)
 1030P L 435.20 9 (11/2)+
 1030P G 175.39 10 40.6 05 N1+22 +0.15 3
 1030P G 320.0 2 9.6 10
 1030P L 496.16 7 (9/2)-
 1030P G 236.2 3 0.1 6 (E1)
 1030P G 301.0 3 115 15 E1
 1030P G 496.0 7 1.1 3
 1030P L 500.05 10 (5/2)- 2.0 BS 1
 1030P G 400.0 0 47.0 50 E1
 1030P L 639.22 12 (13/2)+
 1030P G 201.01 12 20.0 20 N1+22 +0.10 0
 1030P G 300.2 10 10 6 (E2)
 1030P L 660.06 0 (11/2)-
 1030P G 167.99 10 40.9 05 N1+22 +0.15 3
 1030P L 961.20 11 (13/2)-
 1030P G 147.1 2 35.1 35 N1+22 +0.10 3
 1030P G 165.1 0 2.2 0
 1030P L 970.50 10 (15/2)+
 1030P G 231.27 12 21.0 21 N1+22 +0.10 +0-10
 1030P G 435.5 3 11.0 12 (E2)
 1030P L 1000.69 10 (15/2)-
 1030P G 223.07 12 25.6 26 N1+22 +0.11 5
 1030P G 420.0 5 0.7 7
 1030P L 1127.32 10 (17/2)+
 1030P G 256.0 2 16.7 17 N1+22 +0.10 +5-10
 1030P G 400.0 0 15.6 17 E2

1030P ADOPTED LEVELS 701122
 1030P Q -2040 AP 8095 22 4053 0 2132 10 73000, 7000S
 1030P L 0.00 (5/2)+ 70.0 D 11 2
 1030P L 110.42 3 (7/2)+
 1030P L 250.83 0 (9/2)+
 1030P L 435.20 9 (11/2)+
 1030P L 496.16 7 (9/2)- 7.09 BS 16
 1030P L 500.05 10 (5/2)- 2.0 BS 1 3
 1030P L 620 2 (9/2)- 5
 1030P L 639.22 12 (13/2)+
 1030P L 660.06 0 (11/2)- 0,5
 1030P L 665.00 11 (1/2)-
 1030P L 702 2 1
 1030P L 820.13 10 (3/2)- 17
 1030P L 851.06 12 (7/2)+
 1030P L 861.20 11 (13/2)-
 1030P L 970.50 10 (15/2)+
 1030P L 870.5 5 1/2+ 0
 1030P L 899 2 (7/2)- 3
 1030P L 950.97 15 (3/2)+

103W	103RE	RC	DECAY	700DS					701122
103W	CL	E	E(LEVEL) ADOPTED VALUE 700DS						
103W	CG	E	E(CG) ADOPTED VALUE 700DS						
103W	CG	R	MULTIPOLARITY ADOPTED VALUE 700DS						
103W	CG	T1	INTENSITIES CALCULATED FROM CG-VALUES OF 620A20						
103RE	P	0.0	(5/2+)	70.0 D	11		955		9
103W	Q	-556	0						
103W	L	0.0	1/2-	STABLE					
103W	L	06.000C	10 3/2-						
103W	E	509	0	2E	LP 0.0	67			1
103W	1 G	06.0037	10	01+E2	-0.077	7	2.56	11 77	15
103W	2 G	06.0037		CCL1=3000 600	CCL1=5.00 1				
103W	L	09.0703	10 5/2-						
103W	E	056	0	13	7 0.2	3			1
103W	1 G	52.593	2	01+E2	-0.110	5	6.21	5 20	5
103W	2 G	52.593		CCL1=070 170	CCL1=3.76				
103W	1 G	09.679	2	E2			0.13	10	3 C

103W	1000 (D, T)		72CA01			701122
103W	L	0	1/2-	STABLE		
103W	L	(07)	3/2-		1	
103W	L	(99)	5/2-		3	
103W	L	(200)			1	C
103W	L	(292)	5/2-		3	
103W	L	(309)	9/2-		HIGH	
103W	L	(012)	7/2-		3	
103W	L	(053)	7/2-		3	
103W	L	007	6 13/2+			
103W	L	553	AP 9/2-			
103W	L	596	AP 9/2-			
103W	L	623	10 9/2+		0	
103W	L	742	10 11/2-		HIGH	
103W	L	906	10 5/2-		3, 1	
103W	L	936	6 1/2-		1	
103W	L	960	6 13/2-			
103W	L	1002	6 7/2-		3	
103W	L	1029	6 3/2-		1	
103W	L	1056	6 5/2-		3	
103W	L	1072	6 7/2-		3	
103W	L	1120	10 9/2-		HIGH	
103W	L	1150	10		1	
103W	L	1219	6 9/2-		HIGH	
103W	L	1233	10		3	
103W	L	1265	6 7/2-		(3)	
103W	L	1281	10 11/2-			
103W	L	1310	AP 9/2-			
103W	L	1339	10			
103W	L	1375	AP		3	
103W	L	1397	10 11/2-		HIGH	
103W	L	1401	10			
103W	L	1460	10			
103W	L	1476	10		1, 3	
103W	L	1489	10			
103W	L	1550	20			
103W	L	1562	12 9/2+		3, HIGH	
103W	L	1592	12		3	
103W	L	1650	20			
103W	L	1679	20			