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EVALUATION DATA FILE (EVLDF)
STORING MODEL PARAMETERS FOR NUCLEAR DATA CALCULATION

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Evaluation Data File (EVLDF)
Storing Model Parameters for Nuclear Data Calculation

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Evaluation Data File (EVLDF) is proposed to store parameters used in theoretical calculations of nuclear data. EVLDF stores basic data on nuclei such as nuclear mass, level scheme, deformation parameters, level density parameters and optical model parameters. This report describes a format of EVLDF, and gives an example of application of EVLDF.

Keywords: Nuclear Data Evaluation, Parameters, Theoretical Calculation, Format

* On loan to Institute of Human Factors, Nuclear Power Engineering Corporation

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核データ評価計算用モデルパラメータのデータファイル(ＥＶＬＤＦ)

日本原子力研究所東海研究所原子炉工学部
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(1997年11月28日受理)

核データ理論計算に使用するパラメータを格納するためにＥＶＬＤＦ (Evaluation Data File)を提案する。ＥＶＬＤＦは、原子核質量等の原子核の基本データ、レベルスキーム、変形パラメータ、レベル密度パラメータ、光学模型パラメータを格納することができる。この報告書には、ＥＶＬＤＦのフォーマットとＥＶＬＤＦの応用例を示す。

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1. Introduction

Evaluation Data File (EVLDF) has been designed to store parameters needed for theoretical calculations of nuclear data. EVLDF has been applied to Integrated Nuclear Data Evaluation System (INDES)[1] which creates input data of various theoretical calculation codes. So far, formats for the following parameters have been determined.

basic data on nuclei
level scheme
deformation parameters
level density parameters
optical model parameters

This report explains the format of EVLDF, and gives examples of data in EVLDF and application to INDES. In Chapter 2, rules and basic formats of EVLDF are described. The formats and some examples of these parameters are given in Chapter 3. The current format of EVLDF is capable of storing those parameters used for the evaluation work of JENDL-3[2]. Two kinds of possible file structure of EVLDF are described in Chapter 4; one is to store the parameters used for the evaluation work of certain nuclide and another is to provide global and/or systematically evaluated parameters. Chapter 5 describes an index file of EVLDF which is an auxiliary file for EVLDF processing. Examples of INDES run is given in Chapter 6.

2. Rules of EVLDF Format

Here some definitions of words and basic format are given.

1) A data line of EVLDF consists of 80 columns. The columns from 73 to 80 can be used for sequential number of data lines or other purposes.
2) Capital letters should be used for the alphabet.
3) Each data line can be continued to the next. No limitations exist on the number of data lines.
4) A record is a group of continued data lines.
5) In the columns from 1 to 10, a record name is given. For example, if a character string DATA is given in the columns of 1 to 4, this record is called a DATA record. Record names defined so far are listed in Table 1.
6) In the case where the same type of record is repeated, the first column of the following records should be "+" and the record name is not needed.

Example

```
CODE        CASTHY
+           ECIS
+           GNASH
```

7) Data stored in the columns from 11 to 72 depend on the record name. They are summarized in Table 1. Usually, data in the columns from 11 to 72 are given in a free format.
8) In a line, any comment can be given after a semi-colon (";").
9) Some record types have corresponding END records. A group of lines from a line with a record name to its END record is a section. For example, an OMP section is a set of data lines from an OMP record to an ENDOMP record.
10) In many cases, a nuclide is represented with an integer calculated from atomic number, mass number and meta-stable-state number as (atomic number)×10000 + (mass number)×10 + (meta-stable-state number). This integer is a nuclide name. Both of the mass number and meta-stable-state number are 0 for natural elements.
11) Units of numerical data are listed in Table 2.

2.1 DATA Section

Parameters are mainly stored in a DATA section. The DATA section starts with a DATA record and ends with an ENDDATA record.

```
DATA        NAME1, NAME2, NAME3, ....

ENDDATA
```

NAME1, NAME2, ... are symbols which indicate parameter names whose values are given in the DATA section. The symbols are written in the columns from 11 to 72, and separated with a comma (",") or blanks. The symbols are listed in Table 3, and explained in Chapter 3. Actual values of the parameters are given after the DATA record in the same order of the symbols.

Example

```
DATA        A, T, PAIR, SCF
```

This record declares that level density parameter (A), nuclear temperature (T), pairing energy (PAIR) and spin cutoff factor (SCF) are following after this DATA record.

In the case of repetition, a symbol of repetition number is followed by a set of symbols to be repeated in "( )".

Example

```
DATA        EL, J, PARITY, NG (FLVL, BR)
```

Level scheme is given after this DATA record. Parameters are given in the order of level energy (EL), spin (J), parity (PARITY) and NG sets of a level number of the final state (FLVL) and a

2.2 MAT section

A MAT section starts with a MAT record and ends with an ENDMAT record, and consists of auxiliary records and parameter sections. The MAT record specifies a nuclide whose data were (can be) calculated by using parameters given in this MAT section..

```
MAT          n
[auxiliary records]
[parameter sections storing parameters used (to be used) in the
evaluation for the material (nuclide) of n]
ENDMAT
```

"n" is a nuclide name. In a MAT record, only one nuclide name can be given. If two or more than two nuclide names have to be specified, the MAT record should be repeated.

Example

```
MAT          922350
+            922360
```

2.3 SET section

A SET section starts with a SET record and ends with an ENDSET record, and is used to give a name to a set of parameters. The SET section can be used in any parameter section.

```
SET          xxxxx
[auxiliary records]
[DATA section]
ENDSET
```

Any set of parameters between a pair of SET and ENDSET records is named as "xxxxx". A set name "xxxxx" is any alphabetic characters and/or integers without any blanks or commas among them. The maximum length of the set name is 20 characters.

branching ratio (BR).

There are no restrictions on the order of symbols. Numerical data in the DATA section should be given under the following rules.

1) Data given in the columns from 1 to 9 of each data line in the DATA section depend on type of parameters. They are DATA-line symbols. The DATA-line symbols defined so far are listed in Table 4.
2) DATA-line symbols should be left adjusted except for the case where the DATA-line symbols are nuclide names.
3) The 10^{th} column indicates continuation to the next line. If the 10^{th} column is not blank, the data are continued to the next line. In this case, a DATA-line symbol of the next line should be the same as the previous line. This rule of continuation is valid only for the numerical data in the DATA section.

Example

```
DATA      NO, EL, J, PARITY, NG (FLVL, BR)
0090190    0, 0.00000E+00,  0.5,  1.0,  0
0090190    1, 1.09900E-01,  0.5, -1.0,  1,  0,  1.00000
0090190    2, 1.97200E-01,  2.5,  1.0,  1,  0,  1.00000
0090190  + 3, 1.34570E+00,  2.5, -1.0,  2,  1,  0.96800,
0090190         2,  0.03200
0090190  + 4, 1.45850E+00,  1.5, -1.0,  3,  0,  0.20500,
0090190         1,  0.68800,  2,  0.10700
0090190  + 5, 1.55410E+00,  1.5,  1.0,  3,  0,  0.02500,
0090190         1,  0.04800,  2,  0.92600
0090190    6, 2.77980E+00,  4.5,  1.0,  1,  2,  1.00000
0090190  + 7, 3.90710E+00,  1.5,  1.0,  4,  0,  0.48000,
0090190         1,  0.17000,  2,  0.14000,  5,  0.21000
```

This example shows a level scheme ^{19}F with γ-ray transition data. The first column shows nuclide name.

4) The numerical data in the columns from 11 to 72 are given in the free format. They are read with a list-directed READ statement of FORTRAN.
5) Units of the numerical data are defined in Table 2.

Example

```
OMP
SET         STANDARDOMP
COMMENT     A set of OMP used in the present work is ....
DATA        ....
...
ENDDATA
ENDSET
ENDOMP
```

The optical potential parameters given in the DATA section are named as STANDARDOMP.

2.4 Auxiliary Records

Auxiliary records commonly used in EVLDF are defined here. Some other auxiliary records are explained in Chapter 3. The auxiliary records have no corresponding end records.

1) CODE record

A CODE record specifies a theoretical-calculation code used in evaluation work for the nuclide indicated by the MAT record. Therefore, the CODE record is used in the MAT section. A name of theoretical calculation code is given in the columns from 11 to 72 of the CODE record. If several codes were used in the evaluation, the CODE records are repeated as follows:

Example

```
CODE        CASTHY; OPTICAL AND STATISTICAL MODEL
             CALCULATION. THE CAPTURE AND INELASTIC
             SCATTERING CROSS SECTIONS WERE BASED ON THIS
             CALCULATION.
+           ECIS
+           GNASH
```

2) EVAL record

Evaluator's names are given in an EVAL record. This record can be used only in the

MAT section.

Example

```
EVAL      K.SHIBATA, T.NAKAGAWA, T.ASAMI, T.FUKAHORI,
          T.NARITA, S.CHIBA, M.MIZUMOTO, A.HASEGAWA,
          Y.KIKUCHI, Y.NAKAJIMA AND S.IGARASI
```

3) REF record

References of the evaluation or parameters are given.

Example

```
REF       JAERI 1319 (1990)
```

4) COMMENT record

Any comment can be given in the columns from 11 to 72. There are no limitations to the number of data lines.

Example

```
COMMENT   THE LEVEL DENSITY PARAMETERS STORED HERE
          WERE MAINLY TAKEN FROM THE EVALUATION BY JNDC
          FP NUCLEAR DATA WORKING GROUP.  THOSE OF NUCLEI
          OUTSIDE OF THE FP REGION WERE EVALUATED BY ...
```

3. Formats

3.1 Basic Data on Nuclei

Basic data of nuclei are stored in a NUCLIDE section.

```
NUCLIDE
[Auxiliary records]
[DATA section]
ENDNUCLIDE
```

In the DATA section, the following data can be stored.

Symbol	data
EL	Level energy (MeV). For the ground state, EL=0.0.
J	Spin. If unknown, SPIN < 0.0.
PARITY	Parity. (1.0 or -1.0). If unknown, PARITY = 0.0.
HL	Half-life (sec). For stable states, 0.0 is given. If unknown, HL < 0.0.
ABN	Abundance (%).
MASSEX	Mass-excess (MEV).

In the columns from 1 to 9, given are nuclide names. The data should be given in the increasing order of nuclide names, and if there are several data lines for the same nuclide, they should be in the increasing order of level energies..

Example

```
NUCLIDE
SET         NUCL92
COMMENT     BASED ON ENSDF AS OF 1992.06
               - EL : LEVEL ENERGY (MEV).
               - J  : TOTAL SPIN. IF UNKNOWN, -1.0 IS GIVEN.
               - PARITY : PARITY. IF UNKNOWN, 0.0 IS GIVEN.
               - MASSEX : MASS-EXCESS(MEV): WAPSTRA-AUDI(1985).
```

```
              - HL : HALF-LIFE (SEC).  IF UNKNOWN, -1.0 IS GIVEN.
              - ABN : ABUNDANCE (%).
DATA      EL, J, PARITY, MASSEX, HL, ABN
0000010   0.0, 0.5, 1.0, 8.07137E+00, 6.24000E+02,   0.0
0010010   0.0, 0.5, 1.0, 7.28903E+00, 0.00000E+00,  99.985
0010020   0.0, 1.0, 1.0, 1.31358E+01, 0.00000E+00,   0.015
0010030   0.0, 0.5, 1.0, 1.49491E+01, 3.89098E+08,   0.0
0010040   0.0, 2.0,-1.0, 2.58400E+01,-1.00000E+00,   0.0
0020030   0.0, 0.5, 1.0, 1.49310E+01, 0.00000E+00, 0.000137
0020040   0.0, 0.0, 1.0, 2.42409E+00, 0.00000E+00, 99.999863
0020050   0.0, 1.5,-1.0, 1.13900E+01, 1.09703E-13,   0.0
      - - - - - - - - - - - - - - - - - - - - -
ENDDATA
ENDSET
ENDNUCLIDE
```

3.2 Level Scheme

Level scheme is stored in a LEVEL section.

```
LEVEL
[auxiliary records]
[DATA section]
ENDLEVEL
```

In the DATA section, the following data can be stored.

Symbol	data
NO	Level number. A ground state should be 0.
EL	Level energy (MeV).
J	Spin. For the level energy above where levels can be assumed to be overlapping, J=-1.0.
PARITY	Parity. Parity of + and - is represented by 1.0 and -1.0, respectively. For the overlapping state, PARITY = 0.0.
HL	Half-life (sec).
NG	Number of γ-rays emitted from the level.
FLVL	Level number of final state.

BR	Branching ratio.
EG	γ-ray energy (MeV).

If γ–transition data are given, NG, FLVL, BR and/or EG have to be specified as follows:

```
DATA        ...  , NG (FLVL, BR)
```

Among these parameter symbols, EL, J and PARITY should be always given. In the case of γ- transition data, in addition to them, NO, NG, FLVL and BR are obligatory. The data should be stored in the increasing order of level numbers and level energies. In the columns from 1 to 9, nuclide names are given. The level data are arranged in the order of nuclide names.

Example

```
LEVEL
SET          J3FPLVL
COMMENT      USED FOR THE EVALUATION OF FP NUCLEAR DATA FOR
             JENDL-3.
DATA         EL,  J,  PARITY
0330750      0.0          ,  1.5,  -1.0
0330750      1.98600E-01,  0.5,  -1.0
0330750      2.64660E-01,  1.5,  -1.0
0330750      2.79540E-01,  2.5,  -1.0
0330750      3.03920E-01,  4.5,   1.0
- - - - - - - - - - - - - - - - - - -
0330750      8.65000E-01, -1.0,   0.0
0340740      0.0          ,  0.0,   1.0
0340740      6.34780E-01,  2.0,   1.0
0340740      8.53800E-01,  0.0,   1.0
0340740      1.26890E+00,  2.0,   1.0
0340740      1.36320E+00,  4.0,   1.0
0340740      1.60000E+00,  2.0,   1.0
- - - - - - - - - - - - - - - - - - - - -
ENDDATA
ENDSET
ENDLEVEL
```

The following is an example of level scheme with γ-transition data.

```
LEVEL
SET         YAMAMURO91; FOR 504 NUCLIDES.
COMMENT    EVALUATED BY N.YAMAMURO FOR SINCROS (1991).
DATA        NO, EL, J, PARITY, NG (FLVL, BR)
0050100      0, 0.00000E+00,  3.0,  1.0,  0
0050100      1, 7.18300E-01,  1.0,  1.0,  1,  0,  1.00000
0050100    + 2, 1.74010E+00,  0.0,  1.0,  2,  1,  0.99800,
0050100           0,  0.00200
0050100    + 3, 2.15430E+00,  1.0,  1.0,  3,  2,  0.51600,
0050100           1,  0.27300, 0,  0.21100
0050100    + 4, 3.58710E+00,  2.0,  1.0,  4,  3,  0.14000,
0050100           2,  0.00300, 1,  0.66800,  0,  0.18900
0050100    + 5, 4.77400E+00,  3.0,  1.0,  2,  1,  0.99500,
0050100           0,  0.00500
0050100    + 6, 5.11030E+00,  2.0, -1.0,  3,  2,  0.05000,
0050100           1,  0.31000, 0,  0.64000
- - - - - - - - - - - - - - - - - - - -
ENDDATA
ENDSET
ENDLEVEL
```

3.3 Deformation Parameters

Deformation parameters are stored in a DEFORM section between DEFORM and ENDDEFORM records.

```
DEFORM
[auxiliary records]
[DATA section]
ENDDEFORM
```

In the DATA section, the following data are stored.

Symbol	data
EL	Level energy (MeV).
J	Spin
PARITY	Parity
DL	Orbital angular momentum transfer
BETA	Deformation parameters (β)

BETA2 Deformation parameters (β^2)

The data should be stored in the increasing order of level energies. In the columns from 1 to 9, nuclide names are given. In one DATA section, the deformation parameters for many nuclei can be stored. In such case, the deformation parameters should be stored in the increasing order of the nuclide names.

Example

```
DEFORM
COMMENT    EVALUATED BY N.YAMAMURO FOR SINCROS (1990).
DATA          EL,          DL,     BETA,
0140280    1.77880E+00,    2,    0.47000
0140280    4.61690E+00,    4,    0.20000
0140280    6.69140E+00,    0,    0.08000
0140290    1.27330E+00,    2,    0.41000
0140290    2.02820E+00,    2,    0.41000
0140290    4.08020E+00,    4,    0.20000
0140290    4.74100E+00,    4,    0.20000
0140300    2.23540E+00,    2,    0.32000
0140300    5.27950E+00,    4,    0.20000
0140300    6.64110E+00,    0,    0.08000
0230510    9.28700E-01,    2,    0.25000
- - - - - - - - - - - - - - - - - - - - -
ENDDATA
ENDDEFORM
```

3.4 Level Density Parameters

Level density parameters are stored in an LDP section starting with an LDP record and ending at an ENDLDP record. The level density parameters are model dependent. In the current format, the parameters for Gilbert and Cameron's composite formula[3] can be stored.

```
LDP
[auxiliary records]
[FORMULA record]
[DATA section]
```

ENDLDP

A FORMULA record identifies a level density formula.

FORMULA xxxxx

xxxxx = GILBERT-CAMERON: Gilbert and Cameron's composite formula[3)]

Gilbert and Cameron's Composite Formula

Density of levels having spin J, parity π and excitation energy E is written by the following equations:

$$\rho_{J\pi} = p(\pi)R(J)\rho_0(E), \tag{3.4.1}$$

where $p(\pi)$ is the normalized parity distribution, and $R(J)$ the normalized spin distribution.

$$R(J) = \frac{2J+1}{2\sigma^2(E)}\exp\left(-\frac{J(J+1)}{2\sigma^2(E)}\right). \tag{3.4.2}$$

The energy dependent part ρ_0(E) is written by the Fermi gas model in the energy region above E_x,

$$\rho_0(E) = \frac{\exp(2\sqrt{aU})}{12\sqrt{2}\sigma(E)a^{1/4}U^{5/4}}, \tag{3.4.3}$$

and by the constant temperature model in the energy region below E_x,

$$\rho_0(E) = C\exp(U/T). \tag{3.4.4}$$

E_x is a connection energy of these two models. U is given by $U = E-\Delta$, where Δ is a pairing energy. The spin cut-off factor σ^2(E) in the energy region above E_x is written as:

$$\sigma^2(E) = C_1\sqrt{aU}\,A^{2/3} = \alpha_M U^{1/2}, \tag{3.4.5}$$

where α_M is a spin cut-off parameter. On the other hand, in the constant temperature model region ($E \le E_x$), several equations of σ^2(E) have been proposed. One parameter to be stored is a spin cut-off factor at 0 MeV, $\sigma^2_{exp}(0)$. For example, the following equation was proposed by Gruppelaar[4)]:

$$\sigma^2(E) = \sigma^2_{exp}(0) + \left\{\sigma^2(E_X) - \sigma^2_{exp}(0)\right\}\frac{E}{E_X}, \tag{3.4.6}$$

The level density parameters are stored with the following auxiliary record and the DATA section.

SCOEF n

"n" is a coefficient of spin cut-off factor (C_1 in Eq.(3.4.5)). If the coefficient is 0.146, this record can be omitted.

In the DATA section, the following parameters are stored.

Symbol	data
A	a (MeV^{-1}) in Eq.(3.4.3).
T	Temperature (MeV) in Eq.(3.4.4).
PAIR	Pairing energy Δ(MeV).
EX	Connecting energy E_x of the constant temperature model and Fermi-gas model (MeV).
SCF	Spin cut-off factor at 0 MeV, $\sigma^2_{exp}(0)$ in Eq.(3.4.6).
SCP	Spin cut-off parameter, α_M in Eq.(3.4.5).
E0	Energy (MeV) where a cumulative number of levels is 1.0.

In the columns from 1 to 9, nuclide names are given. The nuclide names should be given in the increasing order.

Example

```
LDP
SET       J3FPLDP; FOR JENDL-3 FP NUCLEAR DATA
COMMENT    MAIN PART OF THIS LDP SET WAS DETERMINED BY JNDC FP NUCLEAR
           DATA WG FOR EVALUATION WORK OF JENDL-3.
FORMULA   GILBERT-CAMERON
SCOEF     0.146
DATA       A, T, PAIR, EX, SCP, SCF
0320780   1.2340+1, 8.6990-1, 2.930, 9.3949+0, 9.3628+0, 5.0000+0
0320790   1.3620+1, 7.5230-1, 1.360, 6.5668+0, 9.9203+0, 5.0000+0
0330740   1.1320+1, 9.4750-1, 0.000, 7.0329+0, 8.6583+0, 5.0000+0
0330750   1.2500+1, 9.5100-1, 1.880, 1.0084+1, 9.1801+0, 3.5000+0
0330760   1.3300+1, 7.8600-1, 0.000, 5.6109+0, 9.5533+0, 5.0000+0
```

```
0330770   1.3000+1, 8.4400-1, 1.470, 7.9511+0, 9.5276+0, 5.0000+0
0330780   1.1500+1, 7.5000-1, 0.000, 3.8937+0, 9.0385+0, 5.0000+0
0330790   1.2900+1, 8.2300-1, 1.570, 7.5852+0, 9.6546+0, 5.0000+0
0330800   1.1500+1, 7.2500-1, 0.000, 3.5351+0, 9.1924+0, 5.0000+0
0340730   1.4040+1, 8.2500-1, 1.430, 8.2876+0, 9.5555+0, 5.0000+0
0340740   1.2900+1, 8.6200-1, 2.860, 9.6116+0, 9.2428+0, 3.9250+0
0340750   1.3910+1, 8.5000-1, 1.430, 8.7066+0, 9.6841+0, 5.0000+0
0340760   1.3150+1, 8.9000-1, 3.310, 1.0819+1, 9.4993+0, 6.7802+0
0340770   1.4380+1, 8.0000-1, 1.430, 8.0145+0, 1.0021+1, 6.5179+0
0340780   1.2870+1, 8.7500-1, 2.900, 9.8819+0, 9.5618+0, 4.8750+0
0340790   1.4120+1, 8.0000-1, 1.430, 7.8422+0, 1.0101+1, 4.6724+0
  - - - - - - - - - - - - - - - - - - - -
ENDDATA
ENDSET
ENDLDP
```

3.5 Optical Model Parameters

Optical model parameters are stored between OMP and ENDOMP records.

```
OMP
[auxiliary records]
INCIDENT record
[DATA section]
ENDINC
ENDOMP
```

An INCIDENT section has to be used to specify the incident particle. Between INCIDENT and ENDINC records, the optical model parameters of the incident particle specified by the INCIDENT record are stored.

```
INCIDENT     n


ENDINC
```

"n" represents the incident particle in the same rule as nuclide names.

10	neutron
10010	proton
10020	deuteron
10030	triton
20040	α

The following auxiliary records are defined.

TARGET n1, n2

n1 and n2 indicate a range of nuclei for which the optical potential parameters can be applied.

TYPE n

defines type of form factors of imaginary parts as follows.

n	Surface term	Volume term
1	Gaussian form	none
2	derivative Wood-Saxon form	none
3	none	Wood-Saxon form
4	Gaussian form	Wood-Saxon form
5	derivative Wood-Saxon form	Wood-Saxon form

COULOMB n

Coulomb radius parameter (fm) for charged particles.

In the DATA section, potential parameters are stored under the following parameter names.

Symbol	data
V	Real potential depth (MeV)
WV	Volume type imaginary potential depth (MeV)
WS	Surface type imaginary potential depth (MeV)

VSO	Real part of spin-orbit potential depth (MeV)
WSO	Imaginary part of spin-orbit potential depth (MeV)
EMIN	Lower boundary of incident particle energy (MeV)
EMAX	Upper boundary of incident particle energy (MeV)

By using these symbols, an optical potential is written as follows:

$$V(r) = -V \cdot f(r,R,A)_V - iWV \cdot f(r,R,A)_{WV} - iWS \cdot f(r,R,A)_{WS} - (VSO + iWSO)\left(\frac{\hbar}{m_\pi c}\right)^2 \frac{1}{r}\left|\frac{d}{dr} f(r,R,A)_{VSO}\right|(\vec{\sigma}\cdot\vec{\ell}) - V_{Coulomb} \tag{3.5.1}$$

$V_{Coulomb}$ is a Coulomb potential written as follows:

$$V_{Coulomb} = \frac{Zze^2}{2R_c}\left(3 - \frac{r^2}{R_c^2}\right) \qquad r \le R_c$$
$$= \frac{Zze^2}{r} \qquad r \ge R_c \tag{3.5.2}$$

Z and z is the number of protons in the target nuclide and incident particle, respectively. R_c can be written as $R_c = r_c A^{1/3}$ where r_c is a Coulomb radius parameter given in the COULOMB record, and A is a mass number. Form factors, *f(r,R,A)* of Eq.(3.5.1), for V, WV and VSO have Woods-Saxon form:

$$f(r,R,A) = \frac{1}{1+\exp\{(r-R)/A\}} \tag{3.5.3}$$

where R is radius and A is a diffuseness parameter. In the case of WS, the form factor has two possibilities; Gaussian and derivative Woods-Saxon type:

$$f(r,R,A)_{WS} = \exp\left\{-\left[(r-R)/A\right]^2\right\} \qquad \text{Gaussian} \tag{3.5.4}$$

$$f(r,R,A)_{WS} = \frac{4\exp\left[(r-R)/A\right]}{\left\{1+\exp\left[(r-R)/A\right]\right\}^2} \qquad \text{derivative Woods-Saxon} \tag{3.5.4'}$$

Combinations of form factors are specified by the TYPE record.

For each potential depth parameter, the following energy (E), and atomic and mass number (Z, A) dependence can be stored.

$$p(E) = a_0 + a_1 E + a_2 E^2 + a_5 \sqrt{E} + b\frac{N-Z}{A} + c\frac{Z}{A^{1/3}} + gA^{1/3}. \qquad (3.5.5)$$

Nuclear radius (R) for each type of potential is expressed as:

$$R = r_0 + r_a A^{1/3} + r_1 E + r_2 E^2 + \ldots + r_s\frac{N-Z}{A} + r_{A1}A + r_{A2}A^2 + \ldots \qquad (3.5.6)$$

Diffuseness parameters (a) have almost the same form as nuclear radii.

$$a = a_0 + a_1 E + a_2 E^2 + \ldots + a_s\frac{N-Z}{A}. \qquad (3.5.7)$$

DATA-line symbols in the columns from 1 to 9 of the DATA section represent the terms of above expressions as follows:

Symbol	meaning
E0	Constant term. a_0 in Eq.(3.5.5).
E1	First order term of energy. a_1 in Eq.(3.5.5).
E2	Second order term of energy. a_2 in Eq.(3.5.5).
E5	Square root term. a_5 in Eq.(3.5.5).
E9	$Z/A^{1/3}$ term. c in Eq.(3.5.5).
E10	$A^{1/3}$ term. g in Eq.(3.5.5)
SYM	Symmetric term. b in Eq.(3.5.5).
R	Nuclear radius parameter. r_a in Eq.(3.5.6).
RC	Constant term of nuclear radius. r_0 in Eq.(3.5.6).
A	Diffuseness parameter. a_0 in Eq.(3.5.7).

Energy dependent terms and symmetric terms of R and A are represented as

R-E1 ($=r_1$),

R-SYM ($=r_s$),

R-A1 ($=r_{A1}$),

A-E1 ($=a_1$),

A-SYM ($=a_s$).

Example

```
OMP
INCIDENT   10; neutron
```

```
TARGET      130000, 239999
TYPE         1
DATA         V, WS, VSO, EMIN, EMAX
E0          48.46, 4.94, 6.0, 0.0, 11.0
E0          51.87, 7.14, 6.0, 11.0, 20.0
E1          0.0, 0.20, 0.0, 0.0, 11.0
E1          -0.31, 0.0, 0.0, 11.0, 20.0
R           1.18, 1.26, 1.01, 0.0, 20.0
A           0.64, 0.58, 0.5, 0.0, 20.0
ENDDATA
ENDINC
ENDOMP
```

This example stores the following potential parameters:

V = 48.46 for E_n<11 MeV, and = 51.87 - 0.31×E_n for E_n>11 MeV,

W_S = 4.94 + 0.2×E_n for E_n<11 MeV, and = 7.14 for E_n>11 MeV,

V_{SO} = 6.0 MeV

R (real term) = $1.18\times A^{1/3}$ fm,

R (surface term) = $1.26\times A^{1/3}$ fm,

R (volume term) = $1.01\times A^{1/3}$ fm,

Diffuseness parameter of the real term = 0.64 fm,

Diffuseness parameter of the surface term = 0.58 fm,

Diffuseness parameter of the volume term = 0.50 fm.

4. File Structure of EVLDF

There are two ways of storing parameters into EVLDF. One is a way to store the parameters which were used for evaluation of each material. Another way is to store global parameters or systematically evaluated parameters. A file made in the first way is a material-wise file and the file in the second way a parameter-wise file.

4.1 Material-wise File

In a material-wise file, parameters used for the evaluation of material n_1 is compiled in a MAT section as follows:

MAT n_1
EVAL record
REF record
CODE record
COMMENT record
NUCLIDE section
LEVEL section
DEFORM section
LDP section
OMP section
ENDMAT

Any records and sections which have no data to be stored are omitted. After the MAT section, another MAT section can be stored. In such case, MAT sections should be given in increasing order of nuclide names.

4.2 Parameter-wise File

A parameter-wise file stores global parameters and/or parameters evaluated systematically. In the parameter-wise file, the MAT section cannot exist. The following is an example of the parameter-wise file for the optical potential parameters.

OMP

INCIDENT n_1

SET NN01

REF record

TARGET record

DATA section

[other pairs of the TARGET record and the DATA section]*)

ENDSET

[other SET sections for the incident particle n_1]

ENDINC

[other INCIDENT sections]

ENDOMP

*) Pairs of the TARGET record and the DATA section should be given in the increasing order of nuclide names.

In the parameter-wise file, parameter sets should be named by SET and ENDSET records. Several kinds of parameters can be stored in a file.

5. Index of EVLDF

Since parameters are stored in several material-wise files and/or several parameter-wise files, an index file of the parameters stored in the EVLDF files is useful. The format of the index file has been defined as follows:

Columns	format	description
1 - 33	A33	Data-set name of an EVLDF file. In the case of a PO file, a member name should be specified also.
34 - 40	I7	Position of the SET record.
41 - 45	I5	Number of data lines in the SET section.
46 - 54	A9	Name of record (MAT, LDP, OMP, LEVEL or NUCLIDE).
(for parameter-wise files)		
55 - 74	A20	Parameter-set name defined by the SET record.
(for material-wise files)		
55 - 59		Blanks
60 - 66	I7	Minimum nuclide name given in the MAT record.
67 - 73	I7	Maximum nuclide name given in the MAT record.
74		Blank
(for both types)		
75 - 81	I7	Incident particle for OMP, blanks for other parameters.
82 - 88	I7	Minimum nuclide name of the TARGET record or the DATA section.
89 - 95	I7	Maximum nuclide name of the TARGET record or the DATA section.

If the columns from 55 to 59 are blank, the EVLDF file is a material-wise file. An example of the index file is given in Fig. 1. A small program, EVLDFIND, was made to create the index file.

6. Application of EVLDF

EVLDF has been applied to INDES (Integrated Nuclear Data Evaluation System)[1]. One of main functions of INDES is to create JCL (JOB Control Language) and input data for theoretical calculation codes by using parameters stored in the EVLDF files.

INDES is an interactive program used under TSS environment. Before starting INDES, each user of INDES has to provide his own parameter file which should be a PO file (Partitioned Organized file). By using INDES, one can retrieve the parameters from the EVLDF files into his own parameter file. Or he can put the parameters into his parameter file by applying the EVLDF format.

There are many functions in INDES. Each function is called "segment". Figure 2 shows a screen of TSS terminal for the GET segment of INDES. After specifying NUCLIDE (range of nuclides whose parameters will be retrieved), PARAMTERS (type of parameters; OMP, LEVEL, LDP, etc.) and PARAM FILE (file name of user's parameter file), and "EXEC" on COMMAND line, the parameters are retrieved into user's parameter file. In the case of this example, the level scheme data for Ru isotopes are written in the file of J2608.PP.DATA(LEVEL). A member name of user's parameter file is the same as the type of parameters. All parameters needed for the calculation should be prepared in user's parameter file.

As an example of making JCL and input data, the case of CASTHY[5] is explained. Figure 3 is the first screen of CASTHY segment of INDES. Each screen is called "panel". The names of parameter files are automatically listed at the bottom of the first panel. JCL FILE is a data file to which INDES writes JCL and input data for CASTHY. As is shown in Fig.4, by specifying TARGET (target nuclide, ^{101}Ru in this example, whose data will be calculated), NEN (option for incident neutron energies), ENORML (an energy where normalization of the capture cross section will be performed), SIGCAP (the capture cross section at ENORML), COMPETING-SIG FILE (name of a data file storing competing cross-section data in the ENDF format), MAT and MT numbers (MAT and MT numbers of the competing cross section), OUTPUT FILE (results of CASTHY calculation will be written on this file in the ENDF format) and MAT number of results, all parameters for the calculation are read from user's parameter file. Then the first panel changes to Fig. 5.

In order to confirm the parameters and to modify them if needed, several panels are available in the CASTHY segment. Figure 6 is the second panel for optical potential parameters. Here one can change the optical potential parameters, or can exchange the parameter file written at the bottom of the panel. Other panels show the level density parameters (Fig. 7), the level scheme (Fig. 8) and the competing cross sections (Fig. 9). Any parameters and data can be modified or replaced from the screens (panels).

Then entering "EXEC" on the COMMAND line of any panel like Fig. 9, the JCL and input data of CASTHY are written on the JCL FILE (J2608.JCLFILE.CNTL in this example). When the EXEC command has been executed, JCL and input data are listed on the screen (Fig. 10). From this screen, any part of JCL and input data can be modified if needed. After confirmation of JCL and input data, one can submit this JCL as a batch job.

In the evaluation work for JENDL-3.2[6], INDES and EVLDF were frequently used. Especially, for the case of fission product nuclides where the parameters were systematically determined, and almost the same evaluation procedure was applied to many nuclides, it was found that the INDES and EVLDF system was a convenient and powerful tool for the nuclear data evaluation work.

7. Conclusion

The outline of EVLDF was described in this report. So far, the formats for optical model parameters, level density parameters, level scheme, deformation parameters and basic data on nuclei (such as mass, spin) have been determined. The definitions are not enough yet. They will be modified if some inconveniences are found, and new formats for other parameters should be defined.

Examples of data stored in the EVLDF format are given in Appendixes. The EVLDF have been applied to INDES which was used in the evaluation work for JENDL-3.2, as was explained in Chapter 6. Through this experience, it was found that such system as INDES with EVLDF is very useful to reduce the time for preparation of input data for theoretical calculation codes and human errors, and the results of calculation becomes more reliable.

Acknowledgment

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Table 1 Records in EVLDF

record name	functions	11-72 col*	END record
CODE	specifies a theoretical code used for an evaluation work.	C1	none
COMMENT	stores any comment.	C2	none
DATA	defines parameters to be stored. A heading line of a DATA section.	C3	ENDDATA
DEFORM	starts a deformation parameter section.	Blanks	ENDDEFORM
EVAL	evaluator's name.	C2	none
FORMULA	a formalism of level density parameters.	C1	none
INCIDENT	specifies an incident particle. Used in a OMP section.	N	none
LDP	starts a level density parameter section.	Blanks	ENDLDP
LEVEL	starts a level scheme section.	Blanks	ENDLEVEL
MAT	material name.	N	ENDMAT
NUCLIDE	starts a section of basic data on nuclei.	Blanks	ENDNUCLIDE
OMP	starts an optical model parameter section.	Blanks	ENDOMP
REF	references.	C2	none
SCOEF	a coefficient for a spin-cutoff factor.	N	none
SET	names a set of parameters.	C1	ENDSET
TARGET	a range of target nuclei.	N_1, N_2	none
TYPE	type of an optical potential.	N	none

*) C1 characters without blanks and ","

C2 any characters

C3 parameter symbols defined in Table 3.

N,N_1,N_2 numerical data (integer)

Table 2 Units of physical quantities

unit	quantities
MeV	energy, mass excess
fm	nuclear radius
barns	cross section
sec	half-life
%	abundance

Table 3 Parameter Symbols used in DATA section

Symbol	Parameter type	Description
A	LDP	a (MeV^{-1})
ABN	NUCLIDE	abundance (%)
BETA	DEFORM	deformation parameter (β)
BETA2	DEFORM	deformation parameter (β^2)
BR	LEVEL	branching ratio of γ-ray transition
DL	DEFORM	angular momentum transfer
EG	LEVEL	γ-ray energy (MeV)
EMIN	OMP	lower boundary of incident particle energy (MeV)
EMAX	OMP	upper boundary of incident particle energy (MeV)
E0	LDP	an energy where cumulative number of levels is 1.0.
EL	LEVEL, DEFORM	level energy (MeV)
EX	LDP	a connection energy between the constant temperature model and the Fermi gas model (MeV)
FLVL	LEVEL	level number of final state
HL	NUCLIDE	half-life (sec)
J	DEFORM, LEVEL, NUCLIDE	spin
MASSEX	NUCLIDE	mass excess (MeV)
NG	LEVEL	number of γ-rays
NO	LEVEL	level number
PAIR	LDP	pairing energy (MeV)
PARITY	DEFORM, LEVEL, NUCLIDE	parity
SCF	LDP	spin-cutoff factor at 0 MeV
SCP	LDP	spin-cutoff parameter
T	LDP	temperature (MeV)
V	OMP	real potential depth (MeV)
VSO	OMP	real part of spin-orbit potential (MeV)
WSO	OMP	imaginary part of spin-orbit potential depth (MeV)
WS	OMP	depth of surface type imaginary potential (MeV)
WV	OMP	depth of volume type imaginary potential (MeV)

Table 4 DATA line symbols

Symbol	Parameter	Description
A	OMP	diffuseness parameter (fm)
E0	OMP	constant term of potential depth (MeV)
E1	OMP	first order term of potential depth (MeV)
E2	OMP	second order term of potential depth (MeV)
E5	OMP	square root term of potential depth (MeV)
E9	OMP	$Z/A^{1/3}$ term of potential depth (MeV)
E10	OMP	$A^{1/3}$ term of potential depth (MeV)
R	OMP	nuclear radius parameter (fm)
RC	OMP	constant term of nuclear radius (fm)
SYM	OMP	depth of symmetric term (MeV)
nuclide-name	DEFORM, LEVEL, LDP, NUCLIDE	nuclide name determined as (atomic number) × 10000+(mass number) ×1000+(meta-stable state number)

J2608.EVLDF.DATA(DEFORM01)	2	467DEFORM	YAMAMUR090	0	60120	832090
J2608.EVLDF.DATA(LDP01)	2	484LDP	J3FPLDP	0	130270	952450
J2608.EVLDF.DATA(LVL01)	2	2868LEVEL	J3FPLVL	0	330750	651590
J2608.EVLDF.DATA(LVL03)	2	8194LEVEL	YAMAMUR091	0	20040	832100
J2608.EVLDF.DATA(OMP)	3	90MP	MOLDAUER	10	0	0
J2608.EVLDF.DATA(OMP)	13	90MP	MOLDAUER-C	10	0	0
J2608.EVLDF.DATA(OMP)	23	1740MP	J3FPOMP	10	330000	659999
J2608.EVLDF.DATA(OMP)	198	150MP	B-G	10	0	0
J2608.EVLDF.DATA(OMP)	214	200MP	IGARASI	10	0	999
J2608.EVLDF.DATA(OMP)	235	130MP	W-H	10	0	0
J2608.EVLDF.DATA(OMP)	251	150MP	B-G	10010	0	0
J2608.EVLDF.DATA(OMP)	267	170MP	MENET	10010	0	0
J2608.EVLDF.DATA(OMP)	285	140MP	PEREY	10010	0	0
J2608.EVLDF.DATA(OMP)	302	110MP	PEREY-PEREY	10030	0	0
J2608.EVLDF.DATA(OMP)	316	140MP	B-G	20030	0	0
J2608.EVLDF.DATA(OMP)	333	100MP	LEMOS	20040	0	0
J2608.EVLDF.DATA(NUCL01)	2	2604NUCLIDE	NUCL88	0	100101062630	
J2608.EVLDF.DATA(NUCL02)	2	3129NUCLIDE	NUCL92	0	101072610	

Fig. 1 Example of EVLDF index file

```
          << RETRIEVAL OF PARAMETERS FROM EVL DATA BASE >>

COMMAND ======>

NUCLIDE ======> 440000      -  449999          (RANGE OF NUCLIDES)
NUCLIDE (FOR)=> 0           -  0               (RANGE OF NUCLIDES)
PARAMETERS ===> level
SET NAME =====>
INC. PARTICLE=> 0                          (ONLY FOR OMP)
PARAM FILE ===> J2608.PP.DATA

    COMMAND
          INDEX : TO TAKE INDEX LIST OF EVLDF
          EXEC  : TO START RETRIEVAL
          SYST  : TO GET PARAMETERS BY MEANS OF SYSTEMATICS

    NUCLIDE = Z*10000 + A*10 + ISOMERIC STATE NUMBER
    PARAMETERS
          OMP, LDP, LEVEL, NUCLIDE, DEFORM
    INC. PARTICLE (INCIDENT PARTICLE)
          THE SAME DEFINITION AS NUCLIDE (EX. 10 = NEUTRON)
    PARAM FILE = OUTPUT FILE OF PARAMETERS
```

Fig.2 Example of GET Segment

```
                        << CASTHY PANEL-1 >>
                                          PF9/PF21 : CHANGE SCREEN

COMMAND ===>
TARGET ==== 26056       TITLE =
NEN= 0          OUTPUT OPTION = 11       GAMMA-RAY PROD = 0
EN =
   =
   =
   =
   =
NFLCR = -110
ENORML=  0.0       SIGCAP=  0.0       ERROR  =  1.00000-2
T-GAM =  0.0       D-OBS =  0.0       G-WIDTH=  0.0
NPROF = 1
P11   =  0.0       P12   =  0.0
ER    =  0.0       WIDTH =  0.0       EXCHNG =  0.400000
ER2   =  0.0       WIDTH2=  0.0       SIGBM1 =  0.0       SIGBM2=  0.0
COMPETING-SIG FILE =                                    MAT= 0     MT= 0
MASS EXCESS FILE === J2608.PP.DATA(NUCLIDE)
OMP FILE ========== J2608.PP.DATA(OMP)
LDP FILE ========== J2608.PP.DATA(LDP)
LEVEL SCHEME ======= J2608.PP.DATA(LEVEL)
OUTPUT FILE ========                                    MAT= 0
JCL FILE ========== J2608.JCLFILE.CNTL
```

Fig. 3 First panel of CASTHY Segment

```
                        << CASTHY PANEL-1 >>
                                          PF9/PF21 : CHANGE SCREEN
COMMAND ===>
TARGET ==== 44101        TITLE = ru-101
NEN= -1          OUTPUT OPTION = 11          GAMMA-RAY PROD = 0
EN =
   =
   =
   =
   =
NFLCR = -110
ENORML=  0.1        SIGCAP=  500        ERROR  =  1.00000-2
T-GAM =  0.0        D-OBS =  0.0        G-WIDTH=  0.0
NPROF = 1
P11   =  0.0        P12   =  0.0
ER    =  0.0        WIDTH =  0.0        EXCHNG =  0.400000
ER2   =  0.0        WIDTH2=  0.0        SIGBM1 =  0.0       SIGBM2=  0.0
COMPETING-SIG FILE = J2608.J32RU101.DATA(PEGOUT)      MAT= 4401  MT= 999
MASS EXCESS FILE === J2608.PP.DATA(NUCLIDE)
OMP FILE ========== J2608.PP.DATA(OMP)
LDP FILE ========== J2608.PP.DATA(LDP)
LEVEL SCHEME ======= J2608.PP.DATA(LEVEL)
OUTPUT FILE ======== J2608.CSRU101.DATA                MAT= 4401
JCL FILE ========== J2608.JCLFILE.CNTL
```

Fig. 4 First panel of CASTHY Segment (Main input)

```
                        << CASTHY PANEL-1 >>
                                          PF9/PF21 : CHANGE SCREEN
COMMAND ===>
TARGET ==== 44101        TITLE = RU-101
NEN= 46          OUTPUT OPTION = 11          GAMMA-RAY PROD = 0
EN =  1.00-6 3.00-6 1.00-5 3.00-5 1.00-4 3.00-4 1.00-3 2.00-3 3.00-3 5.00-3
   =  8.00-3 1.00-2  0.015  0.020  0.025  0.030  0.050  0.080  0.100  0.150
   =   0.200  0.250  0.300  0.500  0.700  0.800  0.900  1.000  1.250  1.500
   =   1.750  2.000  3.000  4.000  5.000  6.000  7.000  8.000  9.000 10.000
   =  12.000 14.000 15.000 16.000 18.000 20.000
NFLCR = -110
ENORML=  1.00000-1 SIGCAP=  5.00000+3 ERROR  =  1.00000-2
T-GAM =  0.0        D-OBS =  0.0        G-WIDTH=  0.0
NPROF = 1
P11   =  0.0        P12   =  0.0
ER    =  0.0        WIDTH =  0.0        EXCHNG =  0.400000
ER2   =  0.0        WIDTH2=  0.0        SIGBM1 =  0.0       SIGBM2=  0.0
COMPETING-SIG FILE = J2608.J32RU101.DATA(PEGOUT)      MAT= 4401  MT= 999
MASS EXCESS FILE === J2608.PP.DATA(NUCLIDE)
OMP FILE ========== J2608.PP.DATA(OMP)
LDP FILE ========== J2608.PP.DATA(LDP)
LEVEL SCHEME ======= J2608.PP.DATA(LEVEL)
OUTPUT FILE ======== J2608.CSRU101.DATA                MAT= 4401
JCL FILE ========== J2608.JCLFILE.CNTL
```

Fig. 5 First panel of CASTHY Segment (after pushing Enter key)

```
                    << CASTHY PANEL-2(OMP) >>
                                        PF9/PF21 : CHANGE SCREEN
 COMMAND ===>

 TARGET     = 44101

<POTENTIAL DEPTH>
               CONTS.        E            E*2          SYMMETRIC
  REAL TERM =  4.75000+1     0.0           0.0          0.0
  VOLUME    =  0.0           0.0           0.0
  SURFACE   =  9.740000      0.0           0.0          SQRT TERM=  0.0
  SPIN-ORBIT=  7.000000      0.0           0.0
  IM.(S-O)  =  0.0           0.0           0.0

<FORM FACTOR>
               RADIUS      DIFFUSENESS     TYPE
  REAL TERM =  1.282432      0.620000      WS
  VOLUME    =  0.0           0.0           NO          DWS: DER.WOODS-SAXON
  SURFACE   =  1.415973      0.350000      DWS         WS : WOODS-SAXON
  SPIN-ORBIT=  1.281939      0.620000                  G  : GAUSS

 OMP FILE ========== J2608.PP.DATA(OMP)
```

Fig. 6 Second panel of CASTHY Segment (Optical Potential Parameters)

```
                    << CASTHY PANEL-3(LDP) >>
                                        PF9/PF21 : CHANGE SCREEN
 COMMAND ===>

 TARGET     = 44101

                            TARGET          COMPOUND
              A PARAMETES =  1.72599+1       1.64299+1
 SPIN CUT-OFF PARAMETER =  1.31550+1       1.29190+1
         PAIRING ENERGY =  1.280000        2.220000
                     CO =  3.30082+3       3.17306+3
           JOINT ENERGY =  6.836200        7.106300
            TEMPERATURE =  0.670000        0.655000
               CONSTANT =  7.228213        0.887241
    SPIN CUT-OFF FACTOR =  1.43040+1       7.654400
    FORM OF TEMPERATURE =  0               0
   FORM OF SPIN CUT-OFF =  12              12

 LDP FILE ========== J2608.PP.DATA(LDP)
```

Fig. 7 Third panel of CASTHY (Level density parameters)

```
                    << CASTHY PANEL-4(LEVEL SCHEME) >>
                                          PF9/PF21 : CHANGE SCREEN

 COMMAND ===>
 TARGET     = 44101

NO  ENERGY     SPIN-PRTY  NO  ENERGY     SPIN-PRTY  NO  ENERGY     SPIN-PRTY
GS  0.0          2.5  1   15  0.720000     4.5  1   30
 1  0.127230     1.5  1   16  0.823000     1.5  1   31
 2  0.306850     3.5  1   17  0.842780     3.5  1   32
 3  0.311330     2.5  1   18  0.908000     0.5 -1   33
 4  0.324800     0.5  1   19  0.927000     1.5  1   34
 5  0.422300     1.5  1   20  0.928720     4.5  1   35
 6  0.527500     5.5 -1   21  0.938470     3.5  1   36
 7  0.535000     2.5  1   22  0.973400     2.5  1   37
 8  0.545080     3.5  1   23  1.001200     5.5  1   38
 9  0.598300     2.5 -1   24  1.041000     1.5  1   39
10  0.616300     1.5  1   25  1.051000     3.5  1   40
11  0.623000     1.5  1   26  1.098000     0.5  1   41
12  0.623500     0.5  1   27  1.110000     0.5  1   42
13  0.684000     1.5  1   28  1.169000     1.5  1   43
14  0.718000     0.5 -1   29  1.206800    -1.0  0   44

 LEVEL DATA FILE ==== J2608.PP.DATA(LEVEL)
```

Fig. 8 Fourth panel of CASTHY Segment (Level scheme)

```
                  << CASTHY PANEL-5(COMPETING CROSS SECTION) >>
                                          PF9/PF21 : CHANGE SCREEN

 COMMAND ===> exec
 TARGET     = 44101
NO  ENERGY     SIG          NO  ENERGY     SIG          NO  ENERGY     SIG
 1  1.00000-6 3.37204-9    18  7.99999-2 2.69766-4    35  5.000000  0.224921
 2  3.00000-6 1.01162-8    19  1.00000-1 3.37207-4    36  6.000000  0.366267
 3  1.00000-5 3.37207-8    20  0.150000  5.05811-4    37  7.000000  0.499803
 4  3.00000-5 1.01162-7    21  0.200000  6.74415-4    38  8.000000  6.46054+2
 5  1.00000-4 3.37207-7    22  0.250000  8.43019-4    39  9.000000  1.17136+3
 6  3.00000-4 1.01162-6    23  0.300000  1.01162-3    40  1.00000+1 1.40660+3
 7  9.99999-4 3.37207-6    24  0.500000  1.68604-3    41  1.20000+1 1.56951+3
 8  2.00000-3 6.74415-6    25  0.700000  1.91440-3    42  1.40000+1 1.54104+3
 9  3.00000-3 1.01162-5    26  0.800000  2.03993-3    43  1.50000+1 1.51795+3
10  4.99999-3 1.68603-5    27  0.900000  2.26924-3    44  1.60000+1 1.49283+3
11  8.00000-3 2.69766-5    28  1.000000  2.63785-3    45  1.80000+1 1.50588+3
12  1.00000-2 3.37208-5    29  1.250000  3.84480-3    46  2.00000+1 1.54793+3
13  1.50000-2 5.05812-5    30  1.500000  5.60400-3    47
14  2.00000-2 6.74415-5    31  1.750000  8.16813-3    48
15  2.50000-2 8.43019-5    32  2.000000  1.19055-2    49
16  3.00000-2 1.01162-4    33  3.000000  4.08819-2    50
17  5.00000-2 1.68604-4    34  4.000000  0.107277     51

 DATA FILE ==== J2608.J32RU101.DATA(PEGOUT)      MAT= 4401  MT = 999
```

Fig. 9 Fifth panel of CASTHY Segment (Cross section of competing process)

```
EDIT --- J2608.JCLFILE.CNTL ---------------------------------- COLUMNS 001 072
COMMAND ===> sub                                               SCROLL ===> HALF
****** ***************************** TOP OF DATA ****************V10L30********
000001   T(06) C(02) W(02) I(03)
000002 //JOBPROC DD DSN=J2608.PROCLIB.CNTL
000003 // EXEC CASTHY
000004 //FT20F001 DD DSN=A,DISP=(NEW,PASS),UNIT=TSSWK,
000005 //    SPACE=(TRK,(10,5)),DCB=(RECFM=VBS,DSORG=PS)
000006 //SYSIN DD *
000007     1    1  -11     1RU-101
000008    40   44  101     0   29     2     1 -110     0     0  -46     1     1     0
000009          1 1.00906+2 0.0         9.22034+0 1.40000+0 2.50000-1
000010          6 1.28243+0 0.0         1.41597+0 1.28194+0 0.0
000011         11 6.20000-1 0.0         3.50000-1 6.20000-1 0.0
000012         16 4.75000+1 0.0         9.74000+0 7.00000+0 0.0
000013         21 0.0       0.0         0.0       0.0       0.0
000014         26 0.0       0.0         0.0       0.0       0.0
000015         31 0.0       1.20680+0 1.00000-2 1.43040+1 7.65440+0
000016         66 1.72599+1 1.31550+1 1.28000+0 3.30082+3 6.83620+0
000017         71 1.64299+1 1.29190+1 2.22000+0 3.17306+3 7.10630+0
000018         76 1.00000-1 5.00000+3 0.0       0.0       0.0
000019         81 0.0       0.0       0.0       0.0       4.00000-1
000020         86 0.0       0.0       0.0       0.0       0.0
000021         91 6.70000-1 7.22821+0 0.0       0.0       0.0
```

Fig. 10 JCL of CASTHY

Appendix 1 Example of NUCLIDE section

```
NUCLIDE
SET       NUCL92
COMMENT   BASED ON ENSDF AS OF 1992.06
           - EL : LEVEL ENERGY (MEV).
           - J  : TOTAL SPIN.  IF UNKNOWN, -1.0 IS GIVEN.
           - PARITY : PARITY.  IF UNKNOWN, 0.0 IS GIVEN.
           - MASSEX : MASS-EXCESS(MEV) TAKEN FROM WAPSTRA-AUDI(1985).
                      A.H.WAPSTRA,G.AUDI,K.BOS AND HOEKSTRA,
                      NUCL. PHYS. A432, 1 (1985).  DATA ARE TAKEN
                      FROM RADLST LIB.
           - HL : HALF-LIFE (SEC).  IF UNKNOWN, -1.0 IS GIVEN.
           - ABN : ABUNDANCE (%).  VALUES WERE ADOPTED FROM 'NUCLEAR
                   WALLET CARDS (1990). J.K.TULI.
DATA       EL,          J,  PARITY, MASSEX,      HL,          ABN
     10    0.00000E+00, 0.5, 1.0, 8.07137E+00, 6.24000E+02,   0.0
  10010    0.00000E+00, 0.5, 1.0, 7.28903E+00, 0.00000E+00,  99.985
  10020    0.00000E+00, 1.0, 1.0, 1.31358E+01, 0.00000E+00,   0.015
  10030    0.00000E+00, 0.5, 1.0, 1.49491E+01, 3.89098E+08,   0.0
  10040    0.00000E+00, 2.0,-1.0, 2.58400E+01,-1.00000E+00,   0.0
  20030    0.00000E+00, 0.5, 1.0, 1.49310E+01, 0.00000E+00,  0.000137
  20040    0.00000E+00, 0.0, 1.0, 2.42409E+00, 0.00000E+00,  99.999863
  20050    0.00000E+00, 1.5,-1.0, 1.13900E+01, 1.09703E-13,   0.0
  20060    0.00000E+00, 0.0, 1.0, 1.75920E+01, 8.06700E-01,   0.0
  20070    0.00000E+00, 1.5,-1.0, 2.61100E+01, 4.11385E-16,   0.0
  20080    0.00000E+00, 0.0, 1.0, 3.15980E+01, 1.19000E-01,   0.0
  20090    0.00000E+00,-1.0, 0.0, 4.08100E+01,-1.00000E+00,   0.0
  30040    0.00000E+00, 2.0,-1.0, 2.51200E+01,-1.00000E+00,   0.0
  30050    0.00000E+00, 1.5,-1.0, 1.16800E+01, 4.38812E-14,   0.0
  30060    0.00000E+00, 1.0, 1.0, 1.40850E+01, 0.00000E+00,   7.5
  30070    0.00000E+00, 1.5,-1.0, 1.49060E+01, 0.00000E+00,  92.5
  30080    0.00000E+00, 2.0, 1.0, 2.09450E+01, 8.38000E-01,   0.0
  30090    0.00000E+00, 1.5,-1.0, 2.49530E+01, 1.78300E-01,   0.0
  30100    0.00000E+00,-1.0, 0.0, 3.38300E+01, 5.48514E-14,   0.0
  30110    0.00000E+00,-1.0, 0.0, 4.09000E+01,-1.00000E+00,   0.0
  40060    0.00000E+00, 0.0, 1.0, 1.83740E+01, 7.15453E-16,   0.0
  40070    0.00000E+00, 1.5,-1.0, 1.57680E+01, 4.60426E+06,   0.0
  40080    0.00000E+00, 0.0, 1.0, 4.94107E+00, 9.67966E-15,   0.0
  40090    0.00000E+00, 1.5,-1.0, 1.13470E+01, 0.00000E+00,  100.0
  40100    0.00000E+00, 0.0, 1.0, 1.26070E+01, 5.04912E+13,   0.0
  40110    0.00000E+00, 0.5, 1.0, 2.01740E+01, 1.38100E+01,   0.0
  40120    0.00000E+00, 0.0, 1.0, 2.50770E+01, 2.44000E-02,   0.0
  40130    0.00000E+00,-1.0, 0.0, 3.49500E+01,-1.00000E+00,   0.0
  40140    0.00000E+00,-1.0, 0.0, 4.10200E+01,-1.00000E+00,   0.0
  50070    0.00000E+00, 1.5,-1.0, 2.78700E+01, 5.06321E-14,   0.0
  50080    0.00000E+00, 2.0, 1.0, 2.29200E+01, 7.70000E-01,   0.0
  50090    0.00000E+00, 1.5,-1.0, 1.24150E+01, 1.21892E-13,   0.0
  50100    0.00000E+00, 3.0, 1.0, 1.20501E+01, 0.00000E+00,  19.9
  50110    0.00000E+00, 1.5,-1.0, 8.66800E+00, 0.00000E+00,  80.1
  50120    0.00000E+00, 1.0, 1.0, 1.33690E+01, 2.02000E-02,   0.0
  50130    0.00000E+00, 1.5,-1.0, 1.65620E+01, 1.73600E-02,   0.0
  50140    0.00000E+00, 2.0,-1.0, 2.36640E+01, 1.61000E-02,   0.0
  50150    0.00000E+00,-1.0, 0.0, 2.89700E+01,-1.00000E+00,   0.0
  50160    0.00000E+00,-1.0, 0.0, 3.76400E+01,-1.00000E+00,   0.0
```

50170	0.00000E+00,	-1.0,	0.0,	4.40100E+01,	-1.00000E+00,	0.0
60080	0.00000E+00,	0.0,	1.0,	3.50950E+01,	2.86181E-16,	0.0
60090	0.00000E+00,	1.5,	-1.0,	2.89130E+01,	1.26500E-01,	0.0
60100	0.00000E+00,	0.0,	1.0,	1.57010E+01,	1.92550E+01,	0.0
60110	0.00000E+00,	1.5,	-1.0,	1.06500E+01,	1.22340E+03,	0.0
60120	0.00000E+00,	0.0,	1.0,	0.00000E+00,	0.00000E+00,	98.90
60130	0.00000E+00,	0.5,	-1.0,	3.12502E+00,	0.00000E+00,	1.10
60140	0.00000E+00,	0.0,	1.0,	3.01991E+00,	1.80822E+11,	0.0
60150	0.00000E+00,	0.5,	1.0,	9.87300E+00,	2.44900E+00,	0.0
60160	0.00000E+00,	0.0,	1.0,	1.36940E+01,	7.47000E-01,	0.0
60170	0.00000E+00,	-1.0,	0.0,	2.10300E+01,	-1.00000E+00,	0.0
60180	0.00000E+00,	-1.0,	0.0,	2.48900E+01,	-1.00000E+00,	0.0
60190	0.00000E+00,	-1.0,	0.0,	3.27600E+01,	-1.00000E+00,	0.0
60200	0.00000E+00,	-1.0,	0.0,	3.80300E+01,	-1.00000E+00,	0.0
70100	0.00000E+00,	-1.0,	0.0,	3.97000E+01,	-1.00000E+00,	0.0
70110	0.00000E+00,	-1.0,	0.0,	2.49100E+01,	-1.00000E+00,	0.0
70120	0.00000E+00,	1.0,	1.0,	1.73380E+01,	1.10000E-02,	0.0
70130	0.00000E+00,	0.5,	-1.0,	5.34505E+00,	5.97660E+02,	0.0
70140	0.00000E+00,	1.0,	1.0,	2.86344E+00,	0.00000E+00,	99.63
70150	0.00000E+00,	0.5,	-1.0,	1.01050E-01,	0.00000E+00,	0.37
70160	0.00000E+00,	2.0,	-1.0,	5.68200E+00,	7.13000E+00,	0.0
70161	1.20100E-01,	0.0,	-1.0,	5.80210E+00,	5.25000E-06,	0.0
70170	0.00000E+00,	0.5,	-1.0,	7.87100E+00,	4.16900E+00,	0.0
70180	0.00000E+00,	0.0,	-1.0,	1.31170E+01,	6.30000E-01,	0.0
70190	0.00000E+00,	-1.0,	0.0,	1.58730E+01,	-1.00000E+00,	0.0
70200	0.00000E+00,	-1.0,	0.0,	2.21000E+01,	-1.00000E+00,	0.0
70210	0.00000E+00,	-1.0,	0.0,	2.60500E+01,	-1.00000E+00,	0.0
80120	0.00000E+00,	0.0,	1.0,	3.20600E+01,	1.64554E-16,	0.0
80130	0.00000E+00,	1.5,	-1.0,	2.31110E+01,	8.90000E-03,	0.0
80140	0.00000E+00,	0.0,	1.0,	8.00605E+00,	7.05990E+01,	0.0
80150	0.00000E+00,	0.5,	-1.0,	2.85500E+00,	1.22240E+02,	0.0
80160	0.00000E+00,	0.0,	1.0,	-4.73700E+00,	0.00000E+00,	99.76
80170	0.00000E+00,	2.5,	1.0,	-8.09003E-01,	0.00000E+00,	0.038
80180	0.00000E+00,	0.0,	1.0,	-7.82002E-01,	0.00000E+00,	0.20
80190	0.00000E+00,	2.5,	1.0,	3.33200E+00,	2.69100E+01,	0.0
80200	0.00000E+00,	0.0,	1.0,	3.79600E+00,	1.35700E+01,	0.0
80210	0.00000E+00,	-1.0,	0.0,	8.13000E+00,	-1.00000E+00,	0.0
80220	0.00000E+00,	-1.0,	0.0,	9.44000E+00,	-1.00000E+00,	0.0
80230	0.00000E+00,	-1.0,	0.0,	1.74600E+01,	-1.00000E+00,	0.0
90140	0.00000E+00,	-1.0,	0.0,	3.36100E+01,	-1.00000E+00,	0.0
90150	0.00000E+00,	-1.0,	0.0,	1.67700E+01,	-1.00000E+00,	0.0
90160	0.00000E+00,	1.0,	-1.0,	1.06800E+01,	1.64554E-15,	0.0
90170	0.00000E+00,	2.5,	1.0,	1.95105E+00,	6.45000E+01,	0.0
90180	0.00000E+00,	1.0,	1.0,	8.73002E-01,	6.58620E+03,	0.0
90190	0.00000E+00,	0.5,	1.0,	-1.48704E+00,	0.00000E+00,	100.0
90200	0.00000E+00,	2.0,	1.0,	-1.70330E-02,	1.10300E+01,	0.0
90210	0.00000E+00,	2.5,	1.0,	-4.80000E-02,	4.32000E+00,	0.0
90220	0.00000E+00,	3.0,	1.0,	2.83000E+00,	4.23000E+00,	0.0
90230	0.00000E+00,	1.5,	1.0,	3.35000E+00,	2.23000E+00,	0.0
90240	0.00000E+00,	-1.0,	0.0,	8.75000E+00,	-1.00000E+00,	0.0
90250	0.00000E+00,	-1.0,	0.0,	1.25400E+01,	-1.00000E+00,	0.0
100160	0.00000E+00,	-1.0,	0.0,	2.39890E+01,	-1.00000E+00,	0.0
100170	0.00000E+00,	0.5,	-1.0,	1.64800E+01,	1.09000E-01,	0.0
100180	0.00000E+00,	0.0,	1.0,	5.31900E+00,	1.67000E+00,	0.0
100190	0.00000E+00,	0.5,	1.0,	1.75100E+00,	1.74000E+01,	0.0
100200	0.00000E+00,	0.0,	1.0,	-7.04600E+00,	0.00000E+00,	90.48
100210	0.00000E+00,	1.5,	1.0,	-5.73500E+00,	0.00000E+00,	0.27

```
100220  0.00000E+00, 0.0, 1.0,-8.02601E+00, 0.00000E+00,   9.25
100230  0.00000E+00, 2.5, 1.0,-5.15500E+00, 3.72400E+01,   0.0
100240  0.00000E+00, 0.0, 1.0,-5.95000E+00, 2.02800E+02,   0.0
100250  0.00000E+00, 0.5, 1.0,-2.16000E+00, 6.02000E-01,   0.0
100260  0.00000E+00,-1.0, 0.0, 4.40000E-01,-1.00000E+00,   0.0
100270  0.00000E+00,-1.0, 0.0, 6.75000E+00,-1.00000E+00,   0.0
110180  0.00000E+00,-1.0, 0.0, 2.53200E+01,-1.00000E+00,   0.0
110190  0.00000E+00,-1.0, 0.0, 1.29290E+01,-1.00000E+00,   0.0
110200  0.00000E+00, 2.0, 1.0, 6.84100E+00, 4.46000E-01,   0.0
110210  0.00000E+00, 1.5, 1.0,-2.18801E+00, 2.24800E+01,   0.0
110220  0.00000E+00, 3.0, 1.0,-5.18401E+00, 8.21113E+07,   0.0
110230  0.00000E+00, 1.5, 1.0,-9.53100E+00, 0.00000E+00, 100.0
110240  0.00000E+00, 4.0, 1.0,-8.41900E+00, 5.40720E+04,   0.0
110241  4.72290E-01, 1.0, 1.0,-7.94671E+00, 2.01800E-02,   0.0
110250  0.00000E+00, 2.5, 1.0,-9.35900E+00, 5.96000E+01,   0.0
110260  0.00000E+00, 3.0, 1.0,-6.90600E+00, 1.07200E+00,   0.0
110270  0.00000E+00, 1.5, 1.0,-5.65000E+00, 3.04000E-01,   0.0
110280  0.00000E+00, 1.0, 1.0,-1.14000E+00, 3.05000E-02,   0.0
110290  0.00000E+00,-1.0, 0.0, 2.64000E+00,-1.00000E+00,   0.0
110300  0.00000E+00,-1.0, 0.0, 8.20000E+00,-1.00000E+00,   0.0
110310  0.00000E+00,-1.0, 0.0, 1.18100E+01,-1.00000E+00,   0.0
110320  0.00000E+00,-1.0, 0.0, 1.65300E+01,-1.00000E+00,   0.0
110330  0.00000E+00,-1.0, 0.0, 2.14500E+01, 8.20000E-03,   0.0
110340  0.00000E+00, 1.0, 1.0, 2.66400E+01, 5.50000E-03,   0.0
110350  0.00000E+00,-1.0, 0.0, 3.69886E+01, 1.50000E-03,   0.0
120200  0.00000E+00,-1.0, 0.0, 1.75720E+01,-1.00000E+00,   0.0
120210  0.00000E+00, 1.5, 1.0, 1.09140E+01, 1.22000E-01,   0.0
120220  0.00000E+00, 0.0, 1.0,-3.96006E-01, 3.85700E+00,   0.0
120230  0.00000E+00, 1.5, 1.0,-5.47300E+00, 1.13170E+01,   0.0
120240  0.00000E+00, 0.0, 1.0,-1.39330E+01, 0.00000E+00,  78.89
120250  0.00000E+00, 2.5, 1.0,-1.31920E+01, 0.00000E+00,  10.0
120260  0.00000E+00, 0.0, 1.0,-1.62140E+01, 0.00000E+00,  11.01
120270  0.00000E+00, 0.5, 1.0,-1.45860E+01, 5.67720E+02,   0.0
120280  0.00000E+00, 0.0, 1.0,-1.50180E+01, 7.52399E+04,   0.0
120290  0.00000E+00,-1.0, 0.0,-1.07280E+01, 4.29000E-02,   0.0
120300  0.00000E+00,-1.0, 0.0,-9.10000E+00,-1.00000E+00,   0.0
120310  0.00000E+00,-1.0, 0.0,-3.79000E+00,-1.00000E+00,   0.0
120320  0.00000E+00,-1.0, 0.0,-1.77000E+00,-1.00000E+00,   0.0
120330  0.00000E+00,-1.0, 0.0, 3.93000E+00, 9.00000E-02,   0.0
120340  0.00000E+00, 0.0, 1.0, 6.94000E+00,-1.00000E+00,   0.0
120350  0.00000E+00,-1.0, 0.0, 1.35600E+01,-1.00000E+00,   0.0
130220  0.00000E+00,-1.0, 0.0, 1.80400E+01,-1.00000E+00,   0.0
130230  0.00000E+00,-1.0, 0.0, 6.76700E+00, 4.70000E-01,   0.0
130240  0.00000E+00, 4.0, 1.0,-5.50000E-02, 2.06600E+00,   0.0
130241  4.39000E-01, 1.0, 1.0, 3.84000E-01, 1.30000E-01,   0.0
130250  0.00000E+00, 2.5, 1.0,-8.91500E+00, 7.18300E+00,   0.0
130260  0.00000E+00, 5.0, 1.0,-1.22090E+01, 2.27210E+13,   0.0
130261  2.28440E-01, 0.0, 1.0,-1.19806E+01, 6.34500E+00,   0.0
130270  0.00000E+00, 2.5, 1.0,-1.71960E+01, 0.00000E+00, 100.0
130280  0.00000E+00, 3.0, 1.0,-1.68500E+01, 1.34436E+02,   0.0
130290  0.00000E+00, 2.5, 1.0,-1.82150E+01, 3.93600E+02,   0.0
130300  0.00000E+00, 3.0, 1.0,-1.58900E+01, 3.60000E+00,   0.0
130310  0.00000E+00, 2.5, 1.0,-1.50900E+01, 6.44000E-01,   0.0
130320  0.00000E+00,-1.0, 0.0,-1.11800E+01,-1.00000E+00,   0.0
130330  0.00000E+00,-1.0, 0.0,-9.27000E+00,-1.00000E+00,   0.0
130340  0.00000E+00,-1.0, 0.0,-4.36000E+00,-1.00000E+00,   0.0
130350  0.00000E+00,-1.0, 0.0,-1.44000E+00,-1.00000E+00,   0.0
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130360 0.00000E+00, 0.0, 1.0, 3.91000E+00,-1.00000E+00, 0.0
140240 0.00000E+00,-1.0, 0.0, 1.07550E+01,-1.00000E+00, 0.0
140250 0.00000E+00, 2.5, 1.0, 3.82700E+00, 2.20000E-01, 0.0
140260 0.00000E+00, 0.0, 1.0,-7.14400E+00, 2.21000E+00, 0.0
140270 0.00000E+00, 2.5, 1.0,-1.23850E+01, 4.16000E+00, 0.0
140280 0.00000E+00, 0.0, 1.0,-2.14920E+01, 0.00000E+00, 92.23
140290 0.00000E+00, 0.5, 1.0,-2.18950E+01, 0.00000E+00, 4.67
140300 0.00000E+00, 0.0, 1.0,-2.44330E+01, 0.00000E+00, 3.10
140310 0.00000E+00, 1.5, 1.0,-2.29500E+01, 9.43800E+03, 0.0
140320 0.00000E+00, 0.0, 1.0,-2.40800E+01, 1.04138E+10, 0.0
140330 0.00000E+00,-1.0, 0.0,-2.05700E+01, 6.11000E+00, 0.0
140340 0.00000E+00,-1.0, 0.0,-1.98600E+01, 2.77000E-03, 0.0
140350 0.00000E+00,-1.0, 0.0,-1.45400E+01,-1.00000E+00, 0.0
140360 0.00000E+00,-1.0, 0.0,-1.27600E+01,-1.00000E+00, 0.0
140370 0.00000E+00,-1.0, 0.0,-7.00000E+00,-1.00000E+00, 0.0
140380 0.00000E+00,-1.0, 0.0,-4.66000E+00,-1.00000E+00, 0.0
150260 0.00000E+00,-1.0, 0.0, 1.12600E+01,-1.00000E+00, 0.0
150270 0.00000E+00,-1.0, 0.0,-7.50000E-01,-1.00000E+00, 0.0
150280 0.00000E+00, 3.0, 1.0,-7.16100E+00, 2.70300E-01, 0.0
150290 0.00000E+00, 0.5, 1.0,-1.69500E+01, 4.14200E+00, 0.0
150300 0.00000E+00, 1.0, 1.0,-2.02070E+01, 1.49880E+02, 0.0
150310 0.00000E+00, 0.5, 1.0,-2.44400E+01, 0.00000E+00, 100.0
150320 0.00000E+00, 1.0, 1.0,-2.43050E+01, 1.23206E+06, 0.0
150330 0.00000E+00, 0.5, 1.0,-2.63380E+01, 2.18938E+06, 0.0
150340 0.00000E+00, 1.0, 1.0,-2.45570E+01, 1.24300E+01, 0.0
150350 0.00000E+00, 0.5, 1.0,-2.49400E+01, 4.73000E+01, 0.0
150360 0.00000E+00,-1.0, 0.0,-2.08900E+01, 5.33000E+00, 0.0
150370 0.00000E+00,-1.0, 0.0,-1.91000E+01,-1.00000E+00, 0.0
150380 0.00000E+00,-1.0, 0.0,-1.46600E+01,-1.00000E+00, 0.0
150390 0.00000E+00,-1.0, 0.0,-1.23000E+01,-1.00000E+00, 0.0
150400 0.00000E+00,-1.0, 0.0,-7.62000E+00,-1.00000E+00, 0.0
160280 0.00000E+00,-1.0, 0.0, 4.13000E+00,-1.00000E+00, 0.0
160290 0.00000E+00, 2.5, 1.0,-3.16000E+00, 1.87000E-01, 0.0
160300 0.00000E+00, 0.0, 1.0,-1.40630E+01, 1.24000E+00, 0.0
160310 0.00000E+00, 0.5, 1.0,-1.90450E+01, 2.58400E+00, 0.0
160320 0.00000E+00, 0.0, 1.0,-2.60160E+01, 0.00000E+00, 95.02
160330 0.00000E+00, 1.5, 1.0,-2.65860E+01, 0.00000E+00, 0.75
160340 0.00000E+00, 0.0, 1.0,-2.99320E+01, 0.00000E+00, 4.21
160350 0.00000E+00, 1.5, 1.0,-2.88461E+01, 7.56086E+06, 0.0
160360 0.00000E+00, 0.0, 1.0,-3.06640E+01, 0.00000E+00, 0.02
160370 0.00000E+00, 3.5,-1.0,-2.68960E+01, 3.03000E+02, 0.0
160380 0.00000E+00, 0.0, 1.0,-2.68620E+01, 1.02180E+04, 0.0
160390 0.00000E+00, 3.5,-1.0,-2.30000E+01, 1.15000E+01, 0.0
160400 0.00000E+00,-1.0, 0.0,-2.25200E+01,-1.00000E+00, 0.0
160410 0.00000E+00,-1.0, 0.0,-1.78700E+01,-1.00000E+00, 0.0
160420 0.00000E+00,-1.0, 0.0,-1.64200E+01,-1.00000E+00, 0.0
170300 0.00000E+00,-1.0, 0.0, 4.84000E+00,-1.00000E+00, 0.0
170310 0.00000E+00,-1.0, 0.0,-7.07000E+00,-1.00000E+00, 0.0
170320 0.00000E+00, 1.0, 1.0,-1.33300E+01, 2.98000E-01, 0.0
170330 0.00000E+00, 1.5, 1.0,-2.10030E+01, 2.51100E+00, 0.0
170340 0.00000E+00, 0.0, 1.0,-2.44391E+01, 1.52620E+00, 0.0
170341 1.46360E-01, 3.0, 1.0,-2.42927E+01, 1.93380E+03, 0.0
170350 0.00000E+00, 1.5, 1.0,-2.90131E+01, 0.00000E+00, 75.77
170360 0.00000E+00, 2.0, 1.0,-2.95220E+01, 9.49865E+12, 0.0
170370 0.00000E+00, 1.5, 1.0,-3.17611E+01, 0.00000E+00, 24.23
170380 0.00000E+00, 2.0,-1.0,-2.97980E+01, 2.23440E+03, 0.0
170381 6.71280E-01, 5.0,-1.0,-2.91267E+01, 7.15000E-01, 0.0

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170390    0.00000E+00, 1.5, 1.0,-2.98040E+01, 3.33600E+03,   0.0
170400    0.00000E+00, 2.0,-1.0,-2.75400E+01, 8.10000E+01,   0.0
170410    0.00000E+00, 0.5, 1.0,-2.74000E+01, 3.40000E+01,   0.0
170420    0.00000E+00,-1.0, 0.0,-2.44200E+01, 6.80000E+00,   0.0
170430    0.00000E+00,-1.0, 0.0,-2.31300E+01, 3.30000E+00,   0.0
170440    0.00000E+00,-1.0, 0.0,-2.00100E+01,-1.00000E+00,   0.0
180320    0.00000E+00,-1.0, 0.0,-2.18000E+00,-1.00000E+00,   0.0
180330    0.00000E+00, 0.0, 1.0,-9.38000E+00, 1.73000E-01,   0.0
180340    0.00000E+00, 0.0, 1.0,-1.83790E+01, 8.44500E-01,   0.0
180350    0.00000E+00, 1.5, 1.0,-2.30480E+01, 1.77500E+00,   0.0
180360    0.00000E+00, 0.0, 1.0,-3.02310E+01, 0.00000E+00,   0.337
180370    0.00000E+00, 1.5, 1.0,-3.09470E+01, 3.02746E+06,   0.0
180380    0.00000E+00, 0.0, 1.0,-3.47140E+01, 0.00000E+00,   0.063
180390    0.00000E+00, 3.5,-1.0,-3.32420E+01, 8.48883E+09,   0.0
180400    0.00000E+00, 0.0, 1.0,-3.50390E+01, 0.00000E+00,  99.600
180410    0.00000E+00, 3.5,-1.0,-3.30670E+01, 6.57720E+03,   0.0
180420    0.00000E+00, 0.0, 1.0,-3.44200E+01, 1.03823E+09,   0.0
180430    0.00000E+00,-1.0, 0.0,-3.19800E+01, 3.22200E+02,   0.0
180440    0.00000E+00, 0.0, 1.0,-3.22620E+01, 7.12200E+02,   0.0
180450    0.00000E+00,-1.0, 0.0,-2.97200E+01,-1.00000E+00,   0.0
180460    0.00000E+00, 0.0, 1.0,-2.97200E+01, 8.40000E+00,   0.0
190340    0.00000E+00,-1.0, 0.0,-1.48000E+00,-1.00000E+00,   0.0
190350    0.00000E+00, 1.0, 1.0,-1.11680E+01, 1.90000E-01,   0.0
190360    0.00000E+00, 2.0, 1.0,-1.74260E+01, 3.42000E-01,   0.0
190370    0.00000E+00, 1.5, 1.0,-2.47990E+01, 1.22600E+00,   0.0
190380    0.00000E+00, 3.0, 1.0,-2.88010E+01, 4.58160E+02,   0.0
190381    1.30400E-01, 0.0, 1.0,-2.86706E+01, 9.24600E-01,   0.0
190382    3.45800E+00, 5.0, 1.0,-2.53430E+01, 2.25000E-05,   0.0
190390    0.00000E+00, 1.5, 1.0,-3.38060E+01, 0.00000E+00,  93.2581
190400    0.00000E+00, 4.0,-1.0,-3.35340E+01, 4.02983E+16,   0.0117
190410    0.00000E+00, 1.5, 1.0,-3.55590E+01, 0.00000E+00,   6.7302
190420    0.00000E+00, 2.0,-1.0,-3.50220E+01, 4.44960E+04,   0.0
190430    0.00000E+00, 1.5, 1.0,-3.65920E+01, 8.02799E+04,   0.0
190440    0.00000E+00, 2.0,-1.0,-3.58100E+01, 1.32780E+03,   0.0
190450    0.00000E+00, 1.5, 1.0,-3.66110E+01, 1.03800E+03,   0.0
190460    0.00000E+00, 2.0,-1.0,-3.54200E+01, 1.05000E+02,   0.0
190470    0.00000E+00,-1.0, 0.0,-3.56980E+01,-1.00000E+00,   0.0
190480    0.00000E+00, 2.0,-1.0,-3.21240E+01, 6.80000E+00,   0.0
190490    0.00000E+00,-1.0, 0.0,-3.07900E+01,-1.00000E+00,   0.0
190510    0.00000E+00, 0.5, 1.0,-1.94761E+01, 3.65000E-01,   0.0
190520    0.00000E+00,-1.0, 0.0,-1.40699E+01, 1.05000E-01,   0.0
190530    0.00000E+00, 1.5, 1.0,-1.02967E+01, 3.00000E-02,   0.0
190540    0.00000E+00,-1.0, 0.0,-4.14555E+00, 1.00000E-02,   0.0
```

(omitted)

```
ENDDATA
ENDSET
ENDNUCLIDE
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Appendix 2 Example of Level Scheme

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LEVEL
SET       YAMAMURO91; FOR 504 NUCLIDES.
COMMENT   DATA WERE EVALUATED BY N.YAMAMURO FOR SINCROS (1991).
          FORMAT CONVERTION WAS MADE ON 1992-12-18.
DATA      NO, EL, J, PARITY, NG (FLVL, BR)
0020040    0, 0.00000E+00,  0.0,  1.0,  0
0020040    1, 2.00100E+01,  2.0,  1.0,  1,  0,  1.00000
0020040    2, 2.11800E+01,  1.0, -1.0,  1,  0,  1.00000
0020040    3, 2.20200E+01,  2.0, -1.0,  1,  0,  1.00000
0020040    4, 2.53300E+01,  0.0,  1.0,  1,  1,  1.00000
0020040    5, 2.75000E+01,  1.0, -1.0,  1,  1,  1.00000
0020040    6, 2.95000E+01,  2.0,  1.0,  1,  2,  1.00000
0020040    7, 3.10000E+01,  2.0,  1.0,  1,  2,  1.00000
0020050    0, 0.00000E+00,  1.5, -1.0,  0
0020050    1, 4.00000E+00,  0.5, -1.0,  1,  0,  1.00000
0020050    2, 1.67600E+01,  1.5,  1.0,  1,  0,  1.00000
0020050    3, 1.98000E+01,  1.5,  1.0,  1,  0,  1.00000
0020050    4, 2.40000E+01,  2.5,  1.0,  1,  2,  1.00000
0020060    0, 0.00000E+00,  0.0,  1.0,  0
0020060    1, 1.79700E+00,  2.0,  1.0,  1,  0,  1.00000
0020060    2, 1.36000E+01,  2.0,  1.0,  1,  0,  1.00000
0020060    3, 1.55000E+01,  1.0,  1.0,  1,  0,  1.00000
0020060    4, 2.32000E+01,  3.0,  1.0,  1,  1,  1.00000
0030060    0, 0.00000E+00,  1.0,  1.0,  0
0030060    1, 2.18600E+00,  3.0,  1.0,  1,  0,  1.00000
0030060    2, 3.56290E+00,  0.0,  1.0,  1,  0,  1.00000
0030060    3, 4.31000E+00,  2.0,  1.0,  1,  0,  1.00000
0030060    4, 5.36600E+00,  2.0,  1.0,  1,  0,  1.00000
0030060    5, 5.65000E+00,  1.0,  1.0,  1,  0,  1.00000
0030070    0, 0.00000E+00,  1.5, -1.0,  0
0030070    1, 4.77600E-01,  0.5, -1.0,  1,  0,  1.00000
0030070    2, 4.63000E+00,  3.5, -1.0,  1,  0,  1.00000
0030070    3, 6.68000E+00,  2.5, -1.0,  1,  0,  1.00000
0030070    4, 7.45970E+00,  2.5, -1.0,  1,  0,  1.00000
0030070    5, 9.67000E+00,  3.5, -1.0,  1,  2,  1.00000
0030070    6, 9.85000E+00,  1.5, -1.0,  1,  2,  1.00000
0030070    7, 1.12400E+01,  1.5, -1.0,  1,  2,  1.00000
0030080    0, 0.00000E+00,  2.0,  1.0,  0
0030080    1, 9.80800E-01,  1.0,  1.0,  1,  0,  1.00000
0030080    2, 2.25500E+00,  3.0,  1.0,  1,  0,  1.00000
0030080    3, 3.21000E+00,  1.0,  1.0,  1,  0,  1.00000
0030080    4, 5.40000E+00,  0.0,  1.0,  1,  0,  1.00000
0030080    5, 6.10000E+00,  3.0,  1.0,  1,  1,  1.00000
0030080    6, 6.53000E+00,  4.0,  1.0,  1,  2,  1.00000
0030080    7, 7.10000E+00,  2.0,  1.0,  1,  2,  1.00000
0030090    0, 0.00000E+00,  1.5, -1.0,  0
0030090    1, 2.69100E+00,  0.5, -1.0,  1,  0,  1.00000
0040070    0, 0.00000E+00,  1.5, -1.0,  0
0040070    1, 4.29100E-01,  0.5, -1.0,  1,  0,  1.00000
0040070    2, 4.57000E+00,  3.5, -1.0,  1,  0,  1.00000
0040070    3, 6.73000E+00,  2.5, -1.0,  1,  0,  1.00000
0040070    4, 7.21000E+00,  2.5, -1.0,  1,  1,  1.00000
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0040070    5, 9.27000E+00,  3.5, -1.0,  1,  0,  1.00000
0040070    6, 9.90000E+00,  1.5, -1.0,  1,  1,  1.00000
0040070    7, 1.10100E+01,  1.5, -1.0,  1,  2,  1.00000
0040080    0, 0.00000E+00,  0.0,  1.0,  0
0040080    1, 3.04000E+00,  2.0,  1.0,  1,  0,  1.00000
0040080    2, 1.14000E+01,  4.0,  1.0,  1,  0,  1.00000
0040080    3, 1.66260E+01,  2.0,  1.0,  1,  1,  1.00000
0040080    4, 1.69220E+01,  2.0,  1.0,  1,  1,  1.00000
0040080  + 5, 1.76400E+01,  1.0,  1.0,  4,  4,  0.00000,  3,  0.00100
0040080         1,  0.33200,  0,  0.66700
0040080  + 6, 1.81500E+01,  1.0,  1.0,  4,  4,  0.00900,  3,  0.01100
0040080         1,  0.54800,  0,  0.43300
0040080    7, 1.89100E+01,  2.0, -1.0,  2,  4,  0.37100,  3,  0.62900
0040080    8, 1.90700E+01,  3.0,  1.0,  1,  1,  1.00000
0040090    0, 0.00000E+00,  1.5, -1.0,  0
0040090    1, 1.68500E+00,  0.5,  1.0,  1,  0,  1.00000
0040090    2, 2.42940E+00,  2.5, -1.0,  1,  0,  1.00000
0040090    3, 2.78000E+00,  0.5, -1.0,  1,  0,  1.00000
0040090    4, 3.04900E+00,  2.5,  1.0,  1,  0,  1.00000
0040090    5, 4.70400E+00,  1.5,  1.0,  1,  0,  1.00000
0040090    6, 6.76000E+00,  3.5, -1.0,  1,  0,  1.00000
0040090    7, 7.94000E+00,  0.5, -1.0,  1,  0,  1.00000
0040100    0, 0.00000E+00,  0.0,  1.0,  0
0040100    1, 3.36800E+00,  2.0,  1.0,  1,  0,  1.00000
0040100    2, 5.95830E+00,  2.0,  1.0,  2,  0,  0.22000,  1,  0.78000
0040100    3, 5.95990E+00,  1.0, -1.0,  1,  0,  1.00000
0040100    4, 6.17930E+00,  0.0,  1.0,  2,  1,  0.97100,  3,  0.02900
0040100    5, 6.26330E+00,  2.0, -1.0,  1,  1,  1.00000
0040100    6, 7.37100E+00,  3.0, -1.0,  1,  1,  1.00000
0040100    7, 7.54200E+00,  2.0,  1.0,  2,  1,  0.50000,  2,  0.50000
0040100    8, 9.27000E+00,  4.0, -1.0,  1,  6,  1.00000
0040110    0, 0.00000E+00,  0.5,  1.0,  0
0040110    1, 3.20000E-01,  0.5, -1.0,  1,  0,  1.00000
0040110    2, 1.77800E+00,  2.5,  1.0,  1,  0,  1.00000
0040110    3, 2.69000E+00,  0.5,  1.0,  1,  0,  1.00000
0040110    4, 3.41000E+00,  0.5,  1.0,  1,  0,  1.00000
0040110    5, 3.88700E+00,  3.5,  1.0,  1,  2,  1.00000
0040110    6, 3.95600E+00,  1.5, -1.0,  1,  1,  1.00000
0050080    0, 0.00000E+00,  2.0,  1.0,  0
0050080    1, 7.78000E-01,  1.0,  1.0,  1,  0,  1.00000
0050080    2, 2.32000E+00,  3.0,  1.0,  1,  1,  1.00000
0050090    0, 0.00000E+00,  1.5, -1.0,  0
0050090    1, 1.60000E+00,  0.5, -1.0,  1,  0,  1.00000
0050090    2, 2.36100E+00,  2.5, -1.0,  1,  0,  1.00000
0050090    3, 2.78800E+00,  1.5,  1.0,  1,  0,  1.00000
0050100    0, 0.00000E+00,  3.0,  1.0,  0
0050100    1, 7.18300E-01,  1.0,  1.0,  1,  0,  1.00000
0050100    2, 1.74010E+00,  0.0,  1.0,  2,  1,  0.99800,  0,  0.00200
0050100  + 3, 2.15430E+00,  1.0,  1.0,  3,  2,  0.51600,  1,  0.27300
0050100         0,  0.21100
0050100  + 4, 3.58710E+00,  2.0,  1.0,  4,  3,  0.14000,  2,  0.00300
0050100         1,  0.66800,  0,  0.18900
0050100    5, 4.77400E+00,  3.0,  1.0,  2,  1,  0.99500,  0,  0.00500
0050100  + 6, 5.11030E+00,  2.0, -1.0,  3,  2,  0.05000,  1,  0.31000
0050100         0,  0.64000
0050100  + 7, 5.16390E+00,  2.0,  1.0,  5,  4,  0.07700,  3,  0.64800
0050100         2,  0.00700,  1,  0.22400,  0,  0.04400
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0050100    8, 5.18000E+00,  1.0,  1.0,  1,  2,  1.00000
0050100    9, 5.91950E+00,  2.0,  1.0,  2,  1,  0.18000,  0,  0.82000
0050100   10, 6.02500E+00,  4.0,  1.0,  1,  0,  1.00000
0050100   11, 6.12720E+00,  3.0, -1.0,  1,  0,  1.00000
0050110    0, 0.00000E+00,  1.5, -1.0,  0
0050110    1, 2.12470E+00,  0.5, -1.0,  1,  0,  1.00000
0050110    2, 4.44490E+00,  2.5, -1.0,  1,  0,  1.00000
0050110    3, 5.02030E+00,  1.5, -1.0,  2,  0,  0.85600,  1,  0.14400
0050110  + 4, 6.74290E+00,  3.5, -1.0,  4,  0,  0.67300,  1,  0.02900
0050110         2,  0.28800,  3,  0.01000
0050110  + 5, 6.79180E+00,  0.5,  1.0,  4,  0,  0.67500,  1,  0.28500
0050110         2,  0.00000,  3,  0.04000
0050110  + 6, 7.28550E+00,  2.5,  1.0,  4,  0,  0.86100,  1,  0.01000
0050110         2,  0.05400,  3,  0.07400
0050110  + 7, 7.97780E+00,  1.5,  1.0,  6,  0,  0.46000,  1,  0.52900
0050110         2,  0.00100,  3,  0.00100,  5,  0.00100,  6,  0.00800
0050110  + 8, 8.56030E+00,  2.5, -1.0,  4,  0,  0.56000,  1,  0.30000
0050110         2,  0.05000,  3,  0.09000
0050110  + 9, 8.92020E+00,  2.5, -1.0,  6,  0,  0.91800,  1,  0.01000
0050110         2,  0.04300,  3,  0.01000,  5,  0.01000,  6,  0.01000
0050110  +10, 9.18500E+00,  3.5,  1.0,  4,  0,  0.00900,  2,  0.85500
0050110         4,  0.12300,  6,  0.01300
0050110  +11, 9.27440E+00,  2.5,  1.0,  4,  0,  0.18300,  2,  0.69300
0050110         4,  0.11800,  5,  0.00600
0050110   12, 9.87600E+00,  1.5,  1.0,  2,  0,  0.50000,  1,  0.50000
0050110   13, 1.02600E+01,  1.5, -1.0,  2,  0,  0.90000,  1,  0.10000
0050110   14, 1.03300E+01,  2.5, -1.0,  2,  0,  0.90000,  1,  0.10000
0050110   15, 1.05970E+01,  3.5,  1.0,  2,  0,  0.90000,  1,  0.10000
0050120    0, 0.00000E+00,  1.0,  1.0,  0
0050120    1, 9.53100E-01,  2.0,  1.0,  1,  0,  1.00000
0050120    2, 1.67360E+00,  2.0, -1.0,  2,  0,  0.96800,  1,  0.03200
0050120  + 3, 2.62080E+00,  1.0, -1.0,  3,  0,  0.06000,  1,  0.80000
0050120         2,  0.14000
0050120    4, 2.72300E+00,  0.0,  1.0,  1,  0,  1.00000
0050120    5, 3.38830E+00,  3.0, -1.0,  1,  2,  1.00000
0050120    6, 3.75900E+00,  2.0,  1.0,  1,  1,  1.00000
0050120    7, 4.30100E+00,  1.0, -1.0,  1,  2,  1.00000
0050120    8, 4.46000E+00,  2.0, -1.0,  1,  3,  1.00000
0050120    9, 4.51800E+00,  4.0, -1.0,  1,  2,  1.00000
0050130    0, 0.00000E+00,  1.5, -1.0,  0
0050130    1, 3.48300E+00,  0.5,  1.0,  1,  0,  1.00000
0050130    2, 3.53470E+00,  0.5,  1.0,  1,  0,  1.00000
0050130    3, 3.68100E+00,  0.5,  1.0,  1,  0,  1.00000
0050130    4, 3.71200E+00,  0.5,  1.0,  1,  0,  1.00000
0050130    5, 4.13100E+00,  0.5,  1.0,  1,  0,  1.00000
0060100    0, 0.00000E+00,  0.0,  1.0,  0
0060100    1, 3.35360E+00,  2.0,  1.0,  1,  0,  1.00000
0060110    0, 0.00000E+00,  1.5, -1.0,  0
0060110    1, 2.00000E+00,  0.5, -1.0,  1,  0,  1.00000
0060110    2, 4.31880E+00,  2.5, -1.0,  2,  0,  0.98000,  1,  0.02000
0060110    3, 4.80420E+00,  1.5, -1.0,  2,  0,  0.85200,  1,  0.14800
0060110  + 4, 6.33920E+00,  0.5,  1.0,  4,  0,  0.60500,  1,  0.30500
0060110         2,  0.06400,  3,  0.02700
0060110  + 5, 6.47820E+00,  3.5, -1.0,  4,  0,  0.85100,  1,  0.01900
0060110         2,  0.11100,  3,  0.01900
0060110  + 6, 6.90480E+00,  2.5,  1.0,  6,  0,  0.82000,  1,  0.00900
0060110         2,  0.04100,  3,  0.04100,  4,  0.04500,  5,  0.04500
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0060110  + 7, 7.49970E+00,  1.5,  1.0,  7,  0,  0.32100,  1,  0.57100
0060110  +       2,  0.00900,  3,  0.00900,  4,  0.02700,  5,  0.02700
0060110          6,  0.03600
0060110    8, 8.10450E+00,  1.5, -1.0,  2,  0,  0.74000,  1,  0.26000
0060110    9, 8.42000E+00,  2.5, -1.0,  2,  0,  0.93500,  2,  0.06500
0060110   10, 8.65500E+00,  3.5,  1.0,  2,  6,  0.60000,  7,  0.40000
0060110  +11, 8.70100E+00,  2.5,  1.0,  4,  0,  0.42000,  2,  0.42000
0060110          3,  0.02400,  5,  0.13600
0060110  +12, 9.20000E+00,  2.5,  1.0,  3,  0,  0.74000,  2,  0.06000
0060110          5,  0.20000
0060110  +13, 9.65000E+00,  1.5, -1.0,  3,  0,  0.60000,  2,  0.32000
0060110          3,  0.08000
0060110  +14, 9.78000E+00,  2.5, -1.0,  4,  0,  0.76000,  2,  0.08000
0060110          3,  0.04000,  5,  0.12000
0060110   15, 9.97000E+00,  3.5, -1.0,  2,  2,  0.90000,  5,  0.10000
0060110   16, 1.00830E+01,  3.5,  1.0,  2,  2,  0.83700,  5,  0.16200
0060120    0, 0.00000E+00,  0.0,  1.0,  0
0060120    1, 4.43890E+00,  2.0,  1.0,  1,  0,  1.00000
0060120    2, 7.65420E+00,  0.0,  1.0,  1,  1,  1.00000
0060120    3, 9.64100E+00,  3.0, -1.0,  1,  0,  1.00000
0060120    4, 1.03000E+01,  0.0,  1.0,  1,  1,  1.00000
0060120    5, 1.08440E+01,  1.0, -1.0,  1,  1,  1.00000
0060120    6, 1.11600E+01,  2.0,  1.0,  1,  2,  1.00000
0060120    7, 1.18280E+01,  2.0, -1.0,  1,  3,  1.00000
0060120    8, 1.27100E+01,  1.0,  1.0,  2,  0,  0.86900,  2,  0.13100
0060130    0, 0.00000E+00,  0.5, -1.0,  0
0060130    1, 3.08840E+00,  0.5,  1.0,  1,  0,  1.00000
0060130    2, 3.68440E+00,  1.5, -1.0,  2,  0,  0.99000,  1,  0.01000
0060130  + 3, 3.85360E+00,  2.5,  1.0,  3,  0,  0.62500,  1,  0.01200
0060130          2,  0.36300
0060130    4, 6.86400E+00,  2.5,  1.0,  1,  0,  1.00000
0060130    5, 7.49200E+00,  3.5,  1.0,  1,  3,  1.00000
0060130    6, 7.54700E+00,  2.5, -1.0,  1,  0,  1.00000
0060130    7, 7.67700E+00,  1.5,  1.0,  1,  3,  1.00000
0060130    8, 8.20000E+00,  1.5,  1.0,  1,  3,  1.00000
0060130    9, 8.86000E+00,  0.5, -1.0,  1,  0,  1.00000
0060140    0, 0.00000E+00,  0.0,  1.0,  0
0060140    1, 6.09420E+00,  1.0, -1.0,  1,  0,  1.00000
0060140    2, 6.58980E+00,  0.0,  1.0,  1,  1,  1.00000
0060140    3, 6.72820E+00,  3.0, -1.0,  2,  0,  0.96000,  1,  0.04000
0060140    4, 6.90230E+00,  0.0, -1.0,  1,  1,  1.00000
0060140    5, 7.01200E+00,  2.0,  1.0,  2,  0,  0.98600,  1,  0.01400
0060140  + 6, 7.34140E+00,  2.0, -1.0,  3,  0,  0.16900,  1,  0.48900
0060140          3,  0.34200
0060140    7, 8.31830E+00,  2.0,  1.0,  1,  0,  1.00000
0060150    0, 0.00000E+00,  0.5,  1.0,  0
0060150    1, 7.40000E-01,  2.5,  1.0,  1,  0,  1.00000
0060150    2, 3.10500E+00,  0.5, -1.0,  1,  0,  1.00000
0060150    3, 4.22100E+00,  3.5,  1.0,  1,  1,  1.00000
0070120    0, 0.00000E+00,  1.0,  1.0,  0
0070120    1, 9.00000E-03,  0.0,  1.0,  1,  0,  1.00000
0070120    2, 9.60000E-01,  2.0,  1.0,  1,  0,  1.00000
0070120    3, 1.18900E+00,  2.0, -1.0,  1,  0,  1.00000
0070120    4, 2.41500E+00,  0.0,  1.0,  1,  0,  1.00000
0070120    5, 3.11800E+00,  2.0,  1.0,  1,  0,  1.00000
0070120    6, 3.53400E+00,  0.0,  1.0,  1,  0,  1.00000
0070130    0, 0.00000E+00,  0.5, -1.0,  0
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0070130    1, 2.36530E+00,  0.5,  1.0,  1,  0,  1.00000
0070130    2, 3.51100E+00,  1.5, -1.0,  2,  0,  0.90000,  1,  0.10000
0070130    3, 3.54700E+00,  2.5,  1.0,  1,  0,  1.00000
0070130    4, 6.36400E+00,  2.5,  1.0,  2,  0,  0.30000,  1,  0.70000
0070130    5, 6.88500E+00,  1.5,  1.0,  2,  0,  0.70000,  1,  0.30000
0070130    6, 7.15500E+00,  3.5,  1.0,  1,  3,  1.00000
0070130    7, 7.37600E+00,  2.5, -1.0,  1,  2,  1.00000
0070130    8, 8.00000E+00,  1.5,  1.0,  1,  1,  1.00000
0070140    0, 0.00000E+00,  1.0,  1.0,  0
0070140    1, 2.31290E+00,  0.0,  1.0,  1,  0,  1.00000
0070140    2, 3.94780E+00,  1.0,  1.0,  2,  0,  0.04000,  1,  0.96000
0070140    3, 4.91500E+00,  0.0, -1.0,  1,  0,  1.00000
0070140  + 4, 5.10590E+00,  2.0, -1.0,  3,  0,  0.79000,  1,  0.20000
0070140         2,  0.01000
0070140    5, 5.68960E+00,  1.0, -1.0,  2,  0,  0.35000,  1,  0.65000
0070140    6, 5.83240E+00,  3.0, -1.0,  2,  0,  0.10000,  4,  0.90000
0070140    7, 6.20350E+00,  1.0,  1.0,  2,  0,  0.74000,  1,  0.26000
0070140  + 8, 6.44440E+00,  3.0,  1.0,  4,  0,  0.70000,  2,  0.20000
0070140         4,  0.07000,  6,  0.03000
0070140  + 9, 7.02790E+00,  2.0,  1.0,  3,  0,  0.98600,  1,  0.00500
0070140         2,  0.00900
0070150    0, 0.00000E+00,  0.5, -1.0,  0
0070150    1, 5.27040E+00,  2.5,  1.0,  1,  0,  1.00000
0070150    2, 5.29890E+00,  0.5,  1.0,  1,  0,  1.00000
0070150    3, 6.32380E+00,  1.5, -1.0,  1,  0,  1.00000
0070150    4, 7.15540E+00,  2.5,  1.0,  1,  1,  1.00000
0070150  + 5, 7.30110E+00,  1.5,  1.0,  3,  0,  0.17700,  1,  0.00300
0070150         2,  0.82000
0070150    6, 7.56710E+00,  3.5,  1.0,  1,  0,  1.00000
0070150    7, 8.31280E+00,  0.5,  1.0,  1,  0,  1.00000
0070150  + 8, 8.57140E+00,  1.5,  1.0,  3,  0,  0.33000,  1,  0.64000
0070150         3,  0.03000
0070150  + 9, 9.05000E+00,  0.5,  1.0,  4,  0,  0.90900,  1,  0.03500
0070150         3,  0.04400,  5,  0.01200
0070150   10, 9.15220E+00,  1.5, -1.0,  1,  0,  1.00000
0070150  +11, 9.15530E+00,  2.5,  1.0,  4,  1,  0.11000,  2,  0.10000
0070150         3,  0.21900,  4,  0.57100
0070150  +12, 9.22500E+00,  0.5, -1.0,  3,  0,  0.20000,  2,  0.40000
0070150         3,  0.40000
0070150   13, 9.76000E+00,  2.5, -1.0,  1,  0,  1.00000
0070150  +14, 9.82900E+00,  3.5,  1.0,  5,  1,  0.83400,  3,  0.02300
0070150         4,  0.02600,  5,  0.03900,  6,  0.07800
0070150   15, 9.92800E+00,  0.5,  1.0,  1,  0,  1.00000
0070160    0, 0.00000E+00,  2.0, -1.0,  0
0070160    1, 1.20100E-01,  0.0, -1.0,  1,  0,  1.00000
0070160    2, 2.97000E-01,  3.0, -1.0,  1,  0,  1.00000
0070160    3, 3.97500E-01,  1.0, -1.0,  2,  0,  0.26000,  1,  0.74000
0070160    4, 3.35500E+00,  1.0,  1.0,  1,  0,  1.00000
0070160    5, 3.51900E+00,  2.0,  1.0,  1,  0,  1.00000
0070160    6, 3.96000E+00,  3.0,  1.0,  1,  0,  1.00000
0070160    7, 4.31900E+00,  1.0,  1.0,  1,  0,  1.00000

                        (omitted)

ENDDATA
ENDSET
ENDLEVEL
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Appendix 3 Example of Level Density Parameters

```
LDP
SET       J3FPLDP; FOR JENDL-3 FP NUCLEAR DATA
COMMENT   MAIN PART OF THIS LDP SET WAS DETERMINED BY JNDC FP NUCLEAR
          DATA WG FOR EVALUATION WORK OF JENDL-3 FP NUCLEAR DATA LIB.
          DATA FOR LIGHTER AND HEAVIER NUCLIDES THAN FP MASS REGION WERE
          ADDED.
          - A AND T PARAMETERS WERE DETERMINED BY USING 'LEVDENS' AND
            LEVEL SCHEME DATA RETRIEVED FROM ENSDF.
          - PAIRING ENERGIES WERE TAKEN FROM REPORT BY GILBERT AND
            CAMERON/1/.
          - EX (CONNECTING ENERGY) WAS ESTIMATED FROM CONTINUOUS
            CONNECTION CONDITION BETWEEN FERMI GAS MODEL AND CONSTANT
            TEMPERATURE MODEL. (SEE S.IIJIMA ET AL./2/)
          - SCF (SPIN-CUTOFF FACTOR AT 0 MEV) WAS ASSUMED TO BE 5.0, OR
            CALCULATED FROM LEVEL SCHEME ADOPTED TO THE CALCULATION.
          REFERENCES
           1) A.GILBERT AND A.G.W.CAMERON: CAN. J. PHYS., 43, 1446(1965)
           2) S.IIJIMA ET AL.: J. NUCL. SCI. TECHNOL., 21, 10 (1984).
          HISTORY
           1991-02 DATA WERE CONVERTED FROM PARAMETER FILE OF JOBSETTER.
FORMULA   GILBERT-CAMERON
SCOEF     0.146
DATA      A, T, PAIR, EX, SCP, SCF
0130270     3.7900+0, 2.1200+0, 1.800, 1.1423+1, 2.5581+0, 5.0000+0
0130280     4.3200+0, 1.8000+0, 0.000, 7.6430+0, 2.7981+0, 5.0000+0
0130290     4.6300+0, 1.7500+0, 1.670, 9.7462+0, 2.9653+0, 5.0000+0
0140280     2.8900+0, 2.7800+0, 3.890, 1.6507+1, 2.2886+0, 5.0000+0

                              (omitted)

0400890     1.0950+1, 8.2600-1, 1.200, 5.8638+0, 9.6306+0, 5.0000+0
0400900     9.1520+0, 8.2220-1, 2.130, 5.3826+0, 8.8703+0, 1.0125+1
0400910     1.0360+1, 8.0000-1, 1.200, 5.0571+0, 9.5074+0, 1.2045+1
0400920     1.0880+1, 8.1920-1, 1.920, 6.4290+0, 9.8143+0, 6.9375+0
0400930     1.2980+1, 7.0000-1, 1.200, 5.1834+0, 1.0797+1, 6.1000+0
0400940     1.2750+1, 7.5300-1, 2.320, 7.0189+0, 1.0778+1, 5.5250+0
0400950     1.3310+1, 6.0700-1, 1.200, 3.9854+0, 1.1090+1, 5.6522+0
0400960     1.3200+1, 7.0000-1, 2.490, 6.5890+0, 1.1121+1, 3.7917+0
0400970     1.2590+1, 5.5900-1, 1.200, 3.0839+0, 1.0937+1, 5.0000+0
0410920     1.0400+1, 8.4100-1, 0.000, 4.4773+0, 9.5954+0, 5.0000+0
0410930     1.2500+1, 7.1200-1, 0.720, 4.6290+0, 1.0596+1, 1.0923+1
0410940     1.2810+1, 7.2300-1, 0.000, 4.2504+0, 1.0803+1, 7.4009+0
0410950     1.2770+1, 7.5000-1, 1.120, 5.7816+0, 1.0863+1, 3.6250+0
0410960     1.3310+1, 5.8800-1, 0.000, 2.5304+0, 1.1168+1, 5.0000+0
0410970     1.3370+1, 6.7100-1, 1.290, 5.0255+0, 1.1270+1, 5.0000+0
0410980     1.3800+1, 5.1100-1, 0.000, 1.7311+0, 1.1529+1, 5.0000+0
0420910     1.1680+1, 7.8200-1, 1.280, 5.7702+0, 1.0095+1, 5.0000+0
0420920     1.0640+1, 7.7700-1, 2.210, 5.9383+0, 9.7054+0, 1.3125+1
0420930     1.1250+1, 7.8000-1, 1.280, 5.4568+0, 1.0052+1, 5.0000+0
0420940     1.3010+1, 6.8500-1, 2.000, 5.7695+0, 1.0887+1, 7.7614+0
0420950     1.3600+1, 7.1500-1, 1.280, 5.8351+0, 1.1210+1, 6.1842+0
0420960     1.4030+1, 7.4100-1, 2.400, 7.6451+0, 1.1466+1, 7.6964+0
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0420970 1.5170+1, 6.8000-1, 1.280, 6.0358+0, 1.2005+1, 7.0750+0
0420980 1.5940+1, 6.9000-1, 2.570, 7.8876+0, 1.2390+1, 5.2917+0
0420990 1.7740+1, 6.2000-1, 1.280, 6.0582+0, 1.3160+1, 2.8750+0
0421000 1.7800+1, 6.0000-1, 2.220, 6.6449+0, 1.3271+1, 5.1250+0
0421010 2.0850+1, 5.6500-1, 1.280, 6.0916+0, 1.4458+1, 5.0000+0
0421030 2.1750+1, 5.3000-1, 1.280, 5.6551+0, 1.4961+1, 5.0000+0
0430960 1.7410+1, 5.6400-1, 0.000, 3.6500+0, 1.2772+1, 5.0000+0
0430970 1.6000+1, 6.7000-1, 1.120, 6.0891+0, 1.2329+1, 5.0000+0
0430980 1.6590+1, 6.1200-1, 0.000, 4.1759+0, 1.2640+1, 5.0000+0
0430990 1.6000+1, 6.5500-1, 1.290, 5.9837+0, 1.2498+1, 7.9000+0
0431000 1.6370+1, 5.8500-1, 0.000, 3.6354+0, 1.2727+1, 5.0000+0
0431010 1.6750+1, 6.4400-1, 0.940, 5.7613+0, 1.2959+1, 5.0000+0
0431020 1.7610+1, 5.4000-1, 0.000, 3.3173+0, 1.3375+1, 5.0000+0
0431030 1.8100+1, 6.3100-1, 1.240, 6.3794+0, 1.3648+1, 5.0000+0
0431040 1.6000+1, 5.5000-1, 0.000, 2.9601+0, 1.2915+1, 5.0000+0
0440950 1.3580+1, 6.7200-1, 1.280, 5.1328+0, 1.1202+1, 5.0000+0
0440960 1.3430+1, 6.6800-1, 2.000, 5.7188+0, 1.1218+1, 5.5865+0
0440970 1.5100+1, 6.3900-1, 1.280, 5.3001+0, 1.1977+1, 5.0000+0
0440980 1.3820+1, 7.4000-1, 2.400, 7.5065+0, 1.1537+1, 7.8942+0
0440990 1.6500+1, 6.5700-1, 1.280, 6.2352+0, 1.2692+1, 1.2667+1
0441000 1.5200+1, 7.2000-1, 2.570, 8.0779+0, 1.2263+1, 4.0625+0
0441010 1.7260+1, 6.7000-1, 1.280, 6.8362+0, 1.3155+1, 1.4304+1
0441020 1.6430+1, 6.5500-1, 2.220, 7.1063+0, 1.2919+1, 7.6544+0
0441030 1.8900+1, 6.4800-1, 1.280, 7.1101+0, 1.3947+1, 5.0455+0
0441040 1.6500+1, 6.7800-1, 2.520, 7.8777+0, 1.3115+1, 4.5250+0
0441050 2.0250+1, 6.0600-1, 1.280, 6.7474+0, 1.4623+1, 5.0000+0
0441060 1.8700+1, 6.3000-1, 2.530, 7.8956+0, 1.4141+1, 4.1250+0
0441070 2.0300+1, 6.0000-1, 1.280, 6.6368+0, 1.4826+1, 5.0000+0
0451030 1.5700+1, 6.5500-1, 0.940, 5.4989+0, 1.2711+1, 6.3750+0
0451040 1.7140+1, 5.9100-1, 0.000, 4.0181+0, 1.3367+1, 5.0000+0
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0451060 1.7000+1, 5.3000-1, 0.000, 2.9727+0, 1.3483+1, 5.0000+0
0451070 1.9630+1, 5.4800-1, 1.250, 5.3356+0, 1.4579+1, 5.0000+0
0451090 1.6080+1, 6.2700-1, 1.140, 5.3715+0, 1.3359+1, 5.0000+0
0461010 1.6890+1, 6.4100-1, 1.350, 6.1752+0, 1.3013+1, 5.0000+0
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0461030 1.7330+1, 6.5500-1, 1.350, 6.6374+0, 1.3355+1, 5.0000+0
0461040 1.6300+1, 6.6500-1, 2.290, 7.3049+0, 1.3036+1, 5.6806+0
0461050 1.7910+1, 6.7000-1, 1.350, 7.2074+0, 1.3752+1, 6.2800+0
0461060 1.7170+1, 6.6600-1, 2.590, 8.0242+0, 1.3550+1, 6.4293+0
0461070 1.9160+1, 6.1100-1, 1.350, 6.5069+0, 1.4404+1, 4.3500+0
0461080 1.7900+1, 6.4600-1, 2.600, 7.9567+0, 1.4009+1, 5.8750+0
0461090 2.0710+1, 6.0300-1, 1.350, 6.9246+0, 1.5161+1, 5.0000+0
0461100 1.8800+1, 6.3000-1, 2.490, 7.8965+0, 1.4533+1, 5.8250+0
0461110 2.1430+1, 5.6100-1, 1.350, 6.2675+0, 1.5610+1, 5.0000+0
0471060 1.8390+1, 5.4800-1, 0.000, 3.6958+0, 1.4023+1, 7.3250+0
0471070 1.6500+1, 6.3000-1, 1.240, 5.6985+0, 1.3366+1, 6.6154+0
0471080 1.6710+1, 5.7600-1, 0.000, 3.6091+0, 1.3535+1, 5.0000+0
0471090 1.6500+1, 6.3000-1, 1.250, 5.7085+0, 1.3533+1, 5.7692+0
0471100 1.7910+1, 5.9000-1, 0.000, 4.2815+0, 1.4185+1, 2.7112+0
0471110 1.9550+1, 5.8100-1, 1.140, 5.8345+0, 1.4910+1, 5.0000+0
0481050 1.6000+1, 6.8500-1, 1.360, 6.6116+0, 1.2998+1, 5.0000+0
0481060 1.4680+1, 6.9500-1, 2.300, 7.0784+0, 1.2529+1, 1.0943+1
0481070 1.6471+1, 6.7400-1, 1.360, 6.6263+0, 1.3355+1, 5.0000+0
0481080 1.5410+1, 6.9000-1, 2.600, 7.6548+0, 1.2998+1, 8.0880+0
0481090 1.8115+1, 6.1200-1, 1.360, 6.1323+0, 1.4179+1, 5.0000+0
0481100 1.7500+1, 6.3000-1, 2.610, 7.4825+0, 1.4022+1, 9.0774+0

0481110 1.8740+1, 5.9300-1, 1.360, 6.0004+0, 1.4598+1, 4.6364+0
0481120 1.7970+1, 6.1900-1, 2.500, 7.3507+0, 1.4380+1, 3.2361+0
0481130 1.9730+1, 5.7600-1, 1.360, 6.0177+0, 1.5158+1, 5.7333+0
0481140 1.9100+1, 6.0100-1, 2.680, 7.6111+0, 1.5002+1, 3.8750+0
0481150 2.0720+1, 5.5700-1, 1.360, 5.9658+0, 1.5716+1, 5.0000+0
0481160 1.9900+1, 5.7500-1, 2.510, 7.2060+0, 1.5491+1, 3.9250+0
0481170 2.1070+1, 5.6200-1, 1.360, 6.1814+0, 1.6032+1, 5.0000+0
0491120 1.7430+1, 5.0900-1, 0.000, 2.7790+0, 1.4163+1, 5.0000+0
0491130 1.8850+1, 5.0700-1, 1.140, 4.2802+0, 1.4816+1, 6.6042+0
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0491160 1.7100+1, 5.6500-1, 0.000, 3.5621+0, 1.4360+1, 5.0000+0
0491170 1.6780+1, 6.0100-1, 1.150, 5.2077+0, 1.4307+1, 5.0000+0
0491190 1.9400+1, 5.3400-1, 1.240, 4.9994+0, 1.5558+1, 5.0000+0
0491210 1.6010+1, 6.0600-1, 1.430, 5.2766+0, 1.4291+1, 5.0000+0
0491230 1.4700+1, 6.1000-1, 1.090, 4.4831+0, 1.3845+1, 5.0000+0
0491240 1.6550+1, 5.2400-1, 0.000, 2.7474+0, 1.4770+1, 5.0000+0
0491260 1.6000+1, 5.1600-1, 0.000, 2.4695+0, 1.4678+1, 5.0000+0
0501110 1.4960+1, 6.6100-1, 1.190, 5.5161+0, 1.3043+1, 5.0000+0
0501120 1.4630+1, 6.6800-1, 2.440, 6.7302+0, 1.2975+1, 7.9076+0
0501130 1.6350+1, 5.9800-1, 1.190, 5.0335+0, 1.3798+1, 5.0000+0
0501140 1.5150+1, 6.2700-1, 2.330, 6.1748+0, 1.3361+1, 7.5481+0
0501150 1.5670+1, 5.5400-1, 1.190, 4.1001+0, 1.3667+1, 7.4375+0
0501160 1.5290+1, 6.6800-1, 2.510, 7.1105+0, 1.3579+1, 6.1250+0
0501170 1.5830+1, 5.9600-1, 1.190, 4.8039+0, 1.3896+1, 5.3750+0
0501180 1.6330+1, 6.1400-1, 2.340, 6.4478+0, 1.4194+1, 5.4107+0
0501190 1.6350+1, 5.9900-1, 1.190, 5.0503+0, 1.4283+1, 3.5250+0
0501200 1.5950+1, 6.5400-1, 2.430, 7.0833+0, 1.4186+1, 6.5000+0
0501210 1.6300+1, 6.1000-1, 1.190, 5.2173+0, 1.4420+1, 5.0000+0
0501220 1.4340+1, 7.0600-1, 2.620, 7.4157+0, 1.3600+1, 8.5694+0
0501230 1.5090+1, 6.8700-1, 1.190, 6.0317+0, 1.4027+1, 4.5417+0
0501240 1.6010+1, 6.1600-1, 2.280, 6.2944+0, 1.4527+1, 7.9750+0
0501250 1.5910+1, 6.2100-1, 1.190, 5.2488+0, 1.4559+1, 5.0000+0
0501260 1.6460+1, 6.2700-1, 2.390, 6.7783+0, 1.4887+1, 1.1411+1
0501270 1.5770+1, 6.1400-1, 1.190, 5.0749+0, 1.4649+1, 5.0000+0
0511210 1.7300+1, 5.7400-1, 1.240, 5.0219+0, 1.4856+1, 9.2500+0
0511220 1.7720+1, 5.5000-1, 0.000, 3.5168+0, 1.5118+1, 5.0000+0
0511230 1.5850+1, 6.2130-1, 1.430, 5.4694+0, 1.4376+1, 6.4000+0
0511240 1.6960+1, 5.6000-1, 0.000, 3.4331+0, 1.4951+1, 5.0000+0
0511250 1.7000+1, 5.1200-1, 1.090, 3.7922+0, 1.5049+1, 7.2679+0
0511260 1.7000+1, 5.2500-1, 0.000, 2.8965+0, 1.5129+1, 5.0000+0
0511270 1.7000+1, 5.1200-1, 1.200, 3.9022+0, 1.5209+1, 5.0000+0
0511280 1.4680+1, 5.6000-1, 0.000, 2.6582+0, 1.4208+1, 5.0000+0
0511290 1.5960+1, 5.0400-1, 1.040, 3.3328+0, 1.4891+1, 5.0000+0
0511300 1.5660+1, 5.0000-1, 0.000, 2.1538+0, 1.4827+1, 5.0000+0
0521190 1.8190+1, 6.2100-1, 1.140, 6.1175+0, 1.5065+1, 5.0000+0
0521200 1.7000+1, 5.9400-1, 2.290, 6.3087+0, 1.4645+1, 6.3750+0
0521210 1.8000+1, 6.2000-1, 1.140, 6.0220+0, 1.5153+1, 5.0000+0
0521220 1.7050+1, 6.3500-1, 2.380, 7.1602+0, 1.4829+1, 7.5250+0
0521230 1.8740+1, 5.8500-1, 1.140, 5.6267+0, 1.5632+1, 4.2667+0
0521240 1.7840+1, 6.7400-1, 2.570, 8.4793+0, 1.5334+1, 3.9917+0
0521250 1.9920+1, 5.5900-1, 1.140, 5.5274+0, 1.6291+1, 1.0147+1
0521260 1.7060+1, 6.1000-1, 2.230, 6.5544+0, 1.5156+1, 7.5096+0
0521270 2.0040+1, 5.3800-1, 1.140, 5.1646+0, 1.6513+1, 6.0667+0
0521280 1.8000+1, 6.0900-1, 2.340, 7.0102+0, 1.5732+1, 7.6806+0
0521290 2.0150+1, 5.3500-1, 1.140, 5.1415+0, 1.6732+1, 5.9130+0
0521300 1.8000+1, 5.4700-1, 2.180, 5.7354+0, 1.5896+1, 1.2982+1

0521310 1.8460+1, 5.3600-1, 1.140, 4.6514+0, 1.6180+1, 5.0000+0
0521320 1.7450+1, 4.9200-1, 1.840, 4.3730+0, 1.5811+1, 5.0000+0
0531240 1.9500+1, 5.2400-1, 0.000, 3.6111+0, 1.6032+1, 5.0000+0
0531270 1.7170+1, 6.2630-1, 1.090, 5.7569+0, 1.5285+1, 7.0000+0
0531280 1.7150+1, 6.2000-1, 0.000, 4.5420+0, 1.5356+1, 5.0000+0
0531290 1.7200+1, 6.2000-1, 1.200, 5.7621+0, 1.5459+1, 5.2778+0
0531300 1.6400+1, 6.0000-1, 0.000, 3.8961+0, 1.5173+1, 5.0000+0
0531310 1.6000+1, 6.3300-1, 1.040, 5.3425+0, 1.5064+1, 6.4333+0
0531320 1.5500+1, 6.0000-1, 0.000, 3.5520+0, 1.4902+1, 5.0000+0
0531330 1.5590+1, 4.8900-1, 0.700, 2.6906+0, 1.5020+1, 5.0000+0
0531340 1.5000+1, 5.6000-1, 0.000, 2.7692+0, 1.4807+1, 5.0000+0
0531350 1.3500+1, 5.5000-1, 0.850, 2.9614+0, 1.4117+1, 5.0000+0
0531360 1.4500+1, 5.5000-1, 0.000, 2.4595+0, 1.4703+1, 5.0000+0
0541230 1.9080+1, 5.7700-1, 1.120, 5.5731+0, 1.5773+1, 5.0000+0
0541240 1.9920+1, 5.8600-1, 2.360, 7.2856+0, 1.6204+1, 8.9028+0
0541250 2.0500+1, 5.5300-1, 1.120, 5.5757+0, 1.6526+1, 5.0000+0
0541260 1.9080+1, 6.1100-1, 2.550, 7.6761+0, 1.6028+1, 9.4583+0
0541270 1.9820+1, 5.4200-1, 1.120, 5.1525+0, 1.6423+1, 5.0000+0
0541280 1.8000+1, 5.8300-1, 2.210, 6.3963+0, 1.5732+1, 7.2554+0
0541290 1.9360+1, 5.7290-1, 1.120, 5.5903+0, 1.6401+1, 8.1875+0
0541300 1.6710+1, 6.6000-1, 2.320, 7.4270+0, 1.5316+1, 5.6250+0
0541310 1.7400+1, 6.0000-1, 1.120, 5.3945+0, 1.5709+1, 1.1688+1
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0551330 1.7500+1, 6.0000-1, 1.040, 5.3522+0, 1.5914+1, 8.0769+0
0551340 1.5980+1, 6.4500-1, 0.000, 4.5053+0, 1.5283+1, 1.1677+1
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0551370 1.3360+1, 6.2000-1, 0.850, 3.8359+0, 1.4182+1, 4.5714+0
0551380 1.4700+1, 5.7370-1, 0.000, 2.8580+0, 1.4949+1, 5.0000+0
0551400 1.4840+1, 6.5450-1, 0.000, 4.1619+0, 1.5164+1, 5.0000+0
0561290 1.9780+1, 6.4900-1, 1.580, 7.8123+0, 1.6578+1, 5.0000+0
0561300 1.8500+1, 6.2400-1, 2.670, 7.8317+0, 1.6115+1, 8.6964+0
0561310 1.9900+1, 6.0900-1, 1.580, 6.9790+0, 1.6799+1, 5.0000+0
0561320 1.8500+1, 6.3600-1, 2.780, 8.1868+0, 1.6280+1, 6.4250+0
0561330 1.9410+1, 5.9300-1, 1.580, 6.4645+0, 1.6760+1, 5.0000+0
0561340 1.8000+1, 6.1000-1, 2.620, 7.3093+0, 1.6220+1, 3.5096+0
0561350 1.9020+1, 5.8200-1, 1.580, 6.1082+0, 1.6756+1, 5.2857+0
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0561370 1.6450+1, 5.6400-1, 1.580, 4.9055+0, 1.5737+1, 5.6250+0
0561380 1.3900+1, 7.2000-1, 2.430, 7.2329+0, 1.4536+1, 7.9145+0
0561390 2.0220+1, 4.8000-1, 1.580, 4.6286+0, 1.7617+1, 5.0000+0
0561400 1.5000+1, 6.9300-1, 2.340, 7.2444+0, 1.5246+1, 4.5536+0
0561410 1.6000+1, 7.0100-1, 1.580, 7.1406+0, 1.5821+1, 5.0000+0
0571370 1.5580+1, 6.2100-1, 0.700, 4.6242+0, 1.5315+1, 5.0000+0
0571380 1.4500+1, 6.3100-1, 0.000, 3.6338+0, 1.4846+1, 7.5250+0
0571390 1.3800+1, 6.5000-1, 0.850, 4.4677+0, 1.4554+1, 7.8750+0
0571400 1.5580+1, 5.9000-1, 0.000, 3.4247+0, 1.5538+1, 5.0000+0
0571410 1.8940+1, 5.1300-1, 0.760, 4.0240+0, 1.7213+1, 5.0000+0
0571420 2.0260+1, 4.6100-1, 0.000, 2.7487+0, 1.7887+1, 5.0000+0
0571440 1.8430+1, 4.9300-1, 0.000, 2.8055+0, 1.7220+1, 5.0000+0
0581390 1.3740+1, 6.4500-1, 1.170, 4.6849+0, 1.4522+1, 5.0000+0
0581400 1.4130+1, 6.5410-1, 2.020, 5.8520+0, 1.4797+1, 6.1250+0

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0581410    1.7140+1, 5.1500-1, 1.170, 3.9568+0, 1.6375+1, 9.5690+0
0581420    1.6000+1, 6.0000-1, 1.930, 5.6736+0, 1.5895+1, 3.2361+0
0581430    1.9000+1, 5.5000-1, 1.170, 5.0940+0, 1.7403+1, 5.0000+0
0581440    1.7000+1, 6.0000-1, 2.090, 6.2136+0, 1.6538+1, 5.0000+0
0581450    2.1000+1, 5.5000-1, 1.170, 5.7230+0, 1.8466+1, 5.0000+0
0581460    1.9180+1, 6.0370-1, 2.160, 7.1756+0, 1.7729+1, 5.0000+0
0591400    1.4480+1, 6.4300-1, 0.000, 3.8138+0, 1.4979+1, 5.0000+0
0591410    1.4000+1, 6.5000-1, 0.850, 4.5587+0, 1.4799+1, 5.9375+0
0591420    1.5950+1, 6.1500-1, 0.000, 3.9735+0, 1.5871+1, 5.2679+0
0591430    1.5000+1, 6.2800-1, 0.760, 4.5581+0, 1.5463+1, 3.0500+0
0591440    1.6000+1, 6.0000-1, 0.000, 3.7436+0, 1.6044+1, 5.0000+0
0591470    2.4400+1, 4.4200-1, 0.990, 4.2980+0, 2.0088+1, 5.0000+0
0591480    1.9960+1, 4.6900-1, 0.000, 2.8071+0, 1.8250+1, 5.0000+0
0601410    1.4770+1, 6.0910-1, 1.180, 4.5874+0, 1.5200+1, 5.0000+0
0601420    1.2880+1, 6.7100-1, 2.030, 5.5264+0, 1.4262+1, 5.5795+0
0601430    1.8260+1, 4.7100-1, 1.180, 3.6126+0, 1.7061+1, 7.2273+0
0601440    1.7710+1, 5.6400-1, 1.940, 5.6907+0, 1.6880+1, 8.7250+0
0601450    2.0540+1, 5.1200-1, 1.180, 4.8685+0, 1.8263+1, 6.8750+0
0601460    2.0190+1, 5.6600-1, 2.100, 6.7138+0, 1.8190+1, 6.1250+0
0601470    2.3980+1, 4.8500-1, 1.180, 5.2352+0, 1.9914+1, 4.0417+0
0601480    2.3590+1, 5.1500-1, 2.170, 6.7514+0, 1.9841+1, 4.7917+0
0601490    2.6570+1, 4.7500-1, 1.180, 5.6359+0, 2.1151+1, 5.0000+0
0601500    2.4150+1, 5.2800-1, 2.280, 7.3038+0, 2.0255+1, 1.0325+1
0601510    2.6180+1, 4.8000-1, 1.180, 5.6561+0, 2.1183+1, 5.0000+0
0611440    1.8310+1, 5.1000-1, 0.000, 3.0399+0, 1.7163+1, 5.0000+0
0611470    2.1920+1, 4.9130-1, 0.920, 4.5890+0, 1.9039+1, 4.6667+0
0611480    2.2270+1, 4.3000-1, 0.000, 2.6720+0, 1.9278+1, 5.0000+0
0611490    2.3770+1, 4.8900-1, 0.990, 5.0752+0, 2.0006+1, 6.0714+0
0611500    2.2700+1, 3.8000-1, 0.000, 1.9732+0, 1.9638+1, 5.0000+0
0611510    2.8820+1, 4.2600-1, 1.100, 4.9460+0, 2.2225+1, 5.0000+0
0611530    2.2850+1, 4.9500-1, 0.920, 4.8951+0, 1.9964+1, 5.0000+0
0621430    1.6280+1, 5.4310-1, 1.220, 4.1674+0, 1.6109+1, 5.0000+0
0621440    1.5570+1, 5.5430-1, 2.070, 4.9510+0, 1.5827+1, 1.5125+1
0621450    2.0450+1, 4.3430-1, 1.220, 3.5957+0, 1.8223+1, 5.0000+0
0621460    1.8710+1, 5.1170-1, 1.980, 5.1585+0, 1.7510+1, 5.0000+0
0621470    2.2750+1, 4.7700-1, 1.220, 4.8232+0, 1.9396+1, 9.9643+0
0621480    2.0970+1, 5.5050-1, 2.140, 6.6937+0, 1.8707+1, 5.9432+0
0621490    2.3250+1, 5.0520-1, 1.220, 5.5044+0, 1.9786+1, 5.3000+0
0621500    2.3620+1, 5.2300-1, 2.210, 6.9725+0, 2.0032+1, 5.4750+0

                              (omitted)

ENDDATA
ENDSET
ENDLDP
```

Appendix 4 Example of Optical Potential Parameters

```
OMP
INCIDENT    10
SET         J3FPOMP
REF         JNDC FP NUCLEAR DATA SWG
TARGET      330000,379999
TYPE        2
DATA        V,WS,VSO
E0          46.0, 7.0 , 7.0
E1          -0.25,0.0 , 0.0
RC          5.7 , 6.2 , 5.7
A           0.62, 0.35, 0.62
ENDDATA
TARGET      380000,429999
TYPE        2
DATA        V,WS,VSO
E0          46.0, 7.0 , 7.0
E1          -0.25,0.0 , 0.0
RC          5.893, 6.393, 5.893
A           0.62, 0.35, 0.62
ENDDATA
TARGET      430000,459999
TYPE        2
DATA        V,WS,VSO
E0          47.5, 9.74, 7.0
RC          5.9723, 6.5942, 5.97
A           0.62, 0.35, 0.62
ENDDATA
TARGET      460000,489999
TYPE        2
DATA        V,WS,VSO
E0          50.01, 8.165, 5.261
E1          -0.5528, 0.0, 0.0
RC          5.972 , 6.594 , 5.97
A           0.56, 0.44, 0.267
ENDDATA
TARGET      490000,519999
TYPE        2
DATA        V,WS,VSO
E0          47.64, 9.744, 7.0
E1          -0.473, 0.0, 0.0
RC          6.2556, 6.4687, 6.241
A           0.62, 0.35, 0.62
ENDDATA
TARGET      520000,549999
TYPE        2
DATA        V,WS,VSO
E0          45.97 , 6.502 , 7.0
E1          -0.199, 0.0   , 0.0
RC          6.4810, 6.9257, 6.490
A           0.62, 0.35, 0.62
ENDDATA
TARGET      550000,559999
```

```
TYPE      5
DATA      V,WV,WS,VSO
E0        46.0  , 0.0   , 7.0  , 7.0
E1        -0.250, 0.125 , 0.0  , 0.0
E1        0.0   ,-0.0004, 0.0  , 0.0
R         1.16  , 1.16  , 1.16 , 1.16
RC        0.6   , 0.6   , 1.1  , 0.6
A         0.62  , 0.62  , 0.35 , 0.62
ENDDATA
TARGET    560000,569999
TYPE      2
DATA      V,WS,VSO
E0        41.8  , 2.95 , 7.0
E1        0.0   , 0.78 , 0.0
RC        6.89  , 7.098, 6.89
A         0.62  , 0.35 , 0.62
ENDDATA
TARGET    570000,589999
TYPE      2
DATA      V,WS,VSO
E0        41.8  , 2.95 , 7.0
E1        0.0   , 0.78 , 0.0
R         1.327 , 1.367, 1.327
A         0.62  , 0.35 , 0.62
ENDDATA
TARGET    590000,599999
TYPE      1
DATA      V,WS,VSO
E0        46.0  , 7.00 , 7.0
R         1.16  , 1.16 , 1.16
RC        0.6   , 0.6  , 0.6
A         0.62  , 1.00 , 0.62
ENDDATA
TARGET    601420,601439
TYPE      2
DATA      V,WS,VSO
E0        45.76 , 6.97 , 7.0
R         1.29  , 1.23 , 1.28
A         0.60  , 0.45 , 0.60
ENDDATA
TARGET    601440,601489
TYPE      2
DATA      V,WS,VSO
E0        47.94 , 9.13 , 7.0
RC        6.718 , 7.564, 6.771
A         0.60  , 0.45 , 0.60
ENDDATA
TARGET    601500,609999
TYPE      2
DATA      V,WS,VSO
E0        47.94 , 9.13 , 7.0
R         1.27  , 1.43 , 1.28
A         0.60  , 0.45 , 0.60
ENDDATA
TARGET    611470,619999
TYPE      1
DATA      V,WS,VSO
```

```
E0          46.0  , 7.0  , 7.0
R           1.16  , 1.16 , 1.16
RC          0.6   , 0.6  , 0.6
A           0.62  , 1.0  , 0.62
ENDDATA
TARGET      621440,621449
TYPE        2
DATA        V,WS,VSO
E0          46.96 , 8.455, 7.0
E1          -0.0172, 0.0 , 0.0
R           1.19  , 1.44 , 1.28
A           0.655 , 0.448, 0.6
ENDDATA
TARGET      621470,621479
TYPE        2
DATA        V,WS,VSO
E0          43.42 , 9.875, 7.0
E1          -0.1879, -0.0019 , 0.0
R           1.355 , 1.334, 1.355
A           0.6   , 0.45 , 0.6
ENDDATA
TARGET      621480,621489
TYPE        2
DATA        V,WS,VSO
E0          46.96 , 8.455, 7.0
E1          -0.0172, 0.0 , 0.0
R           1.19  , 1.44 , 1.28
A           0.655 , 0.448, 0.6
ENDDATA
TARGET      621490,621499
TYPE        2
DATA        V,WS,VSO
E0          43.42 , 9.875, 7.0
E1          -0.1879,-0.0019 , 0.0
R           1.355 , 1.334, 1.355
A           0.6   , 0.45 , 0.6
ENDDATA
TARGET      621500,629999
TYPE        2
DATA        V,WS,VSO
E0          46.96 , 8.455, 7.0
E1          -0.0172, 0.0 , 0.0
R           1.19  , 1.44 , 1.28
A           0.655 , 0.448, 0.6
ENDDATA
TARGET      631510,639999
TYPE        2
DATA        V,WS,VSO
E0          44.77 , 6.878, 7.0
E1          -0.0164,-0.1408, 0.0
R           1.272 , 1.44 , 1.272
A           0.475 , 0.45 , 0.48
ENDDATA
TARGET      640000,649999
TYPE        2
DATA        V,WS,VSO
E0          38.0  , 8.0  , 7.0
```

```
RC          7.439 , 7.439, 7.439
A           0.47  , 0.52 , 0.47
ENDDATA
TARGET      650000,659999
TYPE        2
DATA        V,WS,VSO
E0          40.7  , 11.3 , 7.0
E1          -0.016, 0.0  , 0.0
R           1.324 , 1.338, 1.324
A           0.47  , 0.47 , 0.47
ENDDATA
ENDSET
SET         B-G ; BECCHETTI-GREENLEES
REF         F.D. BECCHETTEI, JR. AND G.W. GREENLEES: PHES, REV., 182,
            1190 (1969)
COMMENT     THIS SET IS APPLICABLE TO A>40 AND E<50 MEV.
            WV AND WS SHOULD BE ZERO, IF CALCULATED VALUES FROM THE
            PARAMETERS BECOME LESS THAN ZERO.
TYPE        5
DATA        V    , WV  , WS    ,VSO
E0          56.3 , -1.6 , 13.0 , 6.2
E1          -0.32, 0.22 , -0.25, 0.0
SYM         -24.0, 0.0  , -12.0, 0.0
R           1.17 , 1.26 , 1.26 , 1.01
A           0.75 , 0.58 , 0.58 , 0.75
ENDDATA
ENDSET
SET         IGARASI
REF         JNDC: JAERI-M 5752(1974).
TYPE        5
TARGET      75,146 ; MASS RANGE
DATA        V    , WV  , WS    ,VSO
E0          46.0 , 0.0 , 7.0  , 7.0
E1          -0.25, 0.125 , 0.0, 0.0
E2          0.0  ,-0.0004, 0.0, 0.0
R           1.16 , 1.16, 1.16 , 1.16
RC          0.6  , 0.6 , 1.1  , 0.6
A           0.62 , 0.62, 0.35 , 0.62
ENDDATA
TARGET      147,181 ; MASS RANGE
DATA        V    , WV  , WS    ,VSO
E0          52.5 , 0.0 , 7.0  , 7.0
E1          -0.25, 0.125 , 0.0, 0.0
E2          0.0 , -0.0004, 0.0, 0.0
SYM         -40.0, 0.0   , 0.0, 0.0
R           1.16 , 1.16, 1.16 , 1.16
RC          0.6  , 0.6 , 1.3  , 0.6
A           0.62 , 0.62, 0.35 , 0.62
ENDDATA
ENDSET
ENDINC
INCIDENT    10010
SET         B-G; BECCHETTI-GREENLEES
REF         F.D. BECCHETTI, JR. AND G.W. GREENLEES: PHES, REV., 182,
            1190 (1969)
COMMENT     FITTING WAS MADE IN THE RANGE OF MASS < 40, E <50MEV.
TYPE        5
```

```
COULOMB   1.17
DATA      V    , WV  , WS   , VSO
E0        54.0 , -2.7, 11.8 , 6.2
E1        -0.32, 0.22, -0.25, 0.0
E9        0.4  , 0.0 , 0.0  , 0.0
SYM       24.0 , 1.0 , 12.0 , 0.0
R         1.17 , 1.32, 1.32 , 1.01
A         0.75 , 0.51, 0.51 , 0.75
A-SYM     0.0  , 0.7 , 0.7  , 0.0
ENDDATA
ENDSET
SET       MENET
REF       J.J.H. MENET, E.E. CROSS, J.J. MALANIFY AND A. ZUCKER: PHYS.
          REV. C4, 1114(1971).
COMMENT   PARAMETERS OBTAINED BY FITING IN THE ENERGY RANGE FROM
          30 MEV TO 60 MEV
TYPE      5
COULOMB   1.25
DATA      V    , WV   , WS   , VSO
E0        49.9 , 1.2  , 4.2  , 6.04
E1        -0.22, 0.09 , -0.05, 0.0
E9        0.4  , 0.0  , 0.0  , 0.0
SYM       26.4 , 0.0  , 15.5 , 0.0
R         1.16 , 1.37 , 1.37 , 1.064
A         0.75 , 0.74 , 0.74 , 0.78
A-E1      0.0  , -0.008, -0.008, 0.0
A-SYM     0.0  , 1.0  , 1.0  , 0.0
ENDDATA
ENDSET
SET       PEREY
REF       F.G. PEREY: PHYS. REV., 131, 745(1963)
COMMENT   OPTICAL-MODEL ANALYSIS OF PROTON ELASTIC SCATTERING IN THE
          RANGE OF 9 TO 22 MEV
TYPE      2
COULOMB   1.25
DATA      V    , WS   , VSO  , EMIN, EMAX
E0        53.3 , 13.5 , 7.5  ,  9.0 , 17.0
E0        53.3 ,  0.0 , 7.5  , 17.0 , 22.0
E1        -0.55, 0.0  , 0.0  ,  9.0 , 22.0
E9         0.4 , 0.0  , 0.0  ,  9.0 , 22.0
E10        0.0 , 0.0  , 0.0  ,  9.0 , 17.0
E10        0.0 , 3.0  , 0.0  , 17.0 , 22.0
SYM       27.0 , 0.0  , 0.0  ,  9.0 , 22.0
R         1.25 , 1.25 , 1.25 ,  9.0 , 22.0
A         0.65 , 0.47 , 0.65 ,  9.0 , 22.0
ENDDATA
ENDSET
ENDINC
ENDOMP
```