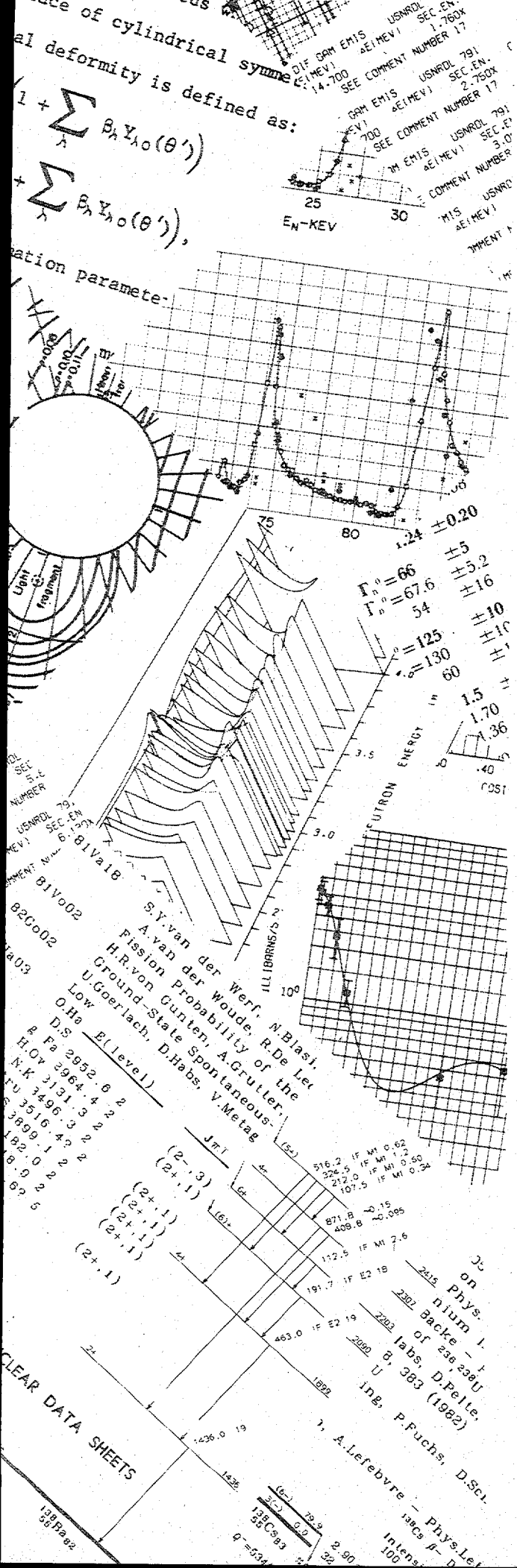

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(Rev. 08/96)
Formal Report

NUCLEAR SCIENCE REFERENCES CODING MANUAL

S. Ramavataram and C.L. Dunford

August 1996

INFORMATION ANALYSIS CENTER REPORT

NATIONAL NUCLEAR DATA CENTER
BROOKHAVEN NATIONAL LABORATORY
UPTON, LONG ISLAND, NEW YORK 11973

DISCLAIMER

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NATIONAL NUCLEAR DATA CENTER
BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.
UNDER CONTRACT NO. DE-AC02-76CH00016 WITH THE
UNITED STATES DEPARTMENT OF ENERGY

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I. INTRODUCTION

This manual is intended as a guide to Nuclear Science References (NSR) compilers. The basic conventions followed at the National Nuclear Data Center (NNDC), which are compatible with the maintenance and updating of and retrieval from the Nuclear Science References (NSR) file, are outlined.

In Section II, the structure of the NSR file such as the valid record identifiers, record contents, text fields as well as the major TOPICS for which <KEYWORDS> are prepared are enumerated. Relevant comments regarding a new entry into the NSR file, assignment of <KEYNO >, generation of <SELECTRS> and linkage characteristics are also given in Section II. In Section III, a brief definition of the Keyword abstract is given followed by specific examples; for each TOPIC, the criteria for inclusion of an article as an entry into the NSR file as well as coding procedures are described. Authors preparing Keyword abstracts either to be published in a Journal (e.g., Nucl. Phys. A) or to be sent directly to NNDC (e.g., Phys. Rev. C) should follow the illustrations in Section III. The scope of the literature covered at the NNDC, the categorization into Primary and Secondary sources, etc., is discussed in Section IV. Useful information regarding permitted character sets, recommended abbreviations, etc., is given under Section V as Appendices.

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II. STRUCTURE OF THE NSR FILE

The The Nuclear Science References (NSR)* data base originated at the Nuclear Data Project (NDP) as part of a project for systematic evaluation of nuclear structure data. Each entry in this computer file corresponds to a bibliographic reference which is uniquely identified by a Keynumber and is describable by a Topic and Keywords. It has been used since 1969 to produce bibliographic citations for mass-chain evaluation published in the Nuclear Data Sheets. Periodic additions to the file are published as the "Recent References" issues of the Nuclear Data Sheets. In October 1980, the maintenance and updating of the NSR file became the responsibility of the NNDC at Brookhaven National Laboratory. The basic structure and contents of the NSR file remained unchanged during the transfer to NNDC. The file uses an ASCII character format of logical records initiated by a ten character identifier. The file contains 80 character physical records with the start of each logical record coinciding with the beginning of a physical record.

The legal record identifiers are:

<KEYNO > - Reference keynumber

<HISTORY > - Administrative record

<CODEN > - Standard form reference

<REFRENCE > - Free text reference

<AUTHORS > - Author names

*W.B. Ewbank, "The Nuclear Structure References (NSR) File," ORNL-5397 (1978).

<TITLE > - Reference title

<KEYWORDS> - Keyword abstract

<SELECTRS> - Indexing parameter list

Only these record types appear in the file and they appear in the above order. Only one record of each type appears in the file for each reference, except for <KEYWORDS> and <SELECTRS> which will be repeated for each major category (i.e., NUCLEAR REACTIONS, NUCLEAR STRUCTURE, etc.) under which the reference is indexed.

A. <KEYNO >

The keynumber has six characters. The first two, the publication year; the second two, the first two letters of the first author's last name; and the final two a unique identifier (2 digits for a Primary reference or 2 letters for a Secondary reference). The keynumbers are upper case as shown in example below.

76LA03 - Primary

76LAZY - Secondary

For an initial entry prepared in the "compiled" mode (see <HISTORY > record below) the keynumber will have five characters. The first four have the same significance as above. The last character is P for Primary source, S for Secondary source. Thus, in the update input file the record would be:

<KEYNO > 76LAP

or

<KEYNO > 76LAS

The program which updates the NSR data base will assign the complete keynumber for the reference.

B. <HISTORY >

This record contains a single character code followed by a date in the form YYMMDD.

The possible codes are:

A - added

M - modified

D - deleted

C - compiled (for use by NSR compilers preparing a new entry)

Examples: <HISTORY > A800211 New reference entry after update of NSR data base

<HISTORY > M791122 Modified reference entry

<HISTORY > D800101 Deleted reference entry

<HISTORY > C950101 New reference entry prepared for NSR data base update

C. <CODEN >

The record contents are essentially unchanged. The field consists of a reference-type code followed by an abbreviated form of the reference. This field cannot have more than 70 characters.

The permitted reference types are:

JOUR	-	Journal
CONF	-	Conference
REPT	-	Report
BOOK	-	Book
PC	-	Private Communication
THESIS	-	Thesis
PREPRINT	-	Preprint

For Primary sources (Journals) the <CODEN > format is standard. A list of Journals scanned at NNDC together with the internationally approved <CODEN > is attached (Section V - Appendix C). A typical <CODEN > entry is given below:

<CODEN >JOUR PRVCA 18 424

It represents an article from Phys. Rev. C18, Page 424.

For Secondary sources except when the reference type is JOUR, the format depends on the reference type. Typical <CODEN> entries are considered in sequence below:

JOUR: Abstracts of Physical Society meetings and Theses are coded under this category:

<CODEN >JOUR CODEN # #,#,First Author's Last Name

Volume No. Page No. Abstr. No.

Example: <CODEN >JOUR BAPSA 18 720,KK12,Nawrocki

Volume No. Page No. Abstr. No.

Example: <CODEN >JOUR DABBB 41,4162,Liu

Volume No. Page No.

CONF: Generally all contributed papers with new data are coded. Invited talks and reviews are included only if they discuss new data relevant to NSR or if a keynumber assignment is requested for by an evaluator or user.

<CODEN >CONF Location held(Subject),P#,First Author's last name

Example: <CODEN >CONF Studsvik(n,Gamma Spectroscopy),P403,Bohm

If the Reference was a contributed paper from Proceedings of the Conference published separately from Invited Talks:

Example: <CODEN >CONF Tokyo(Nuclear Structure) Proc,P403,Bohm

If the Reference was from the Contributions to the Conference published separately from Invited Talks:

Example: <CODEN >CONF Tokyo(Nuclear Structure) Contrib,P403,Bohm

If conference Proceedings had a Report Code assigned:

Example: <CODEN >CONF Leysin Vol2 P1093, CERN-70-30

NOTE: The above example also illustrates how multi-volumed sources are coded. The Vol# appears immediately before the page specification.

Conferences on Nuclear Spectroscopy and Nuclear Structure held in the former USSR:

Example: <CODEN >CONF Erevan,P71,Burmistov

REPT:

<CODEN >REPT CODE-#,P#,First Author's last name

Example: <CODEN >REPT INDC(CCP)-164/1,P9,Skarastov

If References are from Annual Reports of Laboratories without specific code number:

Example: <CODEN >REPT Univ Arkansas Nucl Chem Ann Rept,P4,Kantele

If Reference is taken from Annual Reports of Laboratories with assigned code:

Example: <CODEN >REPT MSUCL 1978 Annual,P50,Daly

Book:

<CODEN >BOOK Title/Abbreviated Title, Publisher

Example: <CODEN >BOOK Table of Isotopes, 7th Ed., John Wiley and Sons

PC:

<CODEN >PC First Author's initials separated by 1 space followed by last name

Example: <CODEN >PC E Spejewski

If Private Communication was dated:

Example: <CODEN >PC E Spejewski,5/28/80

If Private Communication was quoted by another reference already in NSR file:

Example: <CODEN >PC E Spejewski, quoted by 81P002

If quoted Private Communication was dated:

Example: <CODEN >PC E Spejewski,quoted by 81P002 5/13/81

THESIS:

<CODEN >THESIS Author's initials separated by 1 space followed by last name,Affiliation

Example: <CODEN >THESIS W Roney,Univ New Mexico

If Thesis has been assigned a Report Number:

Example: <CODEN >THESIS W Roney,Univ New Mexico, LA-4198

If Thesis abstract is published in Dissertation Abstracts

Example: <CODEN >THESIS W Roney, Univ New Mexico,DABBB 32 2339

Volume No.Page No.

PREPRINT:

Preprints included in NSR file generally have a code number like reports.

Example: <CODEN >PREPRINT PPP/4-81,Ajzenberg-Selove

If preprint has no code number but is dated and author's name is available, then <CODEN > will be as in example given below:

Example: <CODEN >PREPRINT Ajzenberg-Selove, M/D/Y

D. <REFRENCE>, <AUTHORS >, <TITLE >

These are free text fields. All entries have these three records. They can exceed 70 characters. The <REFRENCE> field for Primary sources is standardized. For the <CODEN > example given above (Section IIC), this will be: <REFRENCE>Phys.Rev. C18, 424 (1980)

If an Erratum is published for this Reference in a subsequent issue of the Journal, the entry will be modified as:

<REFRENCE>Phys.Rev. C18, 424 (1980); Erratum Phys.Rev. C19, 530 (1981)

For the Russian Journals for which English Translations are available, this information is included in the <REFRENCE> field. A list of the Journal CODEN together with the modification to the <REFRENCE> field is given below. The modification follows the original information in this field as in the case of an Erratum discussed above.

The convention followed before the breakup of the Soviet Union is given below:

CODEN	Add to <REFRENCE> field	Vol#	P#	(year)
YAFIA	; Sov.J.Nucl.Phys.	55,	P#	(year)
PZETA	; JETP Lett.(USSR)	,		( )
AENGA	; Sov.At.Energy	,		( )
ZETFA	; Sov.Phys.JETP	,		( )
FECAA	; Sov.J.Part.Nucl	,		( )
UFNAA	; Sov.Phys.Usp.	,		( )
RADKA	; Sov.J.Radiochemistry	,		
IANFA	; Bull.Acad.Sci.USSR, Phys.Ser.	,		( )

The convention now being followed for these Journals is given below:

YAFIA	; Bull.Rus.Acad.Sci.Phys.
PZETA	; JETP Lett.
AENGA	; At.Energy
ZETFA	; J.Exper.Theo.Phys.
FECAA	; Phys.Part.Nucl.
UFNAA	; Phys.Usp.
RADKA	; Sov.J.Radiochemistry
BRSPE	; Bull.Rus.Acad.Sci.Phys.

For Secondary sources classified as JOUR, the format is standard. For all the others it is nonstandard. The <REFRENCE> fields for the examples discussed in the <CODEN> section (Section IIC) are considered in sequence.

JOUR:

CODEN:BAPSA

<REFRENCE>Bull.Am.Phys.Soc. 18, No. 4, 720, KK12 (1980)

Issue Number

CODEN:DABBB

<REFRENCE>Diss.Abst.Int. 41B, 4162 (1980)

CODEN:PHCAA

<REFRENCE>Phys.Can. 33, No.3, p.9, CF9 (year)

CONF:

<REFRENCE>Intern.Conf.Neutron Capture Gamma-Ray Spectroscopy, Studsvik, p.403 (1969)

<REFRENCE>Proc.Intern.Conf.Nucl.Struc., Tokyo, p.403 (1969)

If Editors and Publishers are mentioned, then before p.# in example above in <REFRENCE> field add:

, A.Arima, K.Ogata Eds., Plenum Press, New York, p.403 (year)

Editors Publishers location year published

If conference date is different from actual date of publication of proceedings, then use the following format:

<REFRENCE>Proc.Intern.Conf.Nucl.Struct., Tokyo (1969), A. Arima, K. Ogata, Eds., Plenum Press, New York, p.403 (1970)

If the Reference was taken from Contributions to the International Conference then:

<REFRENCE>Contrib.Intern.Conf.Nucl.Struct., p.403 (1969)

If Conference Proceedings had a Report Code:

<REFRENCE>Proc.Intern.Conf.Prop.Nuclei, Leysin, Switzerland, Vol.2, p.1093 (1970); CERN-70-30 (1970)

For Conferences held in the former USSR on Nuclear Spectroscopy and Nuclear Structure:

<REFRENCE>Program and Theses, Proc.19th Ann.Conf.Nucl.Spectrosc.Struct.At.Nuclei, Erevan, p.71 (1969)

REPT:

If a Report has code number assigned:

Example: <REFRENCE>INDC(CCP)-164/L, p.9 (1981)

If Reference is from Annual Reports of Laboratories without specific Code Number:

Example: <REFRENCE>Univ.Arkansas, Nucl.Chem.Res., Ann.Rept., p.4 (1963)

If Laboratories have specific Code:

Example: <REFRENCE>Mich.State Univ.Cyclotron Lab.Ann.Rept., p.50 (1978)

where CODE MSUCL has been expanded in <REFRENCE> field

BOOK:

<REFRENCE>Title, Publisher, Address (year)

Example: <REFRENCE>Table of Isotopes, 7th Ed., John Wiley and Sons, Inc., New York (1978)

PC:

Example: <REFRENCE>Priv.Comm. (1980)

If Private Communication was dated:

Example: <REFRENCE>Priv.Comm. (May 1980)

If Private Communication was quoted by another reference already in NSR file:

Example: <REFRENCE>Priv.Comm., quoted by 81Po02 unpublished (1979)

THESIS:

<REFRENCE>Thesis, Affiliation (year)

Example: <REFRENCE>Thesis, Univ.New Mexico (1969)

If Thesis has been assigned Report Number:

Example: <REFRENCE>Thesis, Univ.New Mexico (1969); LA-4198 (1969)

If Thesis abstract is published in Dissertation Abstracts

Example: <REFRENCE>Thesis, Univ.New Mexico (1969); Diss.Abst.Int. 32B, 2229 (1969)

PREPRINT:

If PREPRINT has code number:

<REFRENCE>CODE-# (year)

Example: <REFRENCE>PPP/4-81 (1981)

If there is no code number:

Example: <REFRENCE>Priv.Comm. (1981)

E. <KEYWORDS>

The allowed major TOPICS are:

NUCLEAR REACTIONS

RADIOACTIVITY

NUCLEAR STRUCTURE

NUCLEAR MOMENTS

COMPILATION

ATOMIC PHYSICS

ATOMIC MASSES

The details for the preparation and coding of <KEYWORDS> are given in Section III.

F. <SELECTRS>

This field is an all upper case field with entries for each indexable parameter for the reference. It is generated automatically from the <KEYWORDS> field by the input program.

The format of each entry is as follows:

(parameter type):(parameter value);(link variable).

Entries are placed successively in the record separated by a single blank. The valid parameter types are:

N	-	Nuclide or element for which structure or decay information is presented	
T	-	Target nuclide or element in a reaction	
R	-	Reaction	
S	-	Special subject or minor category	
M	-	Measured quantity	
D	-	Deduced quantity	
C	-	Calculated quantity	
X	-	Compiled or evaluated quantity	
Z	-	Range of Z	Z:12-24
A	-	Range of A	A:13-29

Dictionaries of valid entries (parameter values) are available on request.

A typical <SELECTRS> field generated by the entry programme for Radioactive decay of ^{249}Cf may appear as:

<SELECTRS>N:249CF;A. M:G-SPECTRA; A. M:A-DECAY;A. N:245CM;B. D:T1/2;B.

where the link variable A is for the Parent nucleus for which measurements were made while B is for the Daughter nucleus whose properties were deduced.

Another example given below is generated when the angular distribution of outgoing protons is measured in the reaction $^{16}O(n,p)$:

<SELECTRS>T:16O;A. R:(N,P); A. M:DSIGMA,A.

G. The character sets used in the NSR file are given in Section V, Appendix A.

III. KEYWORDS

A. General

a) Definition: A miniabstract of essential information from publication. It is headed by a TOPIC and contains brief sentences describing what was measured/calculated/analyzed/compiled followed by what was deduced. Additional details such as experimental techniques, theoretical formalisms, etc., are given as comments at the end. The keywords string should terminate with a period. Specific punctuation rules should be followed. These rules are illustrated by examples under each topic in Section III B.

b) Recommended Abbreviations: The abbreviations and symbols used are given in the introduction and inside back cover of each Recent References issue of Nuclear Data Sheets. These are summarized in Section V, Appendix B.

c) General Keywords Format: <KEYWORDS>PARAMETER 1 PARAMETER 2; PARAMETER 3; PARAMETER 4; PARAMETER 5. PARAMETER 6 PARAMETER 7.

PARAMETER 1: Topic Specifications

Major Topic: Example: NUCLEAR REACTIONS

Major Topic,Minor Topic: Example: ATOMIC PHYSICS, Mesic-Atoms

PARAMETER 2: String of Nuclei investigated. This item is specified for all Topics. The delimiter ';' is used for all topics except NUCLEAR REACTIONS/ATOMIC PHYSICS. For these two cases, PARAMETER 3 follows immediately without any punctuation mark.

PARAMETER 3: (projectile, outgoing particle), projectile energy, energy range, energy units. This parameter is specified only for NUCLEAR REACTIONS/ATOMIC PHYSICS entries.

PARAMETER 4: specification of measured/calculated/analyzed/compiled quantities. A space precedes this Parameter specification.

PARAMETER 5: specification of deduced quantities of a general nature.

PARAMETER 6: specification of deduced Nuclear Properties. String of Nuclei followed by deduced _____.

PARAMETER 7: comments relevant to Experimental and/or Theoretical techniques.

All keywords must terminate with '.' as the delimiter. The 'typical entry' examples given in Section III B correspond exactly to the Keypunch input to the NSR file. Exactly 80 characters are allowed per record in the Keyword string; punctuation marks and blank spaces are also as shown in examples.

B. Specification of Topic, Inclusion Criteria, Coding Procedures, Typical Entries

Topic: NUCLEAR REACTIONS:

Inclusion Criteria

Hadron, light-, heavy-ion, electron, photon, meson induced reactions, fission are included.

Projectile energy or related quantities in keyword string can be specified in any of the following ways:

i) E = ---MeV; implies projectile energy was specified in the article in the laboratory frame.

ii) E(cm) ---MeV; this is used when the researchers have quoted projectile energy in center-of-mass system.

iii) E = ---MeV/nucleon; this is used for heavy-ion reactions when in the article the laboratory energy is not specified anywhere in units of MeV.

iv) E at ---MeV/c; this notation is used when projectile momentum is specified.

v) E at rest; used for reactions where the projectile is stopped in target.

vi) E ≥ (is also used when energy range is only approximately defined in the article)

E ≤ (is also used when energy range is only approximately defined in the article)

E ≈

vii) E = threshold ---MeV;

viii) E not given; used when the projectile energy is not specified anywhere in the article.

ix) For neutron induced reactions the following can be used:

E = reactor spectrum

E = low

E = slow

E = fast

E = thermal

x) For charged particle projectiles the following can be used:

E = tandem

E = cyclotron

Coding Procedure

i) under this topic a string of target nuclei may be included, as well as different reactions induced by a given projectile. The residual nuclei can also be included as a string.

```
<KEYWORDS>NUCLEAR REACTIONS {+12},{+13}C(d,d),(d,p),E=0.4-0.85
MeV; measured |s(E,|q); deduced optical-model parameters.
{+13},{+14}C levels deduced S. Enriched targets.  DWBA analysis.
```

NOTE: The reaction string for given projectile energy is terminated by ','. The delimiter ';' is used to indicate that measured/calculated/analyzed/compiled quantities will follow. The delimiter ';' is used to separate a general deduction such as the

determination of optical model parameters from any specific nuclear properties that may be deduced. The delimiter '.' which is the next punctuation mark in this example indicates that deductions regarding the nuclei ^{13,14}C will follow. Finally, the comment pertaining to experiment 'Enriched target' is separated from the theoretical procedure 'DWBA analysis' by a '.' as a delimiter.

ii) Different reactions used to reach a given set of final nuclei with measured and deduced quantities being the same should be coded as in the following:

```
<KEYWORDS>NUCLEAR REACTIONS {+117}Sn(|a,n),E=16,18,20 MeV;
{+119}Sn(|a,n),E=18 MeV; {+114}Sn(|a,2n),E=22,24 MeV;
{+116}Sn(|a,2n),E=22 MeV; {+106}Pd({+12}C,2n),E=58 MeV;
{+110}Pd({+13}C,3n),E=40,45,49,52 MeV; {+110}Cd({+13}C,3n),E=52
MeV; measured |g|g-coin,|g(|q),|s(E|q).{+116},{+118},{+120},
{+122}Te,{+120}Xe deduced levels,J,|p.  Enriched targets,Ge(Li)
detectors.
```

iii) Different reactions, different measured quantities; coding should be as given below.

```
<KEYWORDS>NUCLEAR REACTIONS {+12},{+13}C({+32}S,{+32}S),
({+28}Si,{+28}Si),E= 55-99 MeV; measured |s(|q=180{+0},E);
{+12}C({+32}S,{+32}S),E=65-99 MeV; measured |s(|q).  Parity
dependent potential,optical model.
```

iv) Fission reactions are included in the following format:

```
<KEYWORDS>NUCLEAR REACTIONS {235}U(n,F),E=1-1000 eV; measured
|s(E),fission fragment-fragment (|q).
```

NOTE: for proper indexing under the subject Fission, the word fission has to appear in the keyword string.

v) Theoretical work on nuclear reactions is coded exactly like an experimental abstract except that measured is replaced by calculated. Deduced information is included if available.

```
<KEYWORDS>NUCLEAR REACTIONS {+12}C({+6}Li,{+6}Li),({+6}Li,d),E=13
MeV; calculated |s(|q).  Optical,DWBA models.
```

vi) NSR file entry program automatically indexes residual nuclei in a nuclear reaction when the outgoing particles are fully specified. In cases where this is not possible, such as in the case of spallation, neutron, neutron plus charged particle evaporation reactions, residual nuclei will be indexed if the keyword string is written as shown in the example below:

```
NUCLEAR REACTIONS {+54}Fe({+58}Ni,X){+72}Zn/{+73}Zn/{+61}Fe/
{+62}Fe,E=108 MeV; measured residuals production |s.  Activation
technique.
```

In the above example, the residual nuclei ^{70,73}Zn, ^{61,62}Fe produced in the spallation reaction are specified just before the projectile energy part of Parameter 3 (P18) is specified. The delimiter '/' is used to allow the indexing program to pick out the residual nuclei in sequence.

Topic: RADIOACTIVITY

Inclusion Criteria

γ-,β-,α-decay, delayed-particle emission, internal conversion, spontaneous fission, exotic decay related information is included. For a given nuclide, all possible decay modes are specified. If there is a string of nuclei, all nuclei with a given decay mode can be bunched together and the decay mode specified just before the last nuclide. This will result in proper indexing and economy of indexing variables generated in the <SELECTRS> string. This is illustrated in the examples given below.

Coding Procedure

The items measured/calculated/analyzed/and deduced are separated by delimiters (punctuation marks) analogous to NUCLEAR REACTIONS entries.

i) `<KEYWORDS>RADIOACTIVITY {+62m}Co(β+),(EC); measured T{-½},E|b,|b|g-coin,|g CP; deduced log ft,Q. {+62}Ni deduced levels,J,ICC. Ge(Li) detector.`

NOTE: the delimiter ';' is used after Parent Nucleus specification while the delimiter '.' is used before Daughter Nucleus specification.

ii) Parent Nuclei should follow in a string after Topic is specified. Daughter nuclei should also follow in sequence if same quantities are deduced.

`<KEYWORDS>RADIOACTIVITY {+230}Ra,{+230}Ac(|b{+-}); measured E|g,I|g,E|b; deduced log ft. {+230}Ac,{+230}Th deduced levels.`

iii) Theoretical work under this topic is coded as:

<KEYWORDS>RADIOACTIVITY {+186}Re(|b{+-},(EC);{+188}Re,{+176m}Lu(|b{+-}); calculated log ft,|b-decay strength function.

iv) General deductions as well as Daughter Nuclear properties deduced:

RADIOACTIVITY {+227}Th(|a); measured |g|(q,H) in Ni,Co,Fe; deduced hyperfine fields. {+223 }Ra level deduced g.

v) Spontaneous Fission:

<KEYWORDS>RADIOACTIVITY {+252}Cf(SF); measured {T-½},(fragment)|g-coin.

vi) Coding with identification of method, reaction etc., used in producing activity.

<KEYWORDS>RADIOACTIVITY {+173}Lu(EC) [from Ta(p,X),E=1 GeV]; measured --etc.

<KEYWORDS>RADIOACTIVITY {+188}Au(EC),(|b{++}) [from on-line separator]; measured ---etc.

Topic: NUCLEAR STRUCTURE

Inclusion Criteria

Any model calculation of levels, electromagnetic transition probabilities, multipole moments, nuclear form factors, giant resonance characteristics, nuclear systematics, binding energies, etc.

Coding Procedures

i) `<KEYWORDS>NUCLEAR STRUCTURE {+14},{+15}N,{+16},{+17},{+18}O; calculated single-particle binding energies. Hartree-Fock method, parity mixing.`

ii) `<KEYWORDS>NUCLEAR STRUCTURE {+106},{+108},{+110}Cd; calculated levels,B(|1). Pairing,quadrupole interaction.`

NOTE: Nuclei are given in sequence following Topic specification and the delimiter ';' is used before "calculated". The delimiter ';' will be used after all calculated quantities have been specified and before any deduced items are enumerated. The comment statements regarding model, interactions etc., will follow after the delimiter '.' .

iii) A definite mass or mass range specification can be used before delimiter ';' and after topic specification.

<KEYWORDS>NUCLEAR STRUCTURE A=42; calculated..... ; deduced.....

<KEYWORDS>NUCLEAR STRUCTURE A=42-48; calculated .....; deduced .....

Topic: NUCLEAR MOMENTS

Inclusion Criteria

Hyperfine structure, isotope shift, mesic X-rays, isomer shift information. Both experimental and theoretical articles are coded. The format is similar to RADIOACTIVITY entries.

Coding Procedure

i) <KEYWORDS>NUCLEAR MOMENTS {+131},{+132}Cs; measured hfs,a,b; deduced |m,quadrupole moment.

ii) <KEYWORDS>NUCLEAR MOMENTS {+144},{+148}Sm; measured muonic X-rays; deduced nuclear charge distribution parameters. {+144},{+148}Sm level deduced quadrupole moment.

Topic: COMPILATION

Inclusion Criteria

Any evaluation of nuclear structure, radioactivity data.

Coding Procedure

i) <KEYWORDS>COMPILATION A=16; compiled,evaluated structure data.

ii) <KEYWORDS>COMPILATION {+197}Ir,{+197}Pt; compiled,evaluated structure data.

Topic: ATOMIC PHYSICS

Inclusion Criteria

Mesic atoms, charged-particle induced X-ray emission, ionization probabilities, etc.

Coding Procedure

Format could be either as in NUCLEAR REACTIONS/RADIOACTIVITY/NUCLEAR MOMENTS.

i) <KEYWORDS>ATOMIC PHYSICS Pb(p,X),E=0.9-3 MeV; Dy(p,X),E=0.6-3 MeV; measured E(L X-ray),I(L X-ray),production |s.

ii) <KEYWORDS>ATOMIC PHYSICS,Mesic-Atoms {+181}Ta, {+209}Bi; calculated pionic shifts,widths. Energy dependent optical potential.

Topic: ATOMIC MASSES

Inclusion Criteria

A direct measurement, calculation or compilations of Atomic Masses are included.

Coding Procedure

i) <KEYWORDS>ATOMIC MASSES {+3}H,{+3}He; measured mass difference. Mass spectrometer.

ii) <KEYWORDS>ATOMIC MASSES A=3-50; compiled,evaluated atomic mass data.

MULTIPLE TOPIC KEYWORDING

Article may contain information on more than one topic. For example, a Nuclear Reaction studied, evidence for Radioactive Nuclei deduced and their properties investigated. Then the following will appear as one entry:

<KEYWORDS>NUCLEAR REACTIONS U,Th,Au,Ta(p,X),E=1 GeV; measured E|a,T{-½} of spallation,fragmentation products; deduced reaction mechanism. Helium jet recoil product separation.

<KEYWORDS>RADIOACTIVITY {+150},{+151}Dy,{+152},{+152m}Ho(|a),
(EC),(|b{++}) [from U,Th,Au,Ta(p,X),E=1 GeV]; measured E|a,T{-½}.
Helium jet recoil product separation.

IV. LITERATURE COVERAGE

About 75-80 Journals from all parts of the world are scanned for information on major Topics of interest (Sections II, III) and coded. These are the Primary sources. In addition, relevant information from Secondary sources such as Laboratory Reports, Conference Proceedings, Thesis, etc., is also coded. A list of Journals and Reports routinely scanned at NNDC is given in Section V, Appendix C.

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V. APPENDICES

Appendix A: Character Sets to be used for Nuclear Science References

The Nuclear Science References file uses an extended ASCII character set. Attached is the character set which has been defined for the Nuclear Science References file. This 7-BIT system uses control characters to get superscript {+...}, subscript {-...}, and the alternate characters (| standard character).

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APPENDIX A

VALID NSR CHARACTERS

Decimal	Character	Alternate	Decimal	Character	Alternate
32	(blank)		55	7	∫
33	!		56	8	Π
34	"		57	9	∑
35	#		58	:	
36	$		59	;	
37	%		60	<	≤
38	&		61	=	≠
39	'	°	62	>	≥
40	(	←	63	?	≈
41	)	→	64	@	∞
42	*	×	65	A	A
43	+	±	66	B	B
44	,		67	C	H
45	-	∓	68	D	Δ
46	.	∝	69	E	E
47	/		70	F	Φ
48	0		71	G	Γ
49	1		72	H	X
50	2		73	I	I
51	3		74	J	~
52	4	<	75	K	K
53	5	>	76	L	Λ
54	6	√	77	M	M

APPENDIX A
(cont.)

VALID NSR CHARACTERS

Decimal	Character	Alternate	Decimal	Character	Alternate
78	N	Ν	101	e	ε
79	O	Ο	102	f	φ
80	P	Π	103	g	γ
81	Q	Θ	104	h	χ
82	R	ρ	105	i	ι
83	S	Σ	106	j	ϵ
84	T	Τ	107	k	κ
85	U	ϒ	108	l	λ
86	V	∇	109	m	μ
87	W	Ω	110	n	ν
88	X	Ξ	111	o	ο
89	Y	Ψ	112	p	π
90	Z	Ζ	113	q	θ
91	[	{	114	r	ρ
92		|	115	s	σ
93	]	}	116	t	τ
94	^	↑	117	u	υ
95	_	↓	118	v	
96	`	′	119	w	ω
97	a	α	120	x	ξ
98	b	β	121	y	ψ
99	c	η	122	z	ζ
100	d	δ			

APPENDIX A
(cont.)

VALID NSR CHARACTERS

Notes:

1. Alternate characters are represented by the base character preceded by a \ (decimal 124).

2. Superscripts and subscripts are enclosed in braces {(decimal 123) and } (decimal 125). {+ indicates a superscript and {- a subscript.

3. In a subscript, only the numbers 0 through 9 and a / are allowed.

4. In a superscript, only the numbers 0 through 9, m, g, + or - are allowed.

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APPENDIX B

ACCEPTED SYMBOLS AND EXPLANATIONS

Symbol	Explanation
a,b,c	dipole, quadrupole, octupole hyperfine interaction constants
A	mass number A=Z+N
ABMR	atomic-beam magnetic resonance
B(λ)	reduced electromagnetic transition probability
CCBA	coupled-channels Born approximation
ce	conversion electron
cm	center of mass
CP	circular polarization
C^2S	one-nucleon spectroscopic strength for pickup, stripping reactions
d	(1) deutron (2) day
DSA	Doppler shift attenuation
DSD	direct-semidirect model
DWBA	distorted-wave Born approximation
DWIA	distorted-wave impulse approximation
E	(without subscript) energy of incoming particle in nuclear reaction
Eγ,Eα,Ep Ed,Et,E(3He) etc.	(with subscript) energy of outgoing particles in nuclear reaction
EC	electron capture
E1,E2,EL	electric dipole, quadrupole, 2(L)-pole
ENDOR	electron-nucleus double-resonance
EPR,ESR	electron paramagnetic, spin resonance
EWSR	energy-weighted sum rule
F	fission, fission fragment in a nuclear reaction
fragment	fission fragment, spallation reaction product

APPENDIX B
(cont.)

ACCEPTED SYMBOLS AND EXPLANATIONS

Symbol	Explanation
g	gyromagnetic ratio
GDR	giant dipole resonance
GQR	giant quadrupole resonance
h	hour
H	magnetic field
HF	hindrance factor
HFB	Hartree-Fock-Bogoliubov
hfs	hyperfine structure
I	(with subscript) intensity
IAR	isobaric analog resonance
IAS	isobaric analog state
IB	internal bremsstrahlung
ICC	internal-conversion coefficient
IMPAC	ion implantation perturbed angular correlation technique
IT	isomeric transition
J	total angular momentum quantum number
K	projection of J on nuclear symmetry axis
K,L,M	K-, L-, M-shell internal conversion
K/L	K-, L-conversion electron ratio
L	(1) orbital angular momentum (2) multipolarity (3) L-transfer in stripping, pickup rections
m	minute
M1,M2,ML	magnetic dipole, quadrupole, 2 (L)-pole
ms	millisecond

APPENDIX B
(cont.)

ACCEPTED SYMBOLS AND EXPLANATIONS

Symbol	Explanation
N	neutron number, N = A-Z
NMR,NQR	nuclear magnetic, quadrupole resonance
P	(with or without suffix) polarization
PAC	perturbed angular correlation
$p\gamma(\theta)$	angular distribution of γ-rays with respect to a proton beam
$p\gamma(t)$	time distribution of phontons with respect to a pulsed proton beam
PWBA	plane-wave Born approximation
Q	(1) reaction energy (2) disintegration energy
Q(EC)	total disintegration energy in EC decay
$Q(\beta)$	total disintegration energy in β-decay
$Q\alpha$	total disintegration energy in α-decay
rms	root-mean-square
RPA	random-phase approximation
s	second
S	spectroscopic factor
SF	spontaneous fission
t	(1) time (2) triton
T	(1) isotopic or isobaric spin (2) temperature
$T_{½}$	half-life
TDA	Tamm-Dancoff approximation
TDHF	time-dependent Hartree-Fock
tof	time-of-flight measurement
x	number of ejected particles as in (α, xn)

APPENDIX B
(cont.)

ACCEPTED SYMBOLS AND EXPLANATIONS

Symbol	Explanation
X	(1) X-ray (2) unspecified reaction product as in (α,X)
y	(1) year (2) number of ejected particles as in (α,xnyp)
z	number of ejected particles as in (^{12}C, xnypz α)
Z	atomic number, Z = A-N
α	α-particle
αγ,βγ,γγ	coincidences between particles 1 and 2
αγ(θ,H,t) βγ(θ,H,t) γγ(θ,H,t)	αγ-, βγ, γγ coincidences as function of angle, magnetic field, time
β_2, β_3,(βL)	quadrupole, octuple, 2^L-pole nuclear deformation parameter
Γ	total level width
Γγ,Γn,Γp	partial width for γ-, n-, p-emission
γ(θ,H,T)	γ-intensity as function of angle, magnetic field, temperature
γ-branching	relative γ-branching from a level
δ	multipole mixing ratios
θ	in-plane, out-of-plane angular dependence
λ	radiation multipolarity
μ	magnetic moment
ν	neutron shell-model configuration
π	(1) level parity (2) proton shell-model configuration
σ,σ(θ),σ(E)	cross section, angular-, energy-dependence
ω(K),ω(L)	K-, L-fluorescence yield

APPENDIX C

REPORTS SCANNED BY THE NATIONAL NUCLEAR DATA CENTER

CODE	REPORT
AECL	Atomic Energy Canada Ltd.
ANL	Argonne National Laboratory
BNL	Brookhaven National Laboratory
INDC	International Nuclear Data Committee
INS	Institute Nuclear Studies, Tokyo
IPCR	Institute Physics Chem. Research, Japan
IPN	Institute Physics Nuclear, Paris
ISN	Institute Science Nuclear, Grenoble
JINR	Joint Institute Nuclear Research, Dubna
JUL-Spez	Institute fur Kernphysik, Julich
JYFL	University Jyvaskyla, Finland
LA	Los Alamos Science Laboratory
LBL	Lawrence Berkeley Laboratory
NEANDC	Nuclear Energy Agency Nuclear Data Committee
ORNL	Oak Ridge National Laboratory
UTTAC	University Tsukuba Tandem Accelerator Center, Japan
ZFK	Zentralinstitut fur Kernforschung, Dresden

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APPENDIX D

DEFINITIONS

A-DECAY
This subject describes Alpha particle decay including Alpha branching, but not Alpha spectra.

A-SPECTRA
This subject includes Alpha energy, Alpha intensity, Alpha distribution, Alpha-X delayed coincidence and Alpha-X angular correlation where X can be a particle or a photon.

ANALOGS
This subject includes Coulomb displacement energy, isobaric analog resonances, isobaric analog states and Coulomb energy.

B(LAMBDA)
This subject includes transition strengths and transition probabilities.

B+-DECAY
This subject describes positron decay.

B--DECAY
This subject describes BETA decay including log ft, ft, Beta branching, Beta delayed emission, but not BETA spectra.

B-SPECTRA
This subject includes Beta energy, Beta intensity, Beta yields and Beta-Gamma Coincidence.

BREMSSTRAHLUNG
This subject covers bremsstrahlung radiation.

CE
This subject includes Conversion Electron intensity, Internal Conversion Coefficients, Conversion Electron-X coincidence where X is a particle or photon and sub-shell ratios for Conversion Coefficients.

COULEX
This subject includes Nuclear Coulomb Excitation by different projectile inelastic scattering.

APPENDIX D
(continued)

DEFINITIONS

DEFORMATION
This subject includes dipole, quadrupole and multipole deformation associated with nuclear excitation.

DOPPLER
This subject includes Doppler Shift attenuation and Doppler recoil measurements.

DSIGMA
This subject includes differential and double differential cross section measurements.

EC-DECAY
This subject includes Nuclear decay by Electron Capture and associated quantities.

EC/B+-DECAY
This subject includes simultaneous Nuclear decay by Electron Capture and Beta along with associated quantities.

FISSION
This subject includes Shape Isomer, Spontaneous Fission decays.

G-MULTIPOLARITY
This subject includes mixing ratio delta and transition multipolarity.

G-SPECTRA
This subject includes Gamma energy, Gamma intensity, Gamma yields, Gamma multiplicities, Gamma branching, Gamma-X coincidence where X is a particle or photon.

HI
This subject was used in the past to indicate Heavy Ion induced reactions. As scope of the NSR File has enlarged, explicit specification of the Heavy Ion has become the norm.

HIGH-SPN
This subject includes High-spin level schemes.

HYP-DEF
This subject refers to hyper-deformed collective states of nuclei that are of current interest.

APPENDIX D
(continued)

DEFINITIONS

HYP-NUC
This subject refers to hypernuclide structure or production in reactions.

I-SHIFT
This subject includes Isomer and Isotopic Shifts.

ICPND
This subject includes Total Cross Section, Excitation Function, Residual Nuclei Production, Thick Target Yield data entries.

IT-DECAY
This subject includes Isomeric Transition decay and branching.

LEVEL-PROP
This subject includes Spin, Parity, Isospin and Spectroscopic Factor.

MASSES
This subject includes all entries under the topic ATOMIC MASS.

MECPD
This subject includes Total, Differential, Double Differential Cross Section data entries for Medium Energy Nuclear Reactions.

MESIC-ATOMS
This subject includes Meson induced reaction data entries under the topic ATOMIC PHYSICS.

MU
This subject includes Magnetic Moment and Gyromagnetic Factor.

N-DECAY
This subject includes Neutron-, Beta-delayed Neutron decay.

N-SPECTRA
This subject includes Neutron energy, Neutron Intensity, Neutron activity, Neutron multiplicity, delayed Neutrons, Neutron emission.

APPENDIX D
(continued)

DEFINITIONS

P-DECAY
This subject includes Proton decay, branching and Beta-delayed Proton emission.

P-SPECTRA
This subject includes Proton energy, Proton Intensity and Proton distribution.

PARAMETERS
This subject includes R-Matrix, Breit-Wigner, Optical Model parameters, and form factors.

POLARIZATION
This subject includes Gamma circular and linear polarizations, time differential, integrated perturbed Gamma angular distributions, vector, tensor analyzing powers.

Q
This subject includes mass excess, Reaction, Alpha-, Beta-decay Q-values.

QUA-GLU
This subject refers to quark-gluon plasmas and related topics.

QUADRUPOLE
This subject includes Dipole, Quadrupole, Octupole and Hexadecapole.

RADIUS
This subject includes Nuclear Charge and RMS radius.

REL-EFF
This subject refers to relativistic collisions.

RESONANCE
This subject includes Giant resonances, Fission, Nucleon, Alpha decay partial widths, ratios.

ROT-BANDS
This subject includes references to Rotational Bands in Nuclei.

S-FACTOR
This subject refers to the astrophysical S-factor.

APPENDIX D
(continued)

DEFINITIONS

SF-DECAY
This subject includes reference to Spontaneous Nuclear Fission.

SIGMA
This subject includes Total Cross Section, Excitation Function and Isomer ratio.

SPALLATION
This subject refers to Reactions where the ejectile is not specified.

SUP-DEF
This subject refers to the recently discovered super-deformed collective states of nuclei.

SUP-SYM
This subject refers to super-symmetry and related features of nuclei that are of current interest.

T1/2
This subject includes Half-life and Decay Constants.

TTY
This subject includes all reference to Thick Target data.

TWO-B--DECAY
This subject includes Two-Electron, Two-Positron Decays.

TWO-EC-DECAY
This subject refers to Two-Electron Capture Decays.

X-RAYS
This subject includes X-ray energy, X-ray intensity in general as well as for specific sub-shells.

YIELDS
This subject includes mass distributions, cross section versus fragment mass, charge, and energy distributions.

YRAST
This subject refers to the yrast levels in Nuclei.