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CRECTJ: A COMPUTER PROGRAM FOR COMPILATION OF EVALUATED NUCLEAR DATA

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CRECTJ: A Computer Program for Compilation of Evaluated Nuclear Data

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In order to compile evaluated nuclear data in the ENDF format, the computer program CRECTJ has been developed. CRECTJ has two versions; CRECTJ5 treats the data in the ENDF/B-IV and ENDF/B-V format, and CRECTJ6 the data in the ENDF-6 format. These programs have been frequently used to make Japanese Evaluated Nuclear Data Library (JENDL). This report describes input data and examples of CRECTJ.

Keywords: Computer Program, CRECTJ5, CRECTJ6, ENDF Format, Evaluated Nuclear Data Library, JENDL

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CRECTJ: 評価済み核データ編集用プログラム

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評価済み核データを ENDF フォーマットで編集するために、CRECTJ を開発した。CRECTJ には、CRECTJ5 と CRECTJ6 の2つのバージョンがある。CRECTJ5 は、ENDF/B-IV フォーマットと ENDF/B-V フォーマットのデータ、CRECTJ6 は ENDF-6 フォーマットのデータを取り扱う。これらのプログラムは、日本の評価済み核データライブラリーJENDL の開発に利用されてきた。本レポートでは、CRECTJ の入力データと使用例を示す。

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1. Introduction

Japanese Evaluated Nuclear Data Library (JENDL) has been maintained at the Nuclear Data Center of Japan Atomic Energy Research Institute (JAERI) with the aid of Japanese Nuclear Data Committee (JNDC). The most recent version of JENDL is JENDL-3.2.[1] The ENDF format is adopted as the format of JENDL. In order to compile evaluated data in the ENDF format, various kinds of computer programs were developed or introduced. CRECTJ described in this report is one of those programs developed to compile the evaluated data in the ENDF format. This program was written in FORTRAN.

CRECTJ has two versions according to the format to be treated. One is CRECTJ5 to treat the data in the ENDF/B-IV[2] and ENDF/B-V[3] formats, the other is CRECTJ6 to treat the data in the ENDF-6 format.[4] This report describes both versions of CRECTJ as of Spring 1999.

In Chapter 2, input data of CRECTJ are explained. While the ENDF format itself is not explained in this report, terminology and rules of the ENDF format is frequently used. Details of the ENDF format are given in Refs. 2, 3 and 4. In Chapter 3, data handling in CRECTJ and subroutines are shortly described. Several examples of CRECTJ6 jobs are given in Chapter 4.

In Appendix 1, error messages from CRECTJ are listed. The table given in Appendix 2 is a list of MF numbers that can be read by CRECTJ. An auxiliary program DESEP is explained in Appendix 3, which is used to modify output data from CRECTJ. Sometimes there exist more than one same energy points in the CRECTJ output. When two values in the binary form are different but they are very close, it is possible that the values written in the decimal form are equal. To delete such extra energy points, DESEP was provided.

2. Input Data

Input data of CRECTJ are classified into two groups: evaluated data to be processed and control data. The evaluated data must be in the ENDF/B-IV or ENDF/B-V format for CRECTJ5 and in the ENDF/B-IV, ENDF/B-V or ENDF-6 format for CRECTJ6. The control data indicate how to read and write the evaluated data, and how to process them. The control data are called "commands" in this report.

Each command consists of a command name and additional numerical data. For example, the START command is in a form of "START n_1, n_2", where START is a command name, and n_1 and n_2 are additional numerical data. All of the commands are treated by a "free format" with the following rules:

1) Each command must be entered in columns from 1 to 72 on an input data line. It cannot be continued to the next input data line.
2) The first 3 characters are used to identify the command name. Consequently, each command can be shortened by using first three or more than three characters. In the case of START command, the following three forms are acceptable:

    STA n_1, n_2

    STAR n_1, n_2

    START n_1, n_2
3) Both of capital and small letters are acceptable as the command names.
4) The additional numerical data are strictly classified into integer-type and real-type numbers. In the following description, integer-type data start with letters i, j, k, l, m and n, and real-type ones with other characters.
5) The real-type data must be in one of the following forms. For example, the value of 123.0 should be in the form of 123.0, 1.23E+2, 1.23+2, or 1.23E2.
6) Additional numerical data are punctuated by the characters of "=", ",", ":", "(" or ")". A blank is not considered as a punctuation. Any blanks in the command are ignored.
7) In this report, MAT, MF and MT numbers are sometimes written in the parentheses. For example, the CORRECT command is written as

    CORRECT (*mat,mf,mt*)

    The parentheses are used only for convenience, and can be omitted, or can be replaced with other characters.

8) The order of integer-type data and that of real-type ones within each type are quite important. For example, the AVERAGE command needs eight additional numerical:

AVERAGE (*mat*,*mf*,*mt*),e_1,e_2,*nint*,*weight*, *igopt*

The fist integer-type data is *mat*, the second *mf*, the third *mt*, the 4th *nint*, and the 5th *igopt*. The first real-type data is e_1, the second one e_2, and the third one *weight*. Therefore the following input is also correct.

AVERAGE e_1,e_2,(*mat*,*mf*,*mt*), *weight*, *nint*, *igopt*

All available commands are listed in Table 2.1. Some commands require additional command (sub-command) and/or numerical data that are read by formatted READ statements. The sub-commands also obey the above rules. The formats of numerical data are explained in the following sections.

Almost all commands are the same for CRECTJ5 and CRECTJ6. Differences exit in the READ, HEAD, SEQ, END and COPY commands.

2.1 START Command

START n_1, n_2

n_1 and n_2	Logical unit numbers of two scratch files.

This command must be the first one in the input data. The two integers, n_1 and n_2, are logical unit numbers of scratch files, and can be zero or omitted. If they are zero or not specified, they are assumed to be 98 and 99, respectively. Intermediate data under processing are tentatively stored on the scratch files in the binary form.

One more scratch file is used in CRECTJ, of which logical unit number is 50.

2.2 File Open Commands

2.2.1 ROPEN Command

ROPEN *nt* = *file_name*

nt	Logical unit number
file_name	File name

The ROPEN command is used to open an input file in the ENDF format. “ROPEN” stands for “Read Open”. The files are opened in the READONLY mode. In the case where the input files are allocated by JCL, the ROPEN command is not needed.

Example

```
ROPEN 1 = u23501.data
ROPEN 2 = u23502.data
```

Two files are opened by these ROPEN commands. Their logical unit numbers are 1 and 2.

2.2.2 WOPEN Command

WOPEN *nt* = *file_name*

nt	Logical unit number
file_name	File name

The WOPEN command is used to open an output file. “WOPEN” stands for “Write Open”. The files are opened in the WRITE mode. When the output files are allocated by JCL, the WOPEN command is not needed.

Example

```
WOPEN 10 = u235.out
```

A file with a name of u235.out is opened by the WOPEN command. Its logical unit number is 10.

2.3 CLOSE Command

CLOSE (*nt*)

nt	Logical unit number of an input file.

When many input files are opened in a JOB, a size of the I/O buffer is increased. In order to release the I/O buffer of input files, the CLOSE command closes the input file on the logical unit number of *nt*.

Example

```
READ(11) 1225,3,1
READ(12) 2000,4
.....
CLOSE(11)
CLOSE(12)
```

After reading data from the files on the logical unit numbers of 11 and 12, these two files are closed by the CLOSE commands.

2.4 LABEL Command

LABEL(*nt*) *n*

hollerith data for a TPID record

nt	Logical unit number of an output file.
n	Tape identification number written in columns from 67 to 70 of a TPID record.
hollerith data for a TPID record	Any characters written in the columns from 1 to 66 of the TPID record.

In the case where the first hollerith record of the ENDF format (TPID record) is needed, the LABEL command should be entered. The LABEL command must be followed by a hollerith data line which will be written on an output file as the TPID record. When the LABEL command is entered, the output file on the logical unit number of *nt* is rewound, and the TPID record is written.

Example

```
START
LABLE(2) 101
  TEST OF CRECTJ6
```

A TPID record is written on the logical unit number of 2.

2.5 READ Command

2.5.1 Basic Form of READ Command

READ(*nt*) *mat,mf,mt*

nt	Logical unit number of an input file.
mat	MAT number of evaluated data to be read.
mf	MF number of evaluated data to be read.
mt	MT number of evaluated data to be read.

Evaluated data are read from the logical unit number of *nt* and are stored in the scratch files defined by the START command, in the binary form. The three additional integers, *mat*, *mf*, *mt*, specify a set of data to be read. The *mf* and/or *mt* can be zero or omitted. If *mt* is zero, all data of MAT=*mat* and MF=*mf* are read. If *mf* and *mt* are zero, all data with the MAT number of *mat* are read.

CRECTJ5 reads the data in the ENDF/B-V format by the READ command and CRECTJ6 the data in the ENDF-6 format.

In the ENDF format, the evaluated data must be stored in the increasing order of MAT, MF and MT numbers. CRECTJ, however, can treat any order of MAT, MF, and MT numbers. CRECTJ does not read the sequential numbers in the columns from 76 to 80.

For the resolved resonance parameters for the single-level Breit-Wigner or the multi-level Breit-Wigner formula, if LRX is 0, the total width is replaced with the sum of partial widths during the READ command.

For angular distributions given in the form of Legendre polynomials, CRECTJ checks the maximum order of the polynomial. Then, if the maximum order is odd, it is changed to be even by adding a term with a coefficient of 0.0.

Examples

```
READ(1) 1932
```

All data with the MAT number of 1932 are read from the input file on the logical unit number of 1.

```
READ(1) 1932,3
```

All cross section data with the MAT number of 1932 are read.

```
READ(1) 1932,3,2
```

Only the elastic scattering cross section data of the MAT number of 1932 is read.

The READ command can be repeated as many times as needed. If the data read by the READ command have the same MAT, MF and MT as another one previously stored in the scratch files, the previously stored data are replaced with new data. Therefore the replacement of evaluated data can be done by using the READ commands. If the replacement is undesirable, the MAT number of data stored in the scratch files has to be changed by the MAT command (see Section 2.10).

Example

```
READ(1) 1932
READ(2) 1932,3,102
```

All data with the MAT number of 1932 are read by the first READ command from the logical unit number of 1. Then the radiative capture cross section (MF=3, MT=102) is replaced with the data read from the logical unit number of 2.

The evaluated data can be read from the logical unit number of 5 (standard input unit). In this case, the evaluated data are additional data of the READ command and must start with a HEAD record in the ENDF format. Special care should be taken for the last record of the evaluated data, which depends on the READ command. The last input data line of the evaluated data should be a corresponding END record to the READ command as shown below:

READ command	END record	columns 67 – 75
READ(*nt*) *mat,mf,mt*	SEND record	*mat* *mf* 0
READ(*nt*) *mat,mf*	FEND record	*mat* 0 0
READ(*nt*) *mat*	MEND record	0 0 0

Example

```
READ(5) 2925,3,16
 2.90630+ 4 6.23890+ 1          0         99          0          02925 3 16
 0.00000+ 0-1.08541+ 7          0          0          1         102925 3 16
         10          2          0          0          0          02925 3 16
 1.10281+ 7 0.00000+ 0 1.20000+ 7 5.70634- 2 1.30000+ 7 3.04306- 12925 3 16
 1.40000+ 7 4.89723- 1 1.50000+ 7 6.03889- 1 1.60000+ 7 6.73900- 12925 3 16
 1.70000+ 7 7.17176- 1 1.80000+ 7 7.31964- 1 1.90000+ 7 7.34447- 12925 3 16
 2.00000+ 7 7.31558- 1                                            2925 3 16
                                                                  2925 3  0
```

In this example, MAT, MF and MT numbers are specified in the READ command. The last line of the evaluated data, therefore, must be the SEND record (2925,3,0).

2.5.2 READ Command for Data in the ENDF/B-IV Format

4READ(*nt*) *mat,mf,mt*

This command is available in both of CRECTJ5 and CRECTJ6. Function of this command is the same as that of the READ command except that the data to be read must be in the ENDF/B-IV format.

2.5.3 READ Command for Data in the ENDF/B-V Format

5READ(*nt*) *mat,mf,mt*

This command is available in CRECTJ6, and is used to read the data in the ENDF/B-V format.

2.6 OPERATE Command

The OPERATE command is available for addition, subtraction, multiplication and division among data of MF=3 and MF=4.

2.6.1 Basic Form of OPERATE Command for MF=3

1) Addition

OPERATE (mat_0, 3, mt_0)=(mat_1, 3, mt_1)+(mat_2, 3, mt_2)

2) Subtraction

OPERATE (mat_0, 3, mt_0)=(mat_1, 3, mt_1)–(mat_2, 3, mt_2)

3) Multiplication

OPERATE (mat_0, 3, mt_0)=(mat_1, 3, mt_1)*(mat_2, 3, mt_2)

4) Division

OPERATE (mat_0, 3, mt_0)=(mat_1, 3, mt_1)/(mat_2, 3, mt_2)

mat_0, mat_1 and mat_2 MAT numbers,

mt_0, mt_1 and mt_2 MT numbers.

By these commands, arithmetic operations between two cross section sets of (mat_1,3,mt_1) and (mat_2,3,mt_2) are carried out, and the results are stored in the scratch files with MAT, MF and MT numbers of (mat_0,3,mt_0). If data with the same MAT, MF and MT numbers as (mat_0,3,mt_0) exist already, they are replaced with the results of the OPERATE commands.

Results of the OPERATE commands contain all energy points of two cross section data sets. Furthermore, suitable energy points are automatically added so that the cross section curve of (mat_0,3,mt_0) might reproduce a correct one within accuracy of 1.0 %.

The calculation is performed in the whole energy range covering the both data sets of (mat_1,3,mt_1) and (mat_2,3,mt_2). If their energy ranges are not the same, cross sections at the outside of their energy ranges are assumed to be zero.

For the division, if a denominator of (mat_2,3,mt_2) is zero, the quotient is 10^{36}.

ZA and AWR of (mat_0,3,mt_0) are the same as those of (mat_1,3,mt_1). The interpolation scheme of (mat_0,3,mt_0) is assumed also to be equivalent to that of (mat_1,3,mt_1). After the operation, there are cases where the results are negative or zero and the interpolation scheme is logarithmic. In such cases, the results must be corrected manually.

The Q value of (mat_0,3,mt_0) is determined from those of (mat_1,3,mt_1) and (mat_2,3,mt_2). The (mat_0,3,mt_0) has the lower threshold energy of (mat_1,3,mt_1) and (mat_2,3,mt_2). Thus the Q value of (mat_0,3,mt_0) is the bigger one of them. In the case where (mat_0,3,mt_0) is the total or elastic scattering cross section (mt_0=1 or 2), the Q value of zero is selected automatically.

In CRECTJ5, the flag of LFS (final state) is automatically determined from the MT numbers when the END command is performed.

Example

```
READ(1) 1932
OPERATE (1932,3,1)=(1932,3,2)+(1932,3,4)
OPERATE (1932,3,1)=(1932,3,1)+(1932,3,16)
OPERATE (1932,3,1)=(1932,3,1)+(1932,3,102)
```

By these OPERATE commands, the total cross section is calculated as a sum of the elastic scattering, inelastic scattering, (n,2n) and radiative capture cross sections. If the total cross section already exists, it is replaced with the result of these OPERATE commands.

The OPERATE command can be also used to calculate special quantities such as ratios of cross sections. In such cases, any MT numbers can be tentatively adopted for the results.

Example

```
READ(1) 9235,3,18
READ(2) 9238,3,18
OPERATE (9238,3,999)=(9238,3,18)/(9235,3,18)
```

The ^{235}U and ^{238}U fission cross sections are read from input files on the logical unit numbers of 1 and 2, respectively. Ratios of the ^{238}U to ^{235}U fission cross sections are calculated and named (9238,3,999) by the OPERATE command.

The name of OPERATE command can be omitted as follows.

$(mat_0,3,mt_0)=(mat_1,3,mt_1)+(mat_2,3,mt_2)$

$(mat_0,3,mt_0)=(mat_1,3,mt_1)-(mat_2,3,mt_2)$

$(mat_0,3,mt_0)=(mat_1,3,mt_1)/(mat_2,3,mt_2)$

$(mat_0,3,mt_0)=(mat_1,3,mt_1)*(mat_2,3,mt_2)$

Example

```
(9238,3,18)=(9238,3,18)/(9235,3,18)
```

This example is the same as the following OPERATE command.

```
OPERATE (9238,3,18)=(9238,3,18)/(9235,3,18)
```

2.6.2 OPERATE Command in Partial Energy Interval

An energy interval where the operation is performed can be specified as follows;

$(mat_0,3,mt_0)=(mat_1,3,mt_1)+(mat_2,3,mt_2)$, e_1, e_2

$(mat_0,3,mt_0)=(mat_1,3,mt_1)-(mat_2,3,mt_2)$, e_1, e_2

$(mat_0,3,mt_0)=(mat_1,3,mt_1)/(mat_2,3,mt_2)$, e_1, e_2

$(mat_0,3,mt_0)=(mat_1,3,mt_1)*(mat_2,3,mt_2)$, e_1, e_2

e_1 and e_2 — Minimum and maximum energies (eV) of the energy interval.

The data of $(mat_0,3,mt_0)$ in the energy interval from e_1 to e_2 eV are the results of the operation, and is the same as (mat_1,3,mt_1) in the energy ranges below e_1 eV and above e_2 eV.

If the value of e_1 is less than 0.0, the operation is performed only in the energy range of (mat_1,3,mt_1).

Example

```
(9225,3,999)=(9225,3,3)+(9225,3,18), 1.0+4,2.0+7
```

2.6.3 OPERATE Command with Factors

The second cross section set of the OPERATE commands, (mat_2,3,mt_2), can be replaced with a real-type number.

(mat_0,3,mt_0)=(mat_1,3,mt_1)+(*fact*), e_1, e_2

(mat_0,3,mt_0)=(mat_1,3,mt_1)–(*fact*), e_1, e_2

(mat_0,3,mt_0)=(mat_1,3,mt_1)*(*fact*), e_1, e_2

(mat_0,3,mt_0)=(mat_1,3,mt_1)/(*fact*), e_1, e_2

fact A real-type number (factor).

Cross sections calculated with nuclear models sometimes need renormalization to experimental data. The renormalization can be carried out by using this kind of the OPERATE command.

Example

```
READ(1) 1937,3
(1937,3,16)=(1937,3,16)*(1.5)
(1937,3,2)=(1937,3,1)-(1937,3,4)
(1937,3,2)=(1937,3,2)-(1937,3,16)
(1937,3,2)=(1937,3,2)-(1937,3,102)
```

In this example, the (n,2n) reaction cross section is renormalized by the factor of 1.5. To keep consistency among cross sections, the elastic scattering cross section is recalculated by subtracting other partial cross sections from the total cross section.

2.6.4 OPERATE Command for A Range of MT Numbers

In the OPERATE commands, the MT numbers of first and second cross section sets, mt_0 and mt_1, can be replaced with pairs of MT numbers specifying a range of MT numbers.

$(mat_0,3,mt_{01}:mt_{02})=(mat_1,3,mt_{11}:mt_{12})+(mat_2,3,mt_2)$, e_1, e_2

$(mat_0,3,mt_{01}:mt_{02})=(mat_1,3,mt_{11}:mt_{12})-(mat_2,3,mt_2)$, e_1, e_2

$(mat_0,3,mt_{01}:mt_{02})=(mat_1,3,mt_{11}:mt_{12})*(mat_2,3,mt_2)$, e_1, e_2

$(mat_0,3,mt_{01}:mt_{02})=(mat_1,3,mt_{11}:mt_{12})/(mat_2,3,mt_2)$, e_1, e_2

or

$(mat_0,3,mt_{01}:mt_{02})=(mat_1,3,mt_{11}:mt_{12})+(fact)$, e_1, e_2

$(mat_0,3,mt_{01}:mt_{02})=(mat_1,3,mt_{11}:mt_{12})-(fact)$, e_1, e_2

$(mat_0,3,mt_{01}:mt_{02})=(mat_1,3,mt_{11}:mt_{12})*(fact)$, e_1, e_2

$(mat_0,3,mt_{01}:mt_{02})=(mat_1,3,mt_{11}:mt_{12})/(fact)$, e_1, e_2

The pairs of MT numbers must be separated by the character of ":", and satisfy the following relations.

$mt_{01} = mt_{11}$, and $mt_{02} = mt_{12}$.

This kind of OPERATE commands are useful in the case where cross section data in a range of MT numbers are operated with the same data or the same factor. If mat_0 is the same as mat_1, all data from $(mat_0,3,mt_{01})$ to $(mat_0,3,mt_{02})$ are replaced with results of the OPERATE command.

Example

```
READ(1) 1932,3
(1932,3,51:91)=(1932,3,51:91)/(1932,3,4), -1.0
```

By this OPERATE command, all partial inelastic scattering cross sections are replaced with ratios of partial inelastic to total inelastic scattering cross sections.

2.6.5 OPERATE Command for MF=4

1) Addition

OPERATE $(mat_0, 4, mt_0)=(mat_1, 4, mt_1)+(mat_2, 4, mt_2)$

2) Subtraction

OPERATE (mat_0, 4, mt_0)=(mat_1, 4, mt_1)−(mat_2, 4, mt_2)

Above two OPERATE commands are available for the angular distributions. To perform these OPERATE commands, the cross section data corresponding to mt_1 and mt_2 are also needed in order to tentatively calculate the absolute distributions.

Example

```
READ (1) 1000
READ (2) 2000
(1000,4,51)=(1000,4,51)+(2000,4,51)
(1000,4,52)=(1000,4,52)+(2000,4,52)
(1000,3,51)=(1000,3,51)+(2000,3,51)
(1000,3,52)=(1000,3,52)+(2000,3,52)
MAKE (1000,3,4)
DELETE 2000
```

Assume that the data file allocated to the logical unit number of 1 contains the compound inelastic scattering cross sections and angular distributions with the MAT number of 1000, and another file on the logical unit number of 2 the direct inelastic scattering data for the lowest two levels with the MAT number of 2000. Two OPERATE commands for MF=4 make the sum of contributions of compound and direct processes. Then, the sum of cross sections is calculated with the next two OPERATE commands. It should be noted that if the OPERATE commands for MF=3 are entered before those for MF=4, the results of MF=4 are not correct. After the operation, the MAKE command (see Section 2.12) is entered for modifying the total inelastic scattering cross section.

2.7 SUM Command

SUM (mat_0,3,mt_0)=(mat_1,3,mt_{11}:mt_{12})

The cross section data with MT numbers from mt_{11} to mt_{12} are summed up, and the results are named (mat_0,3,mt_0). The two MAT numbers, mat_0 and mat_1, must be the same. The name of command can be omitted.

(mat_0,3,mt_0)=(mat_1,3,mt_{11}:mt_{12})

Example

```
READ(1) 1937
(1937,3,4)=(1937,3,51:91)
```

The total inelastic scattering cross section is calculated from the partial cross sections. This example is completely the same as the MAKE (1937,3,4) command.

2.8 DELETE Command

DELETE (*mat*,*mf*,*mt*)

or

DELETE (mat,mf,mt_1:mt_2)

mat	MAT number of data to be deleted.
mf	MF number of data to be deleted.
mt	MT number of data to be deleted.
mt_1:mt_2	A range of MT numbers of data to be deleted.

The data of (*mat*,*mf*,*mt*) or those in the rage of (mat,mf,mt_1:mt_2) are deleted from the scratch files. The *mt* (mt_1:mt_2) or both of *mf* and *mt* (mt_1:mt_2) can be zero or omitted. If *mt* (mt_1:mt_2) is zero or omitted, all data with MAT=*mat* and MF=*mf* are deleted. If *mf* and *mt* are zero or omitted, all data with MAT=*mat* are deleted.

Example

```
READ(1) 9235,3,18
READ(2) 9238,3,18
OPERATE (9238,3,18)=(9238,3,18)/(9235,3,18)
DELETE 9235,3,18
```

In this example, the data (9235,3,18) is deleted after calculation of ratio data. Then only the data of (9238,3,18) exist in the scratch disks.

2.9 PUT Command

PUT (mat_0,mf_0,mt_0)=(mat_1,mf_1,mt_1)

mat_0,mf_0,mt_0	MAT, MF and MT numbers of a new data set.
mat_1,mf_1,mt_1	MAT, MF and MT numbers of an existing data set.

A new data set of (mat_0,mf_0,mt_0) is created from an already existing one of (mat_1,mf_1,mt_1). The contents of the new data set are completely the same as the old data set. The PUT command can be used for any MF numbers, provided that the MF number mf_1 is the same as mf_0.

After the PUT command, the data of (mat_1,mf_1,mt_1) are still kept in the scratch files. If they are no longer needed, they can be deleted by the DELETE command. If the name of new data set (mat_0,mf_0,mt_0) is the same as an existing data set, the existing data are replaced with the new ones.

The name of PUT command can be omitted.

(mat_0,mf_0,mt_0)=(mat_1,mf_1,mt_1)

Example

```
(1000,3,999)=(9235,3,18)
```

A data set of (1000,3,999) which is the same as (9235,3,18) is created.

2.10 MAT Command

MAT mat_0=mat_1

mat_0	New MAT number.
mat_1	Current MAT number.

A MAT number of data stored in the scratch files is changed from mat_1 to mat_0. If the current MAT number mat_1 is not specified, MAT numbers of all the data in the scratch files are changed to the new MAT number mat_0. This command is useful in the case where two or more than two sets of data having the same MAT number are treated at a time as shown in the following example.

Example

```
READ(1) 9235,3,18
MAT 1000
READ(2) 9235,3,18
(1000,3,999)=(1000,3,18)-(9235,3,18)
DELETE 9235,3,18
DELETE 1000,3,18
```

Differences between two cross section sets which have the same MAT, MF and MT numbers are calculated, and the result is named (1000, 3, 999). If the second READ command immediately follows the first one, the data read by the first READ command are replaced, because they have the same MAT, MF and MT numbers. By using the MAT command, the first data set is renamed (1000, 3, 18). Then two cross section sets can exist after the second READ command.

2.11 CORRECT Command

CORRECT (*mat*, *mf*, *mt*)

mat	MAT number of data to be corrected.
mf	MF number of data to be corrected.
mt	MT number of data to be corrected.

This command only declares the name of data to be corrected. To specify how to correct the data, one or two additional sub-commands must follow the CORRECT command.

2.11.1 REPLACE Sub-command

CORRECT (*mat*,3,*mt*)
REPLACE e_1,e_2,(mat_1,3,mt_1)
CONTROL *nt*

e_1 and e_2	Lower and upper boundaries of the energy interval where the replacement will be done (eV).
(mat_1,3,mt_1)	MAT, MF and MT numbers of new cross section data.
nt	Logical unit number of an input file which contains the data of (mat_1,3,mt_1). If *nt* is 0, the data of (mat_1,3,mt_1) are assumed to be already in process, i.e. existing on the scratch files.

This sub-command can be used only for MF=3. Cross section data of (*mat*,3,*mt*) in the energy interval from e_1 to e_2 eV are replaced with another cross section data of (mat_1,3,mt_1) which exist in an input file on the logical unit number of *nt*.

If the MAT, MF and MT numbers of new cross section data (mat_1,3,mt_1) are the same as

(mat,3,mt), this command does not work. In such cases, the MAT number of the data to be corrected must be changed tentatively by using the MAT command.

The cross section data set (mat_1,3,mt_1) has to include the data in the energy interval from e_1 to e_2 eV. At each boundary of the energy interval, interpolated values of the two cross section sets, (mat,3,mt) and (mat_1,3,mt_1), are compared with each other. If the two values at the boundary are completely the same and the interpolation schemes are also the same, only one data point is stored. Otherwise, two data points are stored at the energy boundary.

Example

```
READ(1) 1937
CORRECT 1937,3,2
REPLACE 1.0-5,100.0,(2000,3,2)
CONTROL 2
CORRECT 1937,3,102
REPLACE 1.0-5,100.0,(2000,3,102)
CONTROL 2
(1937,3,1)=(1937,3,2)+(1937,3,4)
(1937,3,1)=(1937,3,1)+(1937,3,16)
(1937,3,1)=(1937.3,1)+(1937,3,102)
```

This is an example of replacement of cross sections in the resonance region with background data. First, the data with MAT=1937 are read from the input file on the logical unit number of 1. Suppose this data set contains resonance parameters for the resonance region from 10^{-5} to 100.0 eV, and also cross section data. For the final evaluated data file, therefore, the cross section data in the resonance region have to be replaced with background data which are on the other input file on the logical unit number of 2 and have the MAT number of 2000. The elastic scattering and radiative capture cross sections are replaced by the CORRECT command with the background data, respectively. Finally, the total cross section is calculated as a sum of the partial cross sections.

When the data of (mat_1,3,mt_1) are already stored in the scratch files, the logical unit number of the input data on the CONTROL sub-command should be zero.

Example

```
READ(1) 1937
READ(2) 2000,3
CORRECT 1937,3,2
REPLACE 1.0-5,100.0,(2000,3,2)
```

```
CONTROL 0
CORRECT 1937,3,102
REPLACE 1.0-5,100.0,(2000,3,102)
CONTROL 0
(1937,3,1)=(1937,3,2)+(1937,3,4)
(1937,3,1)=(1937,3,1)+(1937,3,16)
(1937,3,1)=(1937.3,1)+(1937,3,102)
DELETE 2000
```

This example is completely the same as the one mentioned above.

The cross section data of (mat_1,3,mt_1) can be entered as additional data. In this case, the sub-commands should be as follows.

CORRECT (*mat*,3,*mt*)

REPLACE e_1,e_2

CONTROL 5,*nr*,*np*

cross section data in the ENDF format

nr	The number of energy intervals of the cross section data where different interpolation schemes are applied.
np	The number of energy points of the cross section data.
cross section data in the ENDF format	The cross section data to be entered.

The cross section data to be entered have to immediately follow the CONTROL sub-command by starting with an interpolation record of TAB1 as shown in the following example. The *np* energy vs. cross section pairs must be given in the format of (6E11.4). The maximum number of pairs is 2500. The MAT, MF and MT numbers in the columns from 67 to 75 and an SEND record are not needed. The cross section data to be entered can include data outside the energy range from e_1 to e_2 eV.

Example

```
CORRECT  1937,3,2
REPLACE  1.0-5,100.0
CONTROL  5,1,4
          4          2
 1.00000- 5 0.00000+ 0 2.53000- 2 0.00000+ 0 1.00000+ 0 0.00000+ 0
 1.00000+ 4 0.00000+ 0
CORRECT  1937,3,102
REPLACE 1.0-5, 100.0
CONTROL  5,1,3
```

```
       3         5
1.00000- 5 6.53889+ 2 2.53000- 2 1.30000+ 0 1.00000+ 2 2.06778- 2
```

The elastic scattering and radiative capture cross sections in the energy range from 10^{-5} to 100 eV are replaced with 0.0 and the 1/v type background cross section, respectively.

2.11.2 DELETE Sub-command

CORRECT (*mat*,3,*mt*)

DELETE e_1,e_2

e_1 and e_2 — Lower and upper boundaries of an energy interval (eV).

The cross section data in the energy range from e_1 to e_2 eV are deleted.

Example

```
READ(1)  1937,3
CORRECT  1937,3,1
DELETE  1.0-5,100.0
```

Another type of the DELETE command is available to delete a part of cross section data by specifying energy points.

CORRECT (*mat*,3,*mt*)

DELETE *np*

a list of energy values to be deleted

np — The number of energy points to be deleted.

a list of energy values to be deleted — Energies (eV) of data points to be deleted.

A list of *np* energy points is given in the format of (3(E11.4,11X)). The energies have to be in the increasing order.

Example

```
READ(1)  1937,3
CORRECT  1937,3,2
DELETE  4
 1.50000+ 1           2.54360+ 1           3.55555+ 1
```

```
5.67200+ 3
```

2.11.3 INSERT Sub-command

(1) Data from the standard input

CORRECT (*mat*, 3, *mt*)
INSERT *np*
a list of data to be inserted

np — The number of data points to be inserted.

a list of data to be inserted — Energies (eV) and cross sections (barns) to be inserted.

The *np* data points are inserted into the cross section data of (*mat*,3,*mt*). The data to be inserted immediately follow the INSERT sub-command in the format of (6E11.4), and in the increasing order of energies. This insertion command is valid even if the new data are outside the energy range of (*mat*, 3, *mt*). If a new data point is given at the same energy as that of (*mat*, 3, *mt*), insertion of the new data point is ignored. The number of energy points *np* must be less than 2500.

Example

```
CORRECT  (1937,3,2 )
INSERT  5
  0.0253     12.5      10.0       13.6       100.0        24.7
  1000.0      4.0      1500.0     15.8
```

(2) Data from a file

CORRECT (*mat*, 3, *mf*)
INSERT (mat_1,3,mt_1), e_1, e_2
CONTROL *nt*

(mat_1,3,mt_1) — MAT, MF, and MT numbers of new cross section data.

e_1, e_2 — The minimum and maximum energies (eV) of the energy range where the data of (mat_1,3,mt_1) are inserted.

nt — Logical unit number of a file storing the data of (mat_1,3,mt_1).

The number of data points of (mat_1,3,mt_1) should be less than 2500. If the MAT, MF and MT numbers of (mat_1,3,mt_1) are the same as (mat,3,mt), this command does not work.

Example

```
CORRECT  (9228,3,2)
INSERT  (1000,3,2),1.0+5,10.0+6
CONTROL   2
```

2.11.4 TMATRIX Sub-command

CORRECT (*mat*, 4, 2)

TMATRIX *n*

n	An option to create or delete the transformation matrix. ≥ 0; to create, < 0; to delete the matrix. This option works only in CRECTJ6.

A pair of these commands creates or deletes the transformation matrix of Legendre coefficients for the angular distributions of elastically scattered neutrons. The calculation of the matrix is made with the same method as the program MATRIX.[5)] The calculation is performed only in the case where the angular distributions are given in the center-of-mass system and in the form of Legendre polynomial. The option *n* is available only in CRECTJ6. The TMATRIX sub-command in CRECTJ5 is always used for creating the matrix.

2.12 MAKE Command

Some kinds of data can be created from others. For example, the total inelastic scattering cross section is a sum of all partial inelastic scattering cross sections. If the cross section data of partial inelastic scattering are given, the total inelastic scattering cross section can be calculated. For this purpose, the MAKE command is available.

2.12.1 MF=2

MAKE (mat,2,151), e_1, e_2, sp, r

e_1	Lower boundary of the resonance region (eV)
e_2	Upper boundary of the resonance region (eV)

sp	Spin of the nuclide
r	Radius (10^{-12} cm) of the nuclide. If zero, *r* is calculated as $0.123A^{1/3}+0.08$, where A is a mass number of the nuclide.

The data section of MF=2 and MT=151 (resonance parameters) is created by this command without any resonance parameters.

2.12.2 Total Inelastic Scattering Cross Section

MAKE (*mat*,3,4)

The total inelastic scattering cross section is calculated as a sum of partial inelastic scattering cross sections (MT=51 to 91) which have the MAT number of *mat*. This command is the same as the following set of OPERATE commands.

(*mat*,3,4)=(*mat*,3,51)+(*mat*,3,52)
(*mat*,3,4)=(*mat*,3,4)+(*mat*,3,53)
- - - - - - - - - - - - - - - -
(*mat*,3,4)=(*mat*,3,4)+(*mat*,3,91)

This MAKE command is also the same as the following SUM command.

(*mat*,3,4)=(*mat*,3,51:91)

2.12.3 Total Fission Cross Section

MAKE (*mat*,3,18)

The total fission cross section is calculated as a sum of partial fission cross sections. This command is the same as the following set of OPERATE commands.

(*mat*,3,18)=(*mat*,3,19)+(*mat*,3,20)

(*mat*,3,18)=(*mat*,3,18)+(*mat*,3,21)

(*mat*,3,18)=(*mat*,3,18)+(*mat*,3,38)

2.12.4 Absorption Cross Section

MAKE (*mat*,3,27)

The absorption cross section is calculated as a sum of the fission and neutron disappearance cross sections. If these two cross sections already exist on the scratch disks, this is the same as the following OPERATE command.

(*mat*,3,27)=(*mat*,3,18)+(*mat*,3,101)

If the fission cross section (MT=18) and/or the neutron disappearance cross section (MT=101) are not yet stored in the scratch files, the MAKE commands for them are automatically performed, and the results of the fission and neutron disappearance cross sections are also kept in the scratch files.

2.12.5 Neutron Disappearance Cross Section

MAKE (*mat*,3,101)

The sum of cross sections for MT numbers from 102 to 119 is calculated. This is the same as the following SUM command.

(*mat*,3,101)=(*mat*,3,102:119)

2.12.6 Average Cosine of Elastically Scattered Neutrons

MAKE (*mat*,3,251)

By this command, the average cosine of scattering angles of elastically scattered neutrons, $\overline{\mu_L}$, is calculated from the angular distributions (MF=4, MT=2), as follows;

$$\overline{\mu_L} = \int_{-1}^{1} \frac{d\sigma_{el}}{d\Omega_L} \mu_L d\mu_L \bigg/ \int_{-1}^{1} \frac{d\sigma_{el}}{d\Omega_L} d\mu_L , \tag{2.1}$$

or

$$\overline{\mu_L} = \int_{-1}^{1} \frac{d\sigma_{el}}{d\Omega_{CM}} \frac{(M\mu_{CM}+1)}{\sqrt{M^2+2M\mu_{CM}+1}} d\mu_{CM} \bigg/ \int_{-1}^{1} \frac{d\sigma_{el}}{d\Omega_{CM}} d\mu_{CM} , \tag{2.2}$$

where M is the mass of the target nuclide in the neutron mass unit, and suffixes L and CM stand for the laboratory and center-of-mass systems, respectively. If the data of (*mat*,3,251) already exist, they are replaced with the results of this command.

Example

```
READ(1) 2600,4,2
MAKE (2600,3,251)
```

2.12.7 Isotropic Angular Distributions

MAKE (*mat*,4,*mt*)

Isotropic angular distribution data are generated by this command. CRECTJ5 adopts Legendre polynomial representation (LTT=1) for the MT numbers of 2 and from 51 to 90, and a tabulated form (LTT=2) for the other MT numbers. The incident neutron energy range is determined from corresponding cross section data in MF=3. Hence the corresponding cross section data must exist in the scratch files. CRECTJ6 adopts the special format (LTT=0) for the isotropic distributions for all MT's.

The flag LCT of 2 (center-of-mass system) is selected for MT's of 2 and from 51 to 90, and LCT of 1 (laboratory system) for other reactions.

If *mt* of this MAKE command is not specified, the isotropic distribution data are made for all reactions which emit neutrons and whose cross section data exist in the scratch files. In the case where the angular distributions already exist for (*mat*,4,*mt*), the isotropic distributions are not generated.

Example

```
READ(1) 1937,3
READ(1) 1937,4,2
MAKE 1937,4
```

The isotropic angular distributions of neutrons except for elastically scattered neutrons are generated.

2.13 NORMALIZE Command

NORMALIZE (*mat,mf,mt*), *p*, e_1, e_2

(*mat,mf,mt*)	A data set to be normalized. The MF numbers must be 4 (angular distributions) or 5 (energy distributions).
p	Normalization value. If p=0.0, p is assumed to be 1.0.
e_1 and e_2	Incident neutron energy range (eV) where the normalization is performed. If e_1 and e_2 are zero, the data in the whole energy range are normalized.

In the case where the angular distributions of secondary neutrons are given in a tabulated form, the distributions must be normalized to unity, i.e.

$$\frac{d\sigma(E)}{d\Omega} = \frac{1}{2\pi}\sigma(E)\times p(\mu,E) \qquad (2.3)$$

$$\int_{-1}^{1} p(\mu,E)d\mu = 1.0 \qquad (2.4)$$

where $p(\mu,E)$ is the normalized probability distributions given in MF=4, and $\sigma(E)$ is the cross section data in MF=3. When the distributions are taken from theoretical calculations or experimental data, and given in the unit of barns/steradian, mb/steradian or arbitrary unit, they must be normalized by this command to unity.

The NORMALIZE command normalizes also the energy distributions (MF=5) given in the tabular form (LF=1).

Example

```
READ(1) 1937,4,2
NORMALIZE (1937,4,2)
```

The angular distributions of elastically scattered neutrons are normalized to unity in the whole incident neutron energy range.

2.14 NATURAL Command

NATURAL *n, (mat,mf,mt), za, awr*

n	Number of isotopes (less than 20).
mat,mf,mt	MAT, MF and MT numbers of natural element data.
za	Atomic number (Z)×1000 + mass number (A) of the natural element. A is usually zero.
awr	Average mass of the natural element in the neutron-mass unit.

Data of a natural element can be constructed by this command. The data of following MF numbers can be treated,

MF = 2	resonance parameters
MF = 3	neutron cross sections
MF = 4	angular distributions except for MT's = 51 – 90.
MF = 5	energy distributions

Among the MAT, MF and MT numbers in the command, *mt* or both of *mf* and *mt* can be omitted or 0. If *mt* is not given or 0, data for all MT numbers are constructed. If *mf* and *mt* are not specified or zero, all data are created.

The NATURAL command is followed by *n* ISOTOPE sub-commands to specify isotopic abundance. The number of ISOTOPE sub-commands, *n*, given in the NATURAL command must be less than or equal to 20. The ISOTOPE sub-command is in the following form:

ISOTOPE mat_i=f_i

mat_i	MAT number of the *i*-th isotope.
f_i	Abundance of the *i*-th isotope.

The sum of f_i should be 1.0. The ISOTOPE sub-commands should be given in the increasing order of isotope mass numbers.

MF=2 (resonance parameters)

The resonance parameters of isotopes are gathered to one set for a natural element. The order of isotopes in the natural element data is equivalent to the order of ISOTOPE sub-commands. If no MF=2 data exist, a set of MF=2 section for the isotope is created by assuming the scattering radius as

$$R = 1.23 \times A^{1/3} + 0.8 \text{ (fm)}, \tag{2.5}$$

where A is a mass number of the isotope.

MF=3 (neutron cross sections)

The data of MF=3 which can be treated by the NATURAL command are classified into three types,

Type 1	cross sections except Type=2 data,
Type 2	inelastic scattering cross sections to discrete levels (MT=51 to 90).
Type 3	$\overline{\mu_L}$ (MT=251).

It should be noted that the data for MT=252 (the average logarithmic energy decrement for elastic scattering), MT=253 (the average of square of the logarithmic energy decrement), and some large MT numbers cannot be processed properly. They are treated as the data of Type 1 although they are assigned to special quantities or to the cross sections of discrete levels.

a) Type 1

The cross sections of Type 1 are simply calculated as

$$\sigma(E) = \sum_{i=1}^{n} \sigma_i(E) \times f_i \,, \tag{2.6}$$

where n is the number of isotopes, $\sigma_i(E)$ and f_i stand for cross section values and abundance of the i-th isotope. This calculation is made with the same way as the OPERATE commands.

b) Type 2

First, the inelastic scattering cross section to each level is multiplied by its isotope abundance f_i. Then all data are sorted by Q values, and their MT numbers are redefined as 51 for the lowest level, 52 for the second one, and so on, up to 90 for the 40th level. In the case where the number of levels exceeds 40, the cross sections above the 40th level are summed up to the continuum level cross section (MT=91). The originally given continuum level cross sections are treated as Type 1 cross sections.

c) Type 3

The $\overline{\mu_L}$ of the natural element is

$$\overline{\mu_L} = \sum_{i=1}^{n} (\overline{\mu_L})_i (\sigma_{el})_i f_i \Big/ \sum_{i=1}^{n} (\sigma_{el})_i f_i \, , \tag{2.7}$$

where $(\sigma_{el})_i$ and f_i are the elastic scattering cross section and abundance of the i-th isotope. Therefore in order to construct the $\overline{\mu_L}$ of the natural element, the elastic scattering cross section of each isotope also has to be in the scratch files.

MF=4 (angular distributions)

The present version of CRECTJ5 and CRECTJ6 treats the angular distributions other than MT's from 51 to 90. The isotope data must be in the same representation each other: in the Legendre polynomials (LTT=1) or the table type (LTT=2), and in the center-of-mass system (LCT=1) or the laboratory system (LCT=2). For the calculation, corresponding cross section data are needed. If they are not given or zero, the results are not correct.

In the case of Legendre polynomials, the coefficient of the l-th term a_l is calculated as follows;

$$a_l = \sum_{i=1}^{n} (a_l)_i (\sigma_{el})_i f_i \Big/ \sum_{i=1}^{n} (\sigma_{el})_i f_i \, . \tag{2.8}$$

This calculation is performed at all neutron energies where the data of each isotope are given. In CRECTJ5, after construction of Legendre polynomial coefficients, the transformation matrix is automatically calculated for MT=2.

In the case of the table type, all the angular distributions are reproduced at the 21 angles defined in the code. Then the same calculation as Eq. (2.8) is performed by replacing a_l with the angular distribution at each angle.

<u>**MF=5 (energy distributions)**</u>

The energy distributions of *mt* for each isotope are arranged in the order of ISOTOPE sub-commands, and the table of fractional part p_k of each distribution is modified. Corresponding cross section data are needed in order to calculate the fractional part.

Example

```
READ(1) 4707
READ(1) 4709
NATURAL 2,(4700,0,0),47000.0,106.951
ISOTOPE 4707=0.5135
ISOTOPE 4709=0.4865
DELETE 4707
DELETE 4709
```

This is an example of construction of natural silver data. In this case, there are two isotopes ^{107}Ag and ^{109}Ag of which abundance is 0.5135 and 0.4865, respectively. After the NATURAL command, DELETE commands are needed to delete the data for isotopes.

2.15 AVERAGE Command

AVERAGE *(mat,mf,mt)*, e_1, e_2, *nint, weight, igopt*
energy boundaries

mat,mf,mt	MAT, MF and MT numbers of data to be averaged.
e_1, e_2	Minimum and maximum boundaries of the energy range where the data are averaged (eV).
nint	Option for energy intervals.
weight	Option for a weighting function.
igopt	Option for the lowest and highest boundaries.
energy boundaries	Energy boundaries (eV) in the format of (6E11.4).

By this command, the data of *(mat,mf,mt)* in the energy range from e_1 to e_2 are replaced with averaged cross sections. The current version of CRECTJ can treat MF=3 and MF=63 that is specially defined for the JENDL PKA/KERMA file.[6] When the value of *mt* is zero, all cross section data are replaced with average values.

The energy intervals are determined by *nint* as follows.

nint= −1	JAERI-FAST 70 group structure[7](see Table 2.2).
nint= −2	100 energy intervals[8] (see Table 2.3).
nint= −3	Energy intervals recommended at 1977 Geel meeting[9] (see Table 2.4).
nint= −4	JAERI-FAST (version 3) 70 group structure[10] (see Table 2.5).
nint= −5	SAND-II 620 group structure[11, 12] (see Table 2.6). This structure is used in dosimetry files.
nint= 0	The energy intervals previously used are applied again. When the intervals are defined by the MESH command, *nint*=0 must be selected.
nint > 0	The energy intervals are given in the input data following the AVERAGE command. The *nint* energy boundaries in eV must be given just after the AVERAGE command, in the format of (6E11.4) and in the increasing order. The number of energy boundaries *nint* should be less than 2000.

An average cross section in the *n*-th energy interval (between E_n and E_{n+1}) is calculated as

$$\overline{\sigma_n} = \int_{E_n}^{E_{n+1}} \sigma(E)S(E)dE \bigg/ \int_{E_n}^{E_{n+1}} S(E)dE, \tag{2.9}$$

where a weighting function, *S*(E), is assumed to be in the following form if *weight* is less than 10.0.

$$S(E) = E^{weight}, \tag{2.10}$$

where E is the incident neutron energy. If *weight* is greater than 10.0, the weighting function must be defined by the SPECTRUM command in advance.

The option of *igopt* controls the lowest and highest energy boundaries of the AVERAGE command. If *igopt* is 0 or not specified, the boundaries are the same as those of the energy intervals. For example, in the case of the following AVERAGE command,

AVERAGE (1200,3,0), 1.0, 450.0+3, −4, −1.0, 0 the averaging is performed in the energy range from 0.87642 eV to 497.87 keV (see Table 2.5). If *igopt* is greater than 0, the calculation is performed in the energy range from e_1 to e_2. For example, by the AVERAGE command of

AVERAGE(1200,3,0), 1.0, 450.0+3, −4, −1.0, 1,

the data in the energy range from 1 eV to 450 keV are averaged. If *weight* is greater than 10.0, only the *igopt* of 0 is permitted.

In the ENDF format, energy-dependent quantities $f(E)$ are represented by a table of energy vs. quantities and five kinds of interpolation schemes. Integration of $f(E)$ can be written as follows;

$$\int_{E_n}^{E_{n+1}} f(E)dE = \sum_i \int_{E_i}^{E_{i+1}} f(E)dE, \tag{2.11}$$

where E_i and E_{i+1} are successive two energies in the table of $f(E)$. Depending on interpolation schemes, the integration of $I = \int_{E_i}^{E_{i+1}} f(E)dE$ is calculated as follows, by using the subroutine ECSI taken from the ENDF/B processing programs.[12)]

1) Interpolation scheme = 1 ($f(E)$ is constant in E)

$$I = f(E_i)(E_{i+1} - E_i). \tag{2.12}$$

2) Interpolation scheme = 2 ($f(E)$ is linear in E)

$$\begin{aligned} a &\equiv f(E_i) - b \times E_i, \\ b &\equiv \frac{f(E_{i+1}) - f(E_i)}{E_{i+1} - E_i}, \\ I &= (E_{i+1} - E_i)[a + 0.5b(E_{i+1} + E_i)] \end{aligned} \tag{2.13}$$

3) Interpolation scheme = 3 ($f(E)$ is linear in ln(E))

$$
\begin{aligned}
&a \equiv (E_{i+1} - E_i),\\
&b \equiv \frac{f(E_{i+1}) - f(E_i)}{\ln(E_{i+1}/E_i)},\\
&I(a \le 0.15) = (E_{i+1} - E_i)f(E_i)\\
&\qquad\qquad + 0.5b \times E_i a^2 \left[1 + a\{-0.3333333 + a(0.16666667 - 0.1a)\}\right],\\
&I(a > 0.15) = (E_{i+1} - E_i)f(E_i) + b \times E_i\left[1 - \frac{E_{i+1}}{E_i}\left\{\ln\frac{E_{i+1}}{E_i} - 1\right\}\right].
\end{aligned}
\tag{2.14}
$$

4) Interpolation scheme = 4 (ln *f*(E) is linear in E)

$$
\begin{aligned}
&a \equiv \ln[f(E_i)] - b \times E_i,\\
&b \equiv \frac{\ln[f(E_{i+1})/f(E_i)]}{E_{i+1} - E_i},\\
&z \equiv (E_{i+1} - E_i) \times b,\\
&I(z \le 0.1) = \exp(a + b \times E_i)(E_{i+1} - E_i)[1 + z(0.5 + 0.16666667z)],\\
&I(z > 0.1) = \frac{1}{b}\exp(a + b \times E_i)[\exp(z) - 1.0].
\end{aligned}
\tag{2.15}
$$

5) Interpolation scheme = 5 (ln(*f*(*E*)) is linear in ln(*E*))

$$
\begin{aligned}
&a \equiv (b+1)\ln(E_{i+1}/E_i),\\
&b \equiv \frac{\ln[f(E_{i+1})/f(E_i)]}{\ln[E_{i+1}/E_i]},\\
&I(a \le 0.1) = f(E_i)E_i \ln\left(\frac{E_{i+1}}{E_i}\right) \times [1 + a(0.5 + 0.16666667a)],\\
&I(a > 0.1) = \frac{1}{b+1} f(E_i)E_i\left[(E_{i+1}/E_i)^{b+1} - 1\right]
\end{aligned}
\tag{2.16}
$$

When the *weight* is not 0.0 or *S*(E) is given by the SPECTRUM command, before integration, the energy-dependent product of σ(E) and *S*(E) is calculated with the accuracy of 0.1 %, then the above integration method is applied by replacing *f*(E) with the product.

By the AVERAGE command, the cross sections in the energy range from e_1 to e_2 eV are replaced with averaged values and their interpolation schemes are changed to constant (interpolation scheme = 1). In the cases of threshold reaction cross sections, their threshold energies are changed to a lower boundary of an energy interval that the threshold energy belongs to.

Examples

```
READ(1) 1937,3
AVERAGE (1937,3,0),1.0-5,100.0,-1,0.0
```

All cross sections are averaged in the neutron energy region from 10^{-5} to 100 eV by applying the JAERI-FAST 70 group structure. The weighting function is constant.

```
READ(1) 1937,3
AVERAGE (1937,3,1),1.0-5,100.0,8,-1.0
  1.00000- 5 1.00000- 4 1.00000- 3 1.00000- 2 1.00000- 1 1.00000+ 0
  1.00000+ 1 1.00000+ 2
```

The total cross section is averaged with a 1/E type weighting function, and eight energy boundaries are given by input data.

2.16 SPECTRUM Command

SPECTRUM (*nt*) (*mat,mf,mt*)

nt	Logical unit number of the file for the weighting function.
mat,mf,mt	MAT, MF and MT numbers of the weighting function.

The weighting function for the AVERAGE command is defined by this command. The weighting function must be in the format of MF=3. If *nt* is zero, the data of (*mat,mf,mt*) are assumed to be already in the scratch files. If no additional numerical data are specified on this command, the weighting function has to follow the SPECTRUM command:

SPECTRUM

Weighting function in TAB1 format

In this case, neither the SEND record nor MAT, MF and MT numbers in the columns from 67 to 75 are needed.

The maximum number of energy points of the weighting function is limited to 3000. The weighting function defined by the SPECTRUM command is not erased even if the END command (see Section 2.20) is entered. Therefore the same weighting function can be used for more than one material. When another SPECTRUM command is entered, the weighting function is replaced with new one.

Examples

```
SPECTRUM (3) 1000,3,1
READ(1) 1934,3
AVERAGE 1934,3,0,1.0-5,20.0+6,-4,20.0
END(2) 1934
READ(1) 1935,3
AVERAGE 1935,3,0,1.0-5,20.0+6,-4,20.0
END(2) 1935
```

The weighting function of (1000,3,1) is read by the SPECTRUM command. The cross section data of MAT = 1934 are averaged in the energy range from 10^{-5} eV to 20 MeV. In this example, the same weighting function is applied for the second material.

```
SPECTRUM
 0.0     + 0 0.0     + 0           0           0           1         128
           128           5
 1.00000- 5 9.71227- 8 1.00000- 3 9.71227- 9 2.53000- 2 1.93090- 9
 6.82572- 1 3.71746-10 1.63398+ 0 2.23042- 9 3.45907+ 0 3.34615- 9
 7.33822+ 0 4.06049- 9 1.55349+ 1 2.59695- 8 2.90232+ 1 1.51789- 7
 4.22287+ 1 1.99897- 7 5.42223+ 1 4.94928- 7 7.88928+ 1 1.03914- 6
 1.30073+ 2 1.72998- 6 1.89255+ 2 4.17043- 6 2.43004+ 2 5.38048- 6
 3.53572+ 2 7.84040- 6 5.82948+ 2 1.22743- 5 8.48185+ 2 1.58357- 5
 1.08909+ 3 1.75640- 5 1.39841+ 3 1.83231- 5 1.79560+ 3 1.69832- 5
 2.13902+ 3 1.20969- 5 2.36399+ 3 6.42503- 6 2.54810+ 3 3.44644- 6
 2.67871+ 3 1.92224- 6 2.88734+ 3 1.14233- 6 3.19101+ 3 2.45818- 6
 3.52659+ 3 4.86910- 6 3.99615+ 3 6.63437- 6 4.88092+ 3 7.63854- 6
 6.26722+ 3 7.78113- 6 8.04730+ 3 6.87758- 6 1.03331+ 4 7.64473- 6
 1.32677+ 4 7.42691- 6 1.70362+ 4 6.38354- 6 2.05499+ 4 6.92966- 6
 2.27110+ 4 6.43165- 6 2.41759+ 4 6.55614- 6 2.54151+ 4 8.84296- 6

   (Omitted)

 3.08818+ 6 1.92505- 8 3.41300+ 6 1.23852- 8 4.06570+ 6 7.92361- 9
 4.96585+ 6 4.70663- 9 5.76949+ 6 2.67835- 9 6.37628+ 6 1.88079- 9
 7.40818+ 6 9.24233-10 9.04837+ 6 3.12925-10 1.10517+ 7 8.26907-11
 1.45501+ 7 1.02798-11 2.00000+ 7 1.00000-20
READ(1) 1934,3
AVERAGE 1934,3,0,1.0-5,20.0+6,-4,20.0
```

The weighting function is given as additional data to the SPECTRUM command.

2.17 MESH Command

MESH *nr*, e_1, e_2

nr	Number of the LOG and LIN sub-commands.
e_1, e_2	Lower and upper boundaries (eV) of an energy range where the energy meshes are created.

This command creates energy meshes for the AVERAGE command. In order to specify the way of energy division, *nr* LOG and/or LIN sub-commands must follow the MESH command.

LIN e_{MAX}, *ng*

or

LOG e_{MAX}, *ng*

e_{MAX}	Upper boundary (eV).
ng	Number of intervals.

By this sub-command, the energy range from E_0 to e_{MAX} is divided into *ng* intervals. Each interval has the same width in the linear or logarithmic scale corresponding to the LIN or LOG sub-command. E_0 is equal to e_1 for the first LIN or LOG sub-command. For the next LIN or LOG sub-command, E_0 is equal to e_{MAX} of the previous sub-command.

To use the energy mesh define by the MESH command, *nint* of the AVERAGE command must be 0.

Example

```
MESH 2, 1.0-5,2.0+7
LOG  1.0+6, 50
LIN  20.0+6,19
AVERAGE (9228,3,0),1.0-5,2.0+7,0,0.0
```

The energy range from 10^{-5} eV to 20 MeV is divided into 69 intervals. Below 1 MeV the intervals are of the same energy width in the logarithmic scale, and above 1 MeV each interval has the width of 1 MeV.

2.18 MOD Command

MOD = *nmod*

or

MOD (*mat*,*mf*,mt_1:mt_2) = *mod*

nmod	Modification number
mod	Modification indicator
mat,*mf*,mt_1:mt_2	MAT, MF and MT numbers of data whose modification indicator is set to *mod*. mt_1 and mt_2 specify a range of MT numbers:

These commands set a modification number and modification indicators to be given in MF=1 and MT=451. In the code, they are initially set to zero. The modification number is replaced with that of the first data of MF=1 and MT=451. The modification indicators are replaced whenever the directory part is read in. If those numbers should be changed, the MOD command is used in the manner as shown in the following examples. When *mat*, *mf* or mt_1:mt_2 is zero, it means a whole range of MAT, MF or MT numbers.

Examples

```
MOD = 2
```

By this MOD command, the modification number of the material is set to be 2.

```
MOD (1000,3,1)=1
MOD (1000,3,51:90)=2
MOD (1000,4,0)=2
```

The first MOD command sets the modification indicator of the total cross section of MAT=1000 to 1, and the second one those of the discrete inelastic scattering cross sections (MT=50–90) to 2. The modification indicators of whole angular distributions are set to 2 by the third MOD command.

2.19 Auxiliary Commands for Output

2.19.1 ZA Command

ZA = *za*, *awr*

za	Atomic number (Z)×1000 + mass number (A).

awr Mass of a material in the neutron mass unit.

This command specifies ZA and AWR of each HEAD record. When the ZA command is not entered, the values of ZA and AWR of the data read by the first READ command are used for the output.

2.19.2 HEAD Command

HEAD $n = f_1, f_2, I_1, I_2, I_3, I_4$

n Record number of headings in MF=1, MT=451.

$f_1, f_2, I_1, I_2, I_3, I_4$

Values to be used in the heading record.

This command is available only in CRECTJ6. The heading part of MF=1 and MT=451 is as follows in the ENDF-6 format.

record #						
1	ZA,	AWR,	LRP,	LFI,	NLIB,	NMOD
2	ELIS,	STA,	LIS,	LISO,	0,	NFOR
3	AWI,	EMAX,	0,	0,	NSUB,	NVER
4	TEMP,	0.0,	LDRV,	0,	NWD,	NXC

LRP indicating whether resolved and/or unresolved resonance parameters are given.

LFI indication whether fissionable or not.

NLIB library identifier.

NMOD modification number.

ELIS excitation energy (eV) of the target nuclide.

STA target stability flag.

LIS state number of the target nuclide.

LISO isomer state number.

NFOR library format.

AWI mass of the projectaile in the neutron mass unit.

EMAX the maximum energy of the file.

NSUB	sub-library number.
NVER	library version number.
TEMP	target temperature (Kelvin).
LDRV	derived material flag.
NWD	number of comment records.
NXC	number of records in the directory part.

Among them, ZA, AWR, NLIB, ELIS, STA, LIS, LISO, AWI, EMAX, NSUB, NEVER, TEMP, and LDRV can be set by the HEAD command. For ZA and AWR, the values set by the ZA command have higher priority. AWI and NSUB are initially set to 1.0 and 10 (incident-neutron data). LRP, LFI, NWD and NXC are automatically set by CRECTJ. NMOD is set by the MOD command. NFOR is always 6.

Example

```
HEAD 2 = 45.0+3, 1.0, 3, 1
HEAD 4 = 300.0
```

ELIS, STA, LIS, LISO and TEMP are defined by these two HEAD commands.

2.19.3 Number of Digits for Neutron Energies

Three formats are available for neutron energies of cross section data (MF=3). They are called as the six-, seven- and nine-digit formats. For example, the energy of 123.456789 eV is written as "1.23457+ 2" in the six-digit format, "1.234568+2" in the seven-digit format, and "123.456789" in the nine-digit format. Usually real-type data are written in the six-digit format. However some computer programs adopt the seven- or nine-digit format, especially for energies of cross sections calculated from resonance parameters. If the usual six-digit format is used for such data, the cross section curves are deformed because of rounding error of energy values. In order to avoid this problem, the output format should be the same as or more accurate than the input data to CRECTJ. One of the following commands selects the output format.

SIX

SEVEN mt_1, mt_2, ..., mt_n

NINE mt_1, mt_2, ..., mt_n

mt_1, mt_2, ..., mt_n MT numbers of cross section data whose energies are to be written in the specified format.

If *mt* is less than zero, it is assumed to be an upper boundary of an MT range. At the maximum, ten pairs of MT numbers can be specified. If no *mt*'s are specified, the MT numbers are assumed to be 1, 2, 3, 18, 19, 101 and 102 that are those of cross sections with resonance structures.

Usually, the SEVEN or NINE command is used to specify the format. Once the format is specified, it is valid until the next SEVEN or NINE command. The SIX command is used to reset the format to the standard six digit one.

If MT=151 is included in these command, the resonance energies given in MF=2, MT=151 are written in the specified format.

Example

```
NINE 1,-3,18,19,102
```

The data of MT=1 to 3, 18, 19 and 102 are written in the nine digit format. Other cross sections are in the six-digit format.

2.19.4 FMIN Command

FMIN= *n*

n The minimum order of real-type data.

Real-type data of which absolute values are smaller than $10^{-|n|}$ are set to zero. This command affects all the real-type data in the ENDF format. This command is valid until the next FMIN command. If *n* is 0, the function of this command is terminated.

Example

```
FMIN=-15
```

Such real-type data as 1.2E−20 and −2.3E−16 are written as 0.0.

2.19.5 SEQ Command

SEQ= *n*

n Option for sequential numbers (NSQ) in the columns from 76 to 80.

=0: normally increasing by 1 up to an MEND record.

=1: At each MEND record, NSQ is set to 99999, and restarted from 1.

=2: At each FEND record, NSQ is set to 99999, and restarted from 1. At the MEND records, NSQ is set to 0.

=3: At each SEND record, NSQ is set to 99999, and restarted from 1. At the FEND and MEND records, NSQ is set to 0.

This command is available only in CRECTJ6. If SEQ=0 or not specified, and the sequential number exceeds 99999, NSQ is fixed to 99999.

Example

`SEQ = 3`

The sequential number is set to 99999 at each SEND, FEND, and MEND record. The following is an example of output with this option .

```
 2.00000+ 7 7.57310- 1                                            9228 3 21   11
                                                                  9228 3  099999
 9.22350+ 4 2.33025+ 2          0          0          0          09228 3 37    1
-1.78856+ 7-1.78856+ 7          0          0          1          69228 3 37    2
          6          2          0          0          0          09228 3 37    3
 1.79624+ 7 0.00000+ 0 1.80000+ 7 1.04999- 8 1.85000+ 7 3.37163- 59228 3 37    4
 1.90000+ 7 1.28435- 4 1.95000+ 7 1.03831- 3 2.00000+ 7 2.88930- 39228 3 37    5
                                                                  9228 3  099999
 9.22350+ 4 2.33025+ 2          0          0          0          09228 3 38    1
 1.93720+ 8 1.93720+ 8          0          0          1        139228 3 38    2
         13          2          0          0          0          09228 3 38    3
 1.40000+ 7 0.00000+ 0 1.45000+ 7 5.00000- 4 1.50000+ 7 1.60000- 39228 3 38    4
 1.55000+ 7 3.75000- 3 1.60000+ 7 7.13000- 3 1.65000+ 7 1.18500- 29228 3 38    5
 1.70000+ 7 1.78900- 2 1.75000+ 7 2.58062- 2 1.80000+ 7 3.62600- 29228 3 38    6
 1.85000+ 7 5.24014- 2 1.90000+ 7 6.85200- 2 1.95000+ 7 1.06759- 19228 3 38    7
 2.00000+ 7 1.44510- 1                                            9228 3 38    8
                                                                  9228 3  099999
 9.22350+ 4 2.33025+ 2          0          0          0          09228 3 51    1
 0.00000+ 0-7.68000+ 1          0          0          1       2529228 3 51    2
        252          2          0          0          0          09228 3 51    3
```

2.20 END Command

END(*nt*) *mat*

nt	Logical unit number of an output file.
mat	MAT number for the output data.

This is the command to output all the data in the scratch files to the output file on the logical unit number of *nt*. The MAT number of the data is set to *mat*. The output is made in the ENDF/B-V format by CRECTJ5 and in the ENDF-6 format by CRECTJ6. In order to make an output in the ENDF/B-IV format, the 4END command is available in CRECTJ5.

4END(*nt*) *mat*

In CRECTJ6, if the MAT number of *mat* is zero or not specified, it is automatically determined according to the rule of ENDF-6 format.

The data are always written from MF=1 and MT=451. Even if there are no data for this section, it is created in order to output a directory table.

In CRECTJ5, LFS flags of cross section data (MF=3) are automatically determined from their MT numbers.

After output, all the data on the scratch disks are erased.

Example

By using the READ command and the END command, simple compilation can be performed when evaluated data are stored in several input files. We assume that the files allocated to the following logical unit numbers contain the evaluated data to be compiled:

Logical unit number	Contents
1	cross section data with MAT=1932
2	resonance parameters with MAT=2000
3	comment data with MAT=1932
4	angular distributions of secondary neutrons with MAT=2100

```
READ(1) 1932,3
READ(2) 2000,2,151
READ(3) 1932,1,451
READ(4) 2100,4
END(10) 1932
```

By these four READ commands, the evaluated data and comments are read into the scratch files. Then, by the END command, they are written on the output file

2.21 COPY Command

COPY(nt_1,nt_2) mat_{MIN}, mat_{MAX}

nt_1	Logical unit number of an input file.
nt_2	Logical unit number of an output file.
mat_{MIN}	Minimum MAT number of data to be copied.
mat_{MAX}	Maximum MAT number of data to be copied.

The data in the ENDF/B-V format [CRECTJ5] or in the ENDF-6 format [CRECTJ6] are copied from the input file of nt_1 to the output file of nt_2. The MAT numbers of mat_{MIN} and mat_{MAX} specify the MAT-number range of data to be copied. If mat_{MAX} is not given, it is assumed to be equal to mat_{MIN}. This command is the same as the following set of input data.

READ(nt_1) mat_1

END(nt_2) mat_1

READ(nt_1) mat_2

END(nt_2) mat_2

READ(nt_1) mat_3

END(nt_2) mat_3

- - - - - - - - -

READ(nt_1) mat_n

END(nt_2) mat_n

where $mat_1 = mat_{MIN}$ and $mat_n = mat_{MAX}$.

The COPY command reads the data into the scratch files, then writes them on the output file.

In CRECTJ5, the following commands are also available so as to change the data format.

54COPY(nt_1, nt_2) mat_{MIN}, mat_{MAX}

45COPY(nt_1, nt_2) mat_{MIN}, mat_{MAX}

4COPY(nt_1, nt_2) mat_{MIN}, mat_{MAX}

The 4COPY command corresponds to a pair of the 4READ and 4END commands. The function of these commands is the same as the COPY command except for that format conversion is performed.

In CRECTJ6, the following commands are available.

46COPY(nt_1, nt_2) mat_{MIN}, mat_{MAX}

56COPY(nt_1, nt_2) mat_{MIN}, mat_{MAX}

It should be noted, however, that the format conversion is done only for some parts of data. For the format conversion, the use of other codes is recommended.

2.22 DCOPY Command

DCOPY(nt_1, nt_2) mat_{MIN}, mat_{MAX}

nt_1	Logical unit number of an input file.
nt_2	Logical unit number of an output file.
mat_{MIN}	Minimum MAT number of data to be copied.
mat_{MAX}	Maximum MAT number of data to be copied.

The data are copied from the input file of nt_1 to the output file of nt_2. The MAT numbers of mat_{MIN} and mat_{MAX} specify the MAT-number range of data to be copied. If mat_{MAX} is not given, it is assumed to be equal to mat_{MIN}. By the DCOPY command, the data are copied without any changes.

Example

```
DCOPY(1,2) 1225,4243
```

2.23 FINISH Command

FINISH(*nt*)

nt	Logical unit number of an output file.

The TEND record is written on the output file of *nt*. Then the output file is rewound.

Example

```
END(10) 2600
FIN(10)
```

2.24 LIST Command

LIST(*nt*) *mat,mf,mt*

nt	Logical unit number of an input file.
mat,mf,mt	MAT,MF and MT numbers of data to be listed.

The data on the logical unit number of *nt* are listed on a line printer (logical unit number of 6). In order to take a list of the results of CRECTJ, this command should be entered after the FINISH command. If one or some of *mat*, *mf* and *mt* is zero, it means 'all';

LIST(*nt*) *mat,mf*

All data of which MAT number is *mat* and MF number is *mf* are listed.

LIST(*nt*) *mat*

All data of which MAT number is *mat* are listed.

LIST(*nt*)

All data on the logical unit number of *nt* are listed.

LIST(*nt*) 0,*mf*,0

All data of which MF number is *mf* are listed.

LIST(*nt*) 0,0,*mt*

All data of which MT number is *mt* are listed.

Example

```
READ(1) 9235,3,18
READ(2) 9238,3,18
```

```
(9238,3,18)=(9238,3,18)/(9235,3,18)
DELETE 9235,3,18
END(3) 9238
FIN(3)
LIST(3)
```

The ratio values of two cross sections of (9238,3,18) and (9235,3,18) are calculated and written on 3. Then, a list of the result made by the LIST command.

2.25 Comment Lines in Input Data

An input data line with an asterisk in the first column is assumed to be a comment line. The comment lines cannot be entered among data lines read by formatted READ statements.

Example

```
START
********************
*   READ DATA FROM INPUT FILE
********************
READ (1) 9238
********************
*   CONSTRUCTION OF THE TOTAL INELASTIC SCATTERING
MAKE 9238,3,4
*   OUTPUT THE RESULTS
END(2) 9238
FIN(2)
LIST(2) 9238,3,4
```

2.26 STOP Command

STOP

This command terminates the CRECTJ job. This command can be omitted if no input data lines exist any more.

Example

```
END(2) 9238
FIN(2)
STOP
```

3. Data Handling and Subroutines in CRECTJ

3.1 Data Handling

In the ENDF format, a smallest group of the data, i.e. a data section, is named with the MAT, MF and MT numbers. As described in Chapter 2, these numbers are used in CRECTJ in order to identify a group of data. The MF numbers that can be read by CRECTJ are listed in Appendix 2.

All records of the ENDF format are classified into the following eleven types.

TPID record	A tape identification record at the beginning of a data file.
HEAD record	The first record of each data section. The format is the same as the CONT record.
CONT record	A record for controlling data that follow the CONT record.
TAB1 record	One-dimensional tabulated data.
TAB2 record	A record for controlling two-dimensional tabulated data.
LIST record	A record to store a series of real-type data such as parameters or coefficients of polynomials.
HOLL record	Hollerith record (comments) in MF=1 and MT=451.
SEND record	The last record of each MT.
FEND record	The last record of each MF.
MEND record	The last record of each MAT.
TEND record	The last record of each data file.

In CRECTJ, data are tentatively stored together with their record name to identify the format of record. As the record name, "CONT", "TAB1", "TAB2" and "LIST" are used. For example, cross section data are represented with a pair of HEAD and TAB1 records. A set of cross section data is stored as follows in a working memory.

"CONT", C1, C2, L1, L2, N1, N2,
"TAB1", C1, C2, L1, L2, N1, N2,
(INTP(I),INTL(I),I=1,N1),
(E(I),σ(I),I=1,N2),
"END"

where "END" indicates the end of the section. The working memory has a size of 5000 words. If the length of the data exceeds the limit of 5000, the data are dumped into a scratch file in the binary form, and the next data are read in the working memory. When the whole data of each data section have been read, all data in the working memory are written on the scratch file. Thus CRECTJ has no limitation for the size of data to be treated. This process is continued until all data sets specified by the READ command have been read. When the READ command terminates, then the scratch file is rewound.

For the purpose of retrieval of stored data, CRECTJ has index arrays for MAT, MF and MT numbers, positions of the first record of each data section (*mat,mf,mt*) on the scratch files, and the number of records. The size of this array is 800, which is the maximum number of data sets treated with CRECTJ at a time.

When CRECTJ has to store new data on a scratch file, another scratch file is used to store them and finally all the data in the scratch file used previously are copied to the new one. Logical unit numbers of these two scratch files are specified by the START command. And for some cases, the scratch file on the logical unit number of 50 is also used to store tentative results.

3.2 Subroutines in CRECTJ

Function of subroutines is shortly explained here.

ADD	performs addition of two floating numbers.
ANGDS	makes a table of angular distributions from the Legendre polynomial.
AVERG	performs the AVERAGE command for MF=3 and MF=63.
BLOCKD	(block data)
CARDSC	counts the number of records of each (*mat,mf,mt*). This subroutine is used to make a directory table in MF=1, MT=451.
CFLO	changes characters to a real-type data.
CHOL	changes characters in separate words to characters in a word.
CINT	changes characters to an integer.
CLEB	calculates Clebsch-Gordan coefficients. This function was taken from the program MATRIX.[5]
CONF2	constructs resonance parameters (MF=2) of a natural element from its isotope data.
CONF3	constructs cross section data (MF=3) of a natural element from its isotope data.

CONF4	constructs angular distributions (MF=4) of a natural element from its isotope data.
CONF5	constructs energy distributions (MF=5) of a natural element from its isotope data.
CONT	writes a CONT record.
CONTR	reads a CONT record.
CONV45	changes the format of fission yields and decay data from ENDF/B-IV to ENDF/B-V by calling CONV5A and CONV5B. [CRECTJ5 only]
CONV54	not completed. [CRECTJ5 only]
CONV5A	changes the format of fission yields. [CRECTJ5 only]
CONV5B	changes the format of decay data. [CRECTJ5 only]
COPY	performs the DCOPY command.
COPYDT	copies data from a scratch file to another record by record.
COPYF	performs the COPY command.
COPYWD	copies data from a scratch file to another word by word.
CPDATA	performs the END command.
DATAB	retrieves one word from a scratch file.
DATART	reads one record from a scratch file by using READT.
DIV	performs division of two real-type numbers.
ECSI	calculates an integral between adjacent two points. (taken from an ENDF/B processing program[13])
EMESH	performs the MESH command.
FEND	writes the SEND, FEND, MEND and TEND records to an output file.
FFIX	rounds a real-type number to given accuracy.
FINDSP	gets a spectrum value at a given energy.
FLOATC	converts a real-type number x to a real-type number f ($1.0 \leq f < 10.0$ or 0.0), S (sign of exponential part) and N (exponent), i.e. $f \times 10^{S \cdot N}$.
GRMTRX	reads parameters for the general R-matrix (not yet completed)
HOLL	writes a HOLL record.
HOLLR	reads a HOLL record.
HSET	skips data in an input file up to the HEAD record of a data set specified by the READ command.
HTEST	sets quantities to be given in heading records of MF=1, MT=451.
INPUT	reads input data from the logical unit number of 5.
INTCHK	checks and modifies an interpolation table after the CORRECT command for cross sections.

INTRG1 performs integration of tabulated data by using ECSI.

INTER makes an interpolation between two data points.

INTER2 makes an interpolation in the two dimensional tabulated data.

LIST writes a LIST record.

LISTR reads a LIST record.

MAKED performs the MAKE command.

MAKED1 performs the SUM command.

MAKED2 performs an operation of cross section data by using OPRT31.

MAKED3 performs the MAKE(*mat*,3,251) command.

MAKED4 performs the MAKE(*mat*,4,*mt*) command.

MAKED5 performs the MAKE(*mat*,2,151) command.

MATNUM determines a MAT number to be output in the case where the END command does not specify it. [CRECTJ6 only]

MATRIX calculates the transformation matrix for the angular distributions of elastically scattered neutrons (MF=4, MT=2).

MESHI makes a fine mesh table of $\sigma(E)\times S(E)$ for integration, where $\sigma(E)$ is the cross section and S(E) the spectrum at E.

MESHP makes a fine mesh table of operation of $(mat_1,3,mt_1)$ and $(mat_2,3,mt_2)$.

MODTAB controls modification indicators given in a directory part of MF=1, MT=451.

MUL performs multiplication of two real-type numbers.

NATUR performs the NATURAL command.

NORM performs the NORMALIZE command by using NORM4 and/or NORM5.

NORM4 performs normalization of angular distributions (MF=4).

NORM5 performs normalization of energy distributions (MF=5).

OPRT performs operations of tabulated data.

OPRT31 performs the OPERATE command for cross sections by using OPRT.

OPRT32 performs the CORRECT command for cross sections (MF=3).

OPRT4 performs the OPERATE command for angular distributions (MF=4).

OPRT42 performs the CORRECT command for angular distributions (MF=4).

OPRTF performs the OPERATE command between (*mat*,3,*mt*) and a real-type number.

PAGE writes a heading line of each page to the logical unit number of 6.

PCH41 performs the TMATRIX sub-command.

PCHCK2 performs the DELETE and INSERT sub-commands of the CORRECT command.

PCHECK performs the REPLACE and DELETE sub-commands of the CRRECT command.

READD	performs the READ command. The subroutines that read the ENDF data are called from this subroutine. The MF numbers which can be treated by CRECTJ are 1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16, 23, 24, 25, 27, 31, 32, 33, 35, 40, 63 and 66. The MF's of 63 and 66 are special ones for the JENDL PKA/KERMA file.[6] The data of each MF number are read with a corresponding subroutine. For example, MF=1 by READF1, and MF=33 by READ33.
READSP	reads spectrum data specified by the SPECTRUM command.
READT	reads one record from a scratch file.
REDUCE	reduces a size of data table so as to reproduce the curve in a given uncertainty. This subroutine is used to reduce the size of a probability table of MF=5.
RESETP	resets a probability table of MF=5.
SKIP	skips records of an input data file up to the end of (MAT,MF,MT).
SKIPDT	skips data records of a scratch file.
SORTIX	sorts the index table before outputting the data in a scratch file in the increasing order of MF and MT numbers.
SPECAV	calculates average values of a given spectrum.
STOCAP	changes small letters in input data to capital ones.
STORE	stores data in a working memory into a scratch file.
SUB	performs the subtraction of two real-type numbers.
TAB1	outputs a TAB1 record.
TAB1R	reads a TAB1 record.
TAB2	outputs a TAB2 record.
TAB2R	reads a TAB2 record.
THSET	makes angular distributions at new angles to reproduce given angular distributions. This is called from CONF4.

4. Examples

4.1 Preparation for Execution

CRECTJ5 and CRECTJ6 should be compiled by adopting the double precision option since a single word of 32 bits is too short to reproduce real-type numbers with accuracy of 7 or 9 digits. In CRECTJ6, the working area is declared as

```
COMMON /BLOCK1/ DATA(5000,3),ND1,ND2
CHARACTER*8     CDATA(5000,3)
EQUIVALENCE     (DATA(1,1),CDATA(1,))
```

CDATA is used to handle the characters of record names and "END" stored in the working area. If the option of compilation with REAL*8 for all real-type variables is not available in the FORTRAN compiler, "CHARACTER*8" should be changed to "CHARACTER*4".

In the JAERI computer GS8400 of which OS is MSP, the load modules are currently stored in the following file:

J2608.LOADE.LOAD(CRECTJ5)

J2608.LOADE.LOAD(CRECTJ6)

Command procedures are provided in the file of J2608.PROCLIB.CNTL, which contains the following.

```
//CRECTJ6 PROC SYSOUT='*',S=100,S2=100
//*****************************************************************
//*  CRECTJ6
//*****************************************************************
//CRECTJ6 EXEC PGM=CRECTJ6,COND=(4,LT)
//STEPLIB  DD DSN=J2608.LOADE.LOAD,DISP=SHR
//SYSPRINT DD SYSOUT=&SYSOUT
//FT05F001 DD DDNAME=SYSIN
//FT06F001 DD SYSOUT=&SYSOUT
//FT99F001 DD DSN=&&FT99,UNIT=VIO,SPACE=(TRK,(&S,&S2)),
//          DCB=(DSORG=PS,LRECL=19064,BLKSIZE=19068,RECFM=VBS)
//FT98F001 DD DSN=&&FT98,UNIT=VIO,SPACE=(TRK,(&S,&S2)),
//          DCB=(DSORG=PS,LRECL=19064,BLKSIZE=19068,RECFM=VBS)
//FT50F001 DD DSN=&&FT50,UNIT=VIO,SPACE=(TRK,(&S,&S2)),
//          DCB=(DSORG=PS,LRECL=19064,BLKSIZE=19068,RECFM=VBS)
```

By using this command procedure file, the JCL (Job Control Language) of CRECTJ6 is written as:

```
//JOBPROC DD DSN=J2608.PROCLIB.CNTL,DISP=SHR
// EXEC CRECTJ6
```

```
// EXPAND .... (input files)
// EXPAND .... (output files)
//SYSIN DD *
```

input data

```
/*
```

In the case of CRECTJ5, it is needed to change **CRECTJ6** to **CRECTJ5**.

For UNIX machines, input and output files are defined by the ROPEN and WOPEN commands. Scratch files are automatically opened by OPEN statements. If input data to be read from the logical unit number of 5 are stored in input_f, the following command is used to execute CRECTJ6 or CRECTJ5.

```
crectj6 < input_f > output_f
```

or

```
crectj5 < input_f > output_f
```

4.2 Example 1 : Compiling an Evaluated Data File

We assume that cross section data and angular distributions have been calculated for the total, elastic, inelastic and capture with CASTHY,[14] resolved and unresolved resonance parameters are given in a separate file, and cross sections and energy distributions are calculated with PEGASUS[15] and stored in the third file. The fourth file contains the contributions from the direct and semi-direct capture. In order to make a complete evaluated data file, they must be gathered, and some modifications are needed.

1) Input files

Logical unit	Contents
1	The total, elastic, inelastic scattering and radiative capture cross sections, and the angular distributions of neutrons are stored with the MAT number of 5635. They are calculated with CASTHY and converted to ENDF/B-IV format with CTOB2.[16]
2	The resolved and unresolved resonance parameters with the MAT number of 5635. The resonance region is from 10^{-5} eV to 100 keV.
3	The data for threshold reactions calculated with PEGASUS are

stored with the MAT number of 5636.

10 The capture cross section of the direct and semi-direct process.

2) Input data

```
START
LABEL(4)
  BA135
4READ(1) 5635
DEL 5635,1,451
DEL 5635,2
READ(2) 5635,2,151
MAT 1000
READ(3) 5635
DEL 5635,3,2
DEL 5635,3,91
DEL 5635,3,102
DEL 5635,3,999
(5635,3,16)=(5635,3,16)*(0.8912)
(5635,3,103)=(5635,3,103)*(0.6001)
(5635,3,107)=(5635,3,107)*(0.7470)
MAT 1000
READ(10) 5635,3,102
(1000,3,102)=(1000,3,102)+(5635,3,102)
DEL 5635
MAT 5635=1000
CORRECT 5635,3,103
INSERT 1
 1.00000+ 5 0.0
CORRECT 5635,3,107
INSERT 1
 1.00000+ 5 0.0
MAKE 5635,3,4
MAKE 5635,3,101
SUM (5635,3,5)=(5635,3,4:50)
(5635,3,3)=(5635,3,5)+(5635,3,101)
(5635,3,2)=(5635,3,1)-(5635,3,3)
CORRECT 5635,3,2
REPLACE 1.0-5,1.0+5
CONT 5,1,3
          3          2
 1.00000- 5 0.00000+ 0 2.53000- 2 0.00000+ 0 1.00000+ 9 0.0
CORRECT 5635,3,102
REPLACE 1.0-5,1.0+5
CONT 5,1,3
          3          2
 1.00000- 5 0.00000+ 0 2.53000- 2 0.00000+ 0 1.00000+ 9 0.0
MAKE 5635,3,101
(5635,3,1)=(5635,3,2)+(5635,3,5)
```

```
45  (5635,3,1)=(5635,3,1)+(5635,3,101)
46  DEL 5635,3,3
47  DEL 5635,3,5
48  DEL 5635,3,101
49  DEL 5635,3,999
50  MAKE  5635,4
51  CORRECT 5635,3,251
52  INSERT 1
53   1.00000- 5 4.98453- 3
54  MOD=2
55  MOD(0,0,0)=1
56  MOD(0,2,0)=2
57  END(4) 5604
58  FIN(4)
59  STOP
```

Line numbers are given at the left side for the sake of explanation. The results of CASTHY calculation on the logical unit number of 1 are read by the 4READ command at #4. The MF=1 and MT=451 (a comment part) and MF=2 (resonance parameters) are not needed. Thus they are deleted by the DELETE commands on #5 and #6. The resonance parameters for the final file are read from the logical unit number of 2 at #7.

The data for the threshold reactions are on the logical unit number of 3 with MAT of 5636 that is the same as that of data in process. If the READ command comes immediately, the data in process with the same MF and MT numbers will be replaced with the data on the logical unit number of 3. Therefore, the MAT command at #8 is needed to tentatively change the MAT number. The threshold reaction data are read at #9. Some data are deleted because they are not adopted as final data.

The OPERATE commands from #14 to #16 modify the (n,2n), (n,p) and (n,α) reaction cross sections so as to agree with the data at 14 MeV. Then the MAT number is renewed at #17 so that all the data in process have the same MAT number of 1000.

The input data of #18 and #20 are correction of the capture cross section by adding the contributions from the direct and semi-direct process.

The CORRECT commands from #21 to #27 insert an effective threshold energy of 100 keV to (n,p) and (n,α) reaction cross sections.

The total inelastic scattering cross section is calculated at #28. The cross section for MT=101 and MT=5 (a tentative MT number) are neutron disappearance and sum of MT=4 to 50, respectively. These two data and MT=3 obtained at #31 are used to calculate the elastic scattering cross section at #32, and deleted later at #46 through #48.

The elastic scattering and capture cross sections below 100 keV where is the resonance region are replaced with the background one of 0.0 by the input data from #33 to #42. The neutron disappearance cross section is recalculated at #43 because the capture cross section was changed.

Finally, the total cross section is calculated as a sum of all the partial cross sections at #44 and #45. The tentative cross section data are deleted at #46 to #49.

As for the angular distributions, an isotropic distribution is assumed by the MAKE command at #50 for the neutron emitting reactions that have no angular distribtion data in the input files.

The CORRECT command at #51 to #53 inserts the average cosine of the scattering angle for elastically scattered neutrons at 10^{-5} eV.

After defining modification numbers at #54 to #56, the results are outputted at #57, in the ENDF-6 format with the MAT number of 5604 to the logical unit number of 4. The tape end record is written by the FINISH command and the CRECTJ job is terminated by the STOP command.

3) Output

The output on a line-printer is shown in Fig. 4.1, and a part of the output file is given in Fig. 4.2.

4.3 Example 2 : Averaging Cross Sections in the Resonance region

As an example of the AVERAGE command, the average cross sections are calculated in the resolved resonance region where the cross sections have many fines structures. Therefore we need average values in appropriate energy intervals. In this example, the cross sections are averaged by applying the JAERI-FAST 70 group structure.

1) Input file

Logical unit	Contents
1	The pointwise cross section data of the nuclide with MAT number of 9228. The resolved resonance region is below 500 eV.

2) Input data

```
START
LABEL(2)
  EXAMPLE 2
READ(1) 9228,3
AVERAGE (9228,3,0),0.32242,582.95,-4,0.0
```

```
END(2) 9228
FIN(2)
STOP
```

Averaging cross sections were made for all cross sections in the energy range from 0.32242 to 582.95 eV with an equal weight. As examples of output, pointwise cross sections and averaged ones are shown in Figs. 4.3 and 4.4, respectively..

4.4 Example 3 : Calculation of Special Quantities

In this example, the ^{10}B(n, α_0) and ^{10}B(n, α_1) cross sections are calculated from the ^{10}B(n, α) cross sections by adopting the ratio of ^{10}B(n, α_0) to ^{10}B(n, α) cross sections calculated from the ENDF/B-VI data. The ratio values are also written with the MT number of 999.

1) Input files

Logical unit	Contents
1	The ^{10}B(n, α) cross sections cross section (MAT=2051).
2	The ENDF/B-VI data (MAT=525).

2) Input data

```
START
LABEL(3)
   EXAMPLE 3
* B-10 (n,a)
READ(1) 2051,3,107
* ENDF/B-VI data
READ(2) 525,3,107
READ(2) 525,3,800
* ratio of ground to total
(1000,3,999)=(525,3,800)/(525,3,107)
* ground
(2051,3,800)=(2051,3,107)*(1000,3,999)
* meta
(2051,3,801)=(2051,3,107)-(2051,3,780)
DELETE 525
END(3) 2051
FIN(3)
STOP
```

The output to the logical unit of 3 is shown in Fig. 4.5. The cross sections of (2051,3,107), (2051,3,800) and (2051,3,801) are given in Fig. 4.6. Figure 4.7 is the ratio of ^{10}B(n, α_0) to ^{10}B(n, α) cross sections calculated from the ENDF/B-VI data.

4.5 Example 4 : Constructing Data for Natural Element

The data of natural copper are created from those of isotope data.

1) Input files

Logical unit	Contents
1	The data of ^{63}Cu with the MAT number of 2925.
2	The data of ^{65}Cu with the MAT number of 2931.

2) Input data

```
START
LABEL(3)
 EXAMPLE 4
READ(1) 2925
READ(2) 2931
NATURAL 2,(2900,0,0),29000.0,63.500
ISOTOPE 2925=0.691
ISOTOPE 2931=0.309
DELETE 2925
DELETE 2931
MAKE 2900,4
END(3) 2900
FIN(3)
STOP
```

The output on a line-printer after the NATURAL command is listed in Fig. 4.8. The resonance parameters of both isotopes are found in the data in process. The cross sections data are multiplied with their abundance and stored with tentative MAT numbers (−1 and −2) in Fig. 4.8(1). The data of $\overline{\mu_L}$ are further multiplied with the elastic scattering cross sections. in Fig. 4.8(2), and the cross sections of the natural Cu are calculated as the sum of these tentative data sets. The cross sections of inelastic scattering cross sections to discrete levels of individual isotopes are arranged in the increasing order of Q values and numbered from MT=51 as the data of the natural Cu. The tentative data of $\overline{\mu_L}$ are divided by the elastic scattering cross section of the natural Cu.

The angular distributions of elastically scattered neutrons are treated at the bottom of Fig. 4.8(2). The listed energy points are those where the distributions are given in the ^{63}Cu and ^{65}Cu data. However at the energies below 50 keV, correct angular distributions cannot be determined because the elastic scattering cross sections given in the input files are zero. In this example, the input data are not pointwise. Hence the cross sections below 50 kev are only the background data. The same messages are written for MT=16 and 91 at their threshold energies. Usualy, the results of such cases are isotropic distributions. Therefore, they are correct at the threshold energies.

The energy distributions are constructed at the bottom of Fig. 4.8(3).

In Fig. 4.8(4), the data of ^{63}Cu and ^{65}Cu are deleted. The isotropic angular distributions are created for the discrete levels by the MAKE(2900,4,0) command. Finally, the data are written on the logical unit number of 3 by the END(3) 2900 command.

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Table 2.1 Available commands and sub-commands

Command†	Section‡	Function
AVERAGE	2.15	calculates average cross sections
CLOSE	2.3	closes a data file
COPY	2.21	copies data
CORRECT	2.11	makes a correction of data.
DCOPY	2.22	copies data
DELETE	2.8	deletes data sets.
DELETE*	2.11.2	deletes a part of cross section data.
END	2.20	outputs the data in scratch files.
FINISH	2.23	writes a TEND record and rewinds an output file.
FMIN	2.19.4	defines the minimum order of real-type numbers.
HEAD	2.19.2	defines HEAD records in MF=1, MT=451.
INSERT*	2.11.3	inserts data points into a cross section data set.
LABEL	2.4	writes a TPID (tape id record) .
LIST	2.24	makes a list of data.
MAKE	2.12	makes a new data set.
MAT	2.10	changes MAT numbers of data in scratch disks.
MESH	2.17	generates energy intervals used in the AVERAGE command.
MOD	2.18	defines a modification number and modification indicators.
NATURAL	2.14	constructs data for a natural element from isotope data
NINE	2.19.3	specifies MT numbers whose data are output in the nine-digit format.
NORMALIZE	2.13	normalizes tabulated angular and energy distributions to 1.0
OPERATE	2.6	performs operations of cross section data.
PUT	2.9	makes a new data set.
READ	2.5	reads data from an input file.
REPLACE*	2.11.1	replaces a part of cross section data with new one.
ROPEN	2.2.1	defines an input file in the ENDF format.
SEQ	2.19.5	controls sequential numbers of output data.
SEVEN	2.19.3	specifies MT numbers whose data are output in the seven-digit format.
SIX	2.19.3	specifies MT numbers whose data are output in the six-digit format.
SPECTRUM	2.16	defines weighting functions for the AVERAGE command.
START	2.1	defines scratch disks.
STOP	2.26	terminates CRECTJ job.
SUM	2.7	makes a sum of cross section data.
TMATRIX*	2.11.4	calculates a transformation matrix for MF=4, MT=2.
WOPEN	2.2.2	defines an output file in the ENDF format.
ZA	2.19.1	defines ZA and AWR in HEAD records.

† * indicates sub-command.
‡ Section numbers where the function of the command is explained.

Table 2.2 JAERI-FAST 70 Group Energy Intervals (*nint* = −1)

No.	Lower energy(eV)	No.	Lower energy(eV)
1	0.0	38	2.1500+ 3
2	2.1500− 1	39	2.7800+ 3
3	2.7800− 1	40	3.6000+ 3
4	3.6000− 1	41	4.6500+ 3
5	4.6500− 1	42	5.9800+ 3
6	5.9800− 1	43	7.7300+ 3
7	7.7300− 1	44	1.0000+ 4
8	1.0000+ 0	45	1.2900+ 4
9	1.2900+ 0	46	1.6600+ 4
10	1.6600+ 0	47	2.1500+ 4
11	2.1500+ 0	48	2.7800+ 4
12	2.7800+ 0	49	3.6000+ 4
13	3.6000+ 0	50	4.6500+ 4
14	4.6500+ 0	51	5.9800+ 4
15	5.9800+ 0	52	7.7300+ 4
16	7.7300+ 0	53	1.0000+ 5
17	1.0000+ 1	54	1.2000+ 5
18	1.2900+ 1	55	1.5000+ 5
19	1.6600+ 1	56	2.0000+ 5
20	2.1500+ 1	57	2.5000+ 5
21	2.7800+ 1	58	3.1000+ 5
22	3.6000+ 1	59	4.0000+ 5
23	4.6500+ 1	60	5.0000+ 5
24	5.9800+ 1	61	6.3000+ 5
25	7.7300+ 1	62	8.0000+ 5
26	1.0000+ 2	63	1.1000+ 6
27	1.2900+ 2	64	1.4000+ 6
28	1.6600+ 2	65	1.9000+ 6
29	2.1500+ 2	66	2.5000+ 6
30	2.7800+ 2	67	3.1000+ 6
31	3.6000+ 2	68	4.0000+ 6
32	4.6500+ 2	69	5.1000+ 6
33	5.9800+ 2	70	6.5000+ 6
34	7.7300+ 2	71	8.3000+ 6
35	1.0000+ 3	72	1.0500+ 7
36	1.2900+ 3	73	2.0000+ 7
37	1.6600+ 3		

Table 2.3 100 Energy Intervals (*nint* = −2)

No.	Lower energy(eV)	No.	Lower energy(eV)
1	0.0	53	1.1109+ 5
2	1.0000− 3	54	1.2277+ 5
3	4.1399− 1	55	1.3569+ 5
4	5.3158− 1	56	1.4996+ 5
5	6.8256− 1	57	1.6573+ 5
6	8.7642− 1	58	1.8316+ 5
7	1.1254+ 0	59	2.0242+ 5
8	1.4450+ 0	60	2.2371+ 5
9	1.8554+ 0	61	2.4724+ 5
10	2.3824+ 0	62	2.7324+ 5
11	3.0590+ 0	63	3.0197+ 5
12	3.9279+ 0	64	3.3373+ 5
13	5.0435+ 0	65	3.6883+ 5
14	6.4760+ 0	66	4.0762+ 5
15	8.3153+ 0	67	4.5049+ 5
16	1.0677+ 1	68	4.9787+ 5
17	1.3710+ 1	69	5.5023+ 5
18	1.7603+ 1	70	6.0810+ 5
19	2.2603+ 1	71	6.7206+ 5
20	2.9023+ 1	72	7.4274+ 5
21	3.7267+ 1	73	8.2085+ 5
22	4.7851+ 1	74	9.0718+ 5
23	6.1442+ 1	75	1.0026+ 6
24	7.8893+ 1	76	1.1080+ 6
25	1.0130+ 2	77	1.2246+ 6
26	1.3007+ 2	78	1.3534+ 6
27	1.6702+ 2	79	1.4957+ 6
28	2.1445+ 2	80	1.6530+ 6
29	2.7536+ 2	81	1.8268+ 6
30	3.5357+ 2	82	2.0190+ 6
31	4.5400+ 2	83	2.2313+ 6
32	5.8295+ 2	84	2.4660+ 6
33	7.4852+ 2	85	2.7253+ 6
34	9.6112+ 2	86	3.0119+ 6
35	1.2341+ 3	87	3.3287+ 6
36	1.5846+ 3	88	3.6788+ 6
37	2.0347+ 3	89	4.0657+ 6
38	2.6126+ 3	90	4.4933+ 6
39	3.3546+ 3	91	4.9659+ 6
40	4.3075+ 3	92	5.4881+ 6
41	5.5308+ 3	93	6.0653+ 6
42	7.1017+ 3	94	6.7032+ 6
43	9.1188+ 3	95	7.4082+ 6
44	1.1709+ 4	96	8.1873+ 6
45	1.5034+ 4	97	9.0484+ 6
46	1.9305+ 4	98	1.0000+ 7
47	2.4788+ 4	99	1.1052+ 7
48	3.1828+ 4	100	1.2214+ 7
49	4.0868+ 4	101	1.3499+ 7
50	5.2475+ 4	102	1.4918+ 7
51	6.7379+ 4	103	2.0000+ 7
52	8.6617+ 4		

Table 2.4 Energy intervals recommended at 1977 Geel Meeting (*nint* = −3)

No.	Lower energy(eV)	No.	Lower energy(eV)
1	0.0	40	6.0000+ 2
2	1.0000− 2	41	8.0000+ 2
3	1.5000− 2	42	1.0000+ 3
4	2.0000− 2	43	1.5000+ 3
5	3.0000− 2	44	2.0000+ 3
6	4.0000− 2	45	3.0000+ 3
7	5.0000− 2	46	4.0000+ 3
8	6.0000− 2	47	5.0000+ 3
9	8.0000− 2	48	6.0000+ 3
10	1.0000− 1	49	8.0000+ 3
11	1.5000− 1	50	1.0000+ 4
12	2.0000− 1	51	1.5000+ 4
13	3.0000− 1	52	2.0000+ 4
14	4.0000− 1	53	3.0000+ 4
15	5.0000− 1	54	4.0000+ 4
16	6.0000− 1	55	5.0000+ 4
17	8.0000− 1	56	6.0000+ 4
18	1.0000+ 0	57	8.0000+ 4
19	1.5000+ 0	58	1.0000+ 5
20	2.0000+ 0	59	1.5000+ 5
21	3.0000+ 0	60	2.0000+ 5
22	4.0000+ 0	61	3.0000+ 5
23	5.0000+ 0	62	4.0000+ 5
24	6.0000+ 0	63	5.0000+ 5
25	8.0000+ 0	64	6.0000+ 5
26	1.0000+ 1	65	8.0000+ 5
27	1.5000+ 1	66	1.0000+ 6
28	2.0000+ 1	67	1.5000+ 6
29	3.0000+ 1	68	2.0000+ 6
30	4.0000+ 1	69	3.0000+ 6
31	5.0000+ 1	70	4.0000+ 6
32	6.0000+ 1	71	5.0000+ 6
33	8.0000+ 1	72	6.0000+ 6
34	1.0000+ 2	73	8.0000+ 6
35	1.5000+ 2	74	1.0000+ 7
36	2.0000+ 2	75	1.5000+ 7
37	3.0000+ 2	76	2.0000+ 7
38	4.0000+ 2		
39	5.0000+ 2		

Table 2.5 JAERI-FAST (Version 3) 70 Group Structure (*nint* = −4)

No.	Lower energy(eV)	No.	Lower energy(eV)
1	0.0	37	2.0347+ 3
2	3.2242− 1	38	2.6126+ 3
3	4.1399− 1	39	3.3546+ 3
4	5.3158− 1	40	4.3074+ 3
5	6.8256− 1	41	5.5308+ 3
6	8.7642− 1	42	7.1017+ 3
7	1.1254+ 0	43	9.1188+ 3
8	1.4450+ 0	44	1.1709+ 4
9	1.8554+ 0	45	1.5034+ 4
10	2.3824+ 0	46	1.9305+ 4
11	3.0590+ 0	47	2.4788+ 4
12	3.9279+ 0	48	3.1828+ 4
13	5.0435+ 0	49	4.0868+ 4
14	6.4760+ 0	50	5.2475+ 4
15	8.3153+ 0	51	6.7379+ 4
16	1.0677+ 1	52	8.6517+ 4
17	1.3710+ 1	53	1.1109+ 5
18	1.7603+ 1	54	1.4264+ 5
19	2.2603+ 1	55	1.8316+ 5
20	2.9023+ 1	56	2.3518+ 5
21	3.7267+ 1	57	3.0197+ 5
22	4.7851+ 1	58	3.8774+ 5
23	6.1442+ 1	59	4.9787+ 5
24	7.8893+ 1	60	6.3928+ 5
25	1.0130+ 2	61	8.2085+ 5
26	1.3007+ 2	62	1.0540+ 6
27	1.6702+ 2	63	1.3534+ 6
28	2.1445+ 2	64	1.7377+ 6
29	2.7536+ 2	65	2.2313+ 6
30	3.5358+ 2	66	2.8650+ 6
31	4.5400+ 2	67	3.6788+ 6
32	5.8295+ 2	68	4.7237+ 6
33	7.4852+ 2	69	6.0653+ 6
34	9.6112+ 2	70	7.7880+ 6
35	1.2341+ 3	71	1.0000+ 7
36	1.5846+ 3	72*	1.2840+ 7
		73*	1.6480+ 7
		74	1.0000+20

* Two energies above 10 MeV were added for CRECTJ.

Table 2.6 SAND-II 620+20 Energy Intervals (*nint* = −5)

No.	energy(eV)	No.	energy(eV)	No.	energy(eV)
1	1.0000− 4	46	1.0000− 3	91	1.0000− 2
2	1.0500− 4	47	1.0500− 3	92	1.0500− 2
3	1.1000− 4	48	1.1000− 3	93	1.1000− 2
4	1.1500− 4	49	1.1500− 3	94	1.1500− 2
5	1.2000− 4	50	1.2000− 3	95	1.2000− 2
6	1.2750− 4	51	1.2750− 3	96	1.2750− 2
7	1.3500− 4	52	1.3500− 3	97	1.3500− 2
8	1.4250− 4	53	1.4250− 3	98	1.4250− 2
9	1.5000− 4	54	1.5000− 3	99	1.5000− 2
10	1.6000− 4	55	1.6000− 3	100	1.6000− 2
11	1.7000− 4	56	1.7000− 3	101	1.7000− 2
12	1.8000− 4	57	1.8000− 3	102	1.8000− 2
13	1.9000− 4	58	1.9000− 3	103	1.9000− 2
14	2.0000− 4	59	2.0000− 3	104	2.0000− 2
15	2.1000− 4	60	2.1000− 3	105	2.1000− 2
16	2.2000− 4	61	2.2000− 3	106	2.2000− 2
17	2.3000− 4	62	2.3000− 3	107	2.3000− 2
18	2.4000− 4	63	2.4000− 3	108	2.4000− 2
19	2.5500− 4	64	2.5500− 3	109	2.5500− 2
20	2.7000− 4	65	2.7000− 3	110	2.7000− 2
21	2.8000− 4	66	2.8000− 3	111	2.8000− 2
22	3.0000− 4	67	3.0000− 3	112	3.0000− 2
23	3.2000− 4	68	3.2000− 3	113	3.2000− 2
24	3.4000− 4	69	3.4000− 3	114	3.4000− 2
25	3.6000− 4	70	3.6000− 3	115	3.6000− 2
26	3.8000− 4	71	3.8000− 3	116	3.8000− 2
27	4.0000− 4	72	4.0000− 3	117	4.0000− 2
28	4.2500− 4	73	4.2500− 3	118	4.2500− 2
29	4.5000− 4	74	4.5000− 3	119	4.5000− 2
30	4.7500− 4	75	4.7500− 3	120	4.7500− 2
31	5.0000− 4	76	5.0000− 3	121	5.0000− 2
32	5.2500− 4	77	5.2500− 3	122	5.2500− 2
33	5.5000− 4	78	5.5000− 3	123	5.5000− 2
34	5.7500− 4	79	5.7500− 3	124	5.7500− 2
35	6.0000− 4	80	6.0000− 3	125	6.0000− 2
36	6.3000− 4	81	6.3000− 3	126	6.3000− 2
37	6.6000− 4	82	6.6000− 3	127	6.6000− 2
38	6.9000− 4	83	6.9000− 3	128	6.9000− 2
39	7.2000− 4	84	7.2000− 3	129	7.2000− 2
40	7.6000− 4	85	7.6000− 3	130	7.6000− 2
41	8.0000− 4	86	8.0000− 3	131	8.0000− 2
42	8.4000− 4	87	8.4000− 3	132	8.4000− 2
43	8.8000− 4	88	8.8000− 3	133	8.8000− 2
44	9.2000− 4	89	9.2000− 3	134	9.2000− 2
45	9.6000− 4	90	9.6000− 3	135	9.6000− 2

Table 2.6 (continued)

No.	energy(eV)	No.	energy(eV)	No.	energy(eV)
136	1.0000– 1	181	1.0000+ 0	226	1.0000+ 1
137	1.0500– 1	182	1.0500+ 0	227	1.0500+ 1
138	1.1000– 1	183	1.1000+ 0	228	1.1000+ 1
139	1.1500– 1	184	1.1500+ 0	229	1.1500+ 1
140	1.2000– 1	185	1.2000+ 0	230	1.2000+ 1
141	1.2750– 1	186	1.2750+ 0	231	1.2750+ 1
142	1.3500– 1	187	1.3500+ 0	232	1.3500+ 1
143	1.4250– 1	188	1.4250+ 0	233	1.4250+ 1
144	1.5000– 1	189	1.5000+ 0	234	1.5000+ 1
145	1.6000– 1	190	1.6000+ 0	235	1.6000+ 1
146	1.7000– 1	191	1.7000+ 0	236	1.7000+ 1
147	1.8000– 1	192	1.8000+ 0	237	1.8000+ 1
148	1.9000– 1	193	1.9000+ 0	238	1.9000+ 1
149	2.0000– 1	194	2.0000+ 0	239	2.0000+ 1
150	2.1000– 1	195	2.1000+ 0	240	2.1000+ 1
151	2.2000– 1	196	2.2000+ 0	241	2.2000+ 1
152	2.3000– 1	197	2.3000+ 0	242	2.3000+ 1
153	2.4000– 1	198	2.4000+ 0	243	2.4000+ 1
154	2.5500– 1	199	2.5500+ 0	244	2.5500+ 1
155	2.7000– 1	200	2.7000+ 0	245	2.7000+ 1
156	2.8000– 1	201	2.8000+ 0	246	2.8000+ 1
157	3.0000– 1	202	3.0000+ 0	247	3.0000+ 1
158	3.2000– 1	203	3.2000+ 0	248	3.2000+ 1
159	3.4000– 1	204	3.4000+ 0	249	3.4000+ 1
160	3.6000– 1	205	3.6000+ 0	250	3.6000+ 1
161	3.8000– 1	206	3.8000+ 0	251	3.8000+ 1
162	4.0000– 1	207	4.0000+ 0	252	4.0000+ 1
163	4.2500– 1	208	4.2500+ 0	253	4.2500+ 1
164	4.5000– 1	209	4.5000+ 0	254	4.5000+ 1
165	4.7500– 1	210	4.7500+ 0	255	4.7500+ 1
166	5.0000– 1	211	5.0000+ 0	256	5.0000+ 1
167	5.2500– 1	212	5.2500+ 0	257	5.2500+ 1
168	5.5000– 1	213	5.5000+ 0	258	5.5000+ 1
169	5.7500– 1	214	5.7500+ 0	259	5.7500+ 1
170	6.0000– 1	215	6.0000+ 0	260	6.0000+ 1
171	6.3000– 1	216	6.3000+ 0	261	6.3000+ 1
172	6.6000– 1	217	6.6000+ 0	262	6.6000+ 1
173	6.9000– 1	218	6.9000+ 0	263	6.9000+ 1
174	7.2000– 1	219	7.2000+ 0	264	7.2000+ 1
175	7.6000– 1	220	7.6000+ 0	265	7.6000+ 1
176	8.0000– 1	221	8.0000+ 0	266	8.0000+ 1
177	8.4000– 1	222	8.4000+ 0	267	8.4000+ 1
178	8.8000– 1	223	8.8000+ 0	268	8.8000+ 1
179	9.2000– 1	224	9.2000+ 0	269	9.2000+ 1
180	9.6000- 1	225	9.6000+ 0	270	9.6000+ 1

Table 2.6 (continued)

No.	energy(eV)	No.	energy(eV)	No.	energy(eV)
271	1.0000+ 2	316	1.0000+ 3	361	1.0000+ 4
272	1.0500+ 2	317	1.0500+ 3	362	1.0500+ 4
273	1.1000+ 2	318	1.1000+ 3	363	1.1000+ 4
274	1.1500+ 2	319	1.1500+ 3	364	1.1500+ 4
275	1.2000+ 2	320	1.2000+ 3	365	1.2000+ 4
276	1.2750+ 2	321	1.2750+ 3	366	1.2750+ 4
277	1.3500+ 2	322	1.3500+ 3	367	1.3500+ 4
278	1.4250+ 2	323	1.4250+ 3	368	1.4250+ 4
279	1.5000+ 2	324	1.5000+ 3	369	1.5000+ 4
280	1.6000+ 2	325	1.6000+ 3	370	1.6000+ 4
281	1.7000+ 2	326	1.7000+ 3	371	1.7000+ 4
282	1.8000+ 2	327	1.8000+ 3	372	1.8000+ 4
283	1.9000+ 2	328	1.9000+ 3	373	1.9000+ 4
284	2.0000+ 2	329	2.0000+ 3	374	2.0000+ 4
285	2.1000+ 2	330	2.1000+ 3	375	2.1000+ 4
286	2.2000+ 2	331	2.2000+ 3	376	2.2000+ 4
287	2.3000+ 2	332	2.3000+ 3	377	2.3000+ 4
288	2.4000+ 2	333	2.4000+ 3	378	2.4000+ 4
289	2.5500+ 2	334	2.5500+ 3	379	2.5500+ 4
290	2.7000+ 2	335	2.7000+ 3	380	2.7000+ 4
291	2.8000+ 2	336	2.8000+ 3	381	2.8000+ 4
292	3.0000+ 2	337	3.0000+ 3	382	3.0000+ 4
293	3.2000+ 2	338	3.2000+ 3	383	3.2000+ 4
294	3.4000+ 2	339	3.4000+ 3	384	3.4000+ 4
295	3.6000+ 2	340	3.6000+ 3	385	3.6000+ 4
296	3.8000+ 2	341	3.8000+ 3	386	3.8000+ 4
297	4.0000+ 2	342	4.0000+ 3	387	4.0000+ 4
298	4.2500+ 2	343	4.2500+ 3	388	4.2500+ 4
299	4.5000+ 2	344	4.5000+ 3	389	4.5000+ 4
300	4.7500+ 2	345	4.7500+ 3	390	4.7500+ 4
301	5.0000+ 2	346	5.0000+ 3	391	5.0000+ 4
302	5.2500+ 2	347	5.2500+ 3	392	5.2500+ 4
303	5.5000+ 2	348	5.5000+ 3	393	5.5000+ 4
304	5.7500+ 2	349	5.7500+ 3	394	5.7500+ 4
305	6.0000+ 2	350	6.0000+ 3	395	6.0000+ 4
306	6.3000+ 2	351	6.3000+ 3	396	6.3000+ 4
307	6.6000+ 2	352	6.6000+ 3	397	6.6000+ 4
308	6.9000+ 2	353	6.9000+ 3	398	6.9000+ 4
309	7.2000+ 2	354	7.2000+ 3	399	7.2000+ 4
310	7.6000+ 2	355	7.6000+ 3	400	7.6000+ 4
311	8.0000+ 2	356	8.0000+ 3	401	8.0000+ 4
312	8.4000+ 2	357	8.4000+ 3	402	8.4000+ 4
313	8.8000+ 2	358	8.8000+ 3	403	8.8000+ 4
314	9.2000+ 2	359	9.2000+ 3	404	9.2000+ 4
315	9.6000+ 2	360	9.6000+ 3	405	9.6000+ 4

Table 2.6 (continued)

No.	energy(eV)	No.	energy(eV)	No.	energy(eV)
406	1.0000+ 5	451	1.0000+ 6	496	5.5000+ 6
407	1.0500+ 5	452	1.1000+ 6	497	5.6000+ 6
408	1.1000+ 5	453	1.2000+ 6	498	5.7000+ 6
409	1.1500+ 5	454	1.3000+ 6	499	5.8000+ 6
410	1.2000+ 5	455	1.4000+ 6	500	5.9000+ 6
411	1.2750+ 5	456	1.5000+ 6	501	6.0000+ 6
412	1.3500+ 5	457	1.6000+ 6	502	6.1000+ 6
413	1.4250+ 5	458	1.7000+ 6	503	6.2000+ 6
414	1.5000+ 5	459	1.8000+ 6	504	6.3000+ 6
415	1.6000+ 5	460	1.9000+ 6	505	6.4000+ 6
416	1.7000+ 5	461	2.0000+ 6	506	6.5000+ 6
417	1.8000+ 5	462	2.1000+ 6	507	6.6000+ 6
418	1.9000+ 5	463	2.2000+ 6	508	6.7000+ 6
419	2.0000+ 5	464	2.3000+ 6	509	6.8000+ 6
420	2.1000+ 5	465	2.4000+ 6	510	6.9000+ 6
421	2.2000+ 5	466	2.5000+ 6	511	7.0000+ 6
422	2.3000+ 5	467	2.6000+ 6	512	7.1000+ 6
423	2.4000+ 5	468	2.7000+ 6	513	7.2000+ 6
424	2.5500+ 5	469	2.8000+ 6	514	7.3000+ 6
425	2.7000+ 5	470	2.9000+ 6	515	7.4000+ 6
426	2.8000+ 5	471	3.0000+ 6	516	7.5000+ 6
427	3.0000+ 5	472	3.1000+ 6	517	7.6000+ 6
428	3.2000+ 5	473	3.2000+ 6	518	7.7000+ 6
429	3.4000+ 5	474	3.3000+ 6	519	7.8000+ 6
430	3.6000+ 5	475	3.4000+ 6	520	7.9000+ 6
431	3.8000+ 5	476	3.5000+ 6	521	8.0000+ 6
432	4.0000+ 5	477	3.6000+ 6	522	8.1000+ 6
433	4.2500+ 5	478	3.7000+ 6	523	8.2000+ 6
434	4.5000+ 5	479	3.8000+ 6	524	8.3000+ 6
435	4.7500+ 5	480	3.9000+ 6	525	8.4000+ 6
436	5.0000+ 5	481	4.0000+ 6	526	8.5000+ 6
437	5.2500+ 5	482	4.1000+ 6	527	8.6000+ 6
438	5.5000+ 5	483	4.2000+ 6	528	8.7000+ 6
439	5.7500+ 5	484	4.3000+ 6	529	8.8000+ 6
440	6.0000+ 5	485	4.4000+ 6	530	8.9000+ 6
441	6.3000+ 5	486	4.5000+ 6	531	9.0000+ 6
442	6.6000+ 5	487	4.6000+ 6	532	9.1000+ 6
443	6.9000+ 5	488	4.7000+ 6	533	9.2000+ 6
444	7.2000+ 5	489	4.8000+ 6	534	9.3000+ 6
445	7.6000+ 5	490	4.9000+ 6	535	9.4000+ 6
446	8.0000+ 5	491	5.0000+ 6	536	9.5000+ 6
447	8.4000+ 5	492	5.1000+ 6	537	9.6000+ 6
448	8.8000+ 5	493	5.2000+ 6	538	9.7000+ 6
449	9.2000+ 5	494	5.3000+ 6	539	9.8000+ 6
450	9.6000+ 5	495	5.4000+ 6	540	9.9000+ 6

Table 2.6 (continued)

No.	energy(eV)	No.	energy(eV)	No.	energy(eV)
541	1.0000+ 7	575	1.3400+ 7	609	1.6800+ 7
542	1.0100+ 7	576	1.3500+ 7	610	1.6900+ 7
543	1.0200+ 7	577	1.3600+ 7	611	1.7000+ 7
544	1.0300+ 7	578	1.3700+ 7	612	1.7100+ 7
545	1.0400+ 7	579	1.3800+ 7	613	1.7200+ 7
546	1.0500+ 7	580	1.3900+ 7	614	1.7300+ 7
547	1.0600+ 7	581	1.4000+ 7	615	1.7400+ 7
548	1.0700+ 7	582	1.4100+ 7	616	1.7500+ 7
549	1.0800+ 7	583	1.4200+ 7	617	1.7600+ 7
550	1.0900+ 7	584	1.4300+ 7	618	1.7700+ 7
551	1.1000+ 7	585	1.4400+ 7	619	1.7800+ 7
552	1.1100+ 7	586	1.4500+ 7	620	1.7900+ 7
553	1.1200+ 7	587	1.4600+ 7	621	1.8000+ 7
554	1.1300+ 7	588	1.4700+ 7	622	1.8100+ 7
555	1.1400+ 7	589	1.4800+ 7	623	1.8200+ 7
556	1.1500+ 7	590	1.4900+ 7	624	1.8300+ 7
557	1.1600+ 7	591	1.5000+ 7	625	1.8400+ 7
558	1.1700+ 7	592	1.5100+ 7	626	1.8500+ 7
559	1.1800+ 7	593	1.5200+ 7	627	1.8600+ 7
560	1.1900+ 7	594	1.5300+ 7	628	1.8700+ 7
561	1.2000+ 7	595	1.5400+ 7	629	1.8800+ 7
562	1.2100+ 7	596	1.5500+ 7	630	1.8900+ 7
563	1.2200+ 7	597	1.5600+ 7	631	1.9000+ 7
564	1.2300+ 7	598	1.5700+ 7	632	1.9100+ 7
565	1.2400+ 7	599	1.5800+ 7	633	1.9200+ 7
566	1.2500+ 7	600	1.5900+ 7	634	1.9300+ 7
567	1.2600+ 7	601	1.6000+ 7	635	1.9400+ 7
568	1.2700+ 7	602	1.6100+ 7	636	1.9500+ 7
569	1.2800+ 7	603	1.6200+ 7	637	1.9600+ 7
570	1.2900+ 7	604	1.6300+ 7	638	1.9700+ 7
571	1.3000+ 7	605	1.6400+ 7	639	1.9800+ 7
572	1.3100+ 7	606	1.6500+ 7	640	1.9900+ 7
573	1.3200+ 7	607	1.6600+ 7	641	1.0000+20
574	1.3300+ 7	608	1.6700+ 7		

The energies above 18 MeV were taken from GROUPIE.[12)]

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          CRECTJ6(VERSION 99-04)  CORRECTION AND OPERATION OF DATA IN ENDF-6 FORMAT          PAGE.    1
TAPES AND DISKES
****************
     TEMPORALY UNITS .....    98   99 AND F50

START OF NEW MATERIAL *****

     LABEL( 4)   TAPE NO.=    0
          (  BA135                                                  )

     READ ( 1)  (5635, 0,  0)
                          MAT = 5635 , MF =  1 , MT = 451
                          MAT = 5635 , MF =  2 , MT = 151    ENERGY   0.0000E+00 TO  0.0000E+00
                          MAT = 5635 , MF =  3 , MT =   1    ENERGY   1.0000E+00 TO  2.0000E+07
                          MAT = 5635 , MF =  3 , MT =   2    ENERGY   1.0000E+00 TO  2.0000E+07
                          MAT = 5635 , MF =  3 , MT =   4    ENERGY   2.2265E+05 TO  2.0000E+07
                          MAT = 5635 , MF =  3 , MT =  51    ENERGY   2.2265E+05 TO  2.0000E+07
                          MAT = 5635 , MF =  3 , MT =  52    ENERGY   2.7021E+05 TO  2.0000E+07
                          MAT = 5635 , MF =  3 , MT =  53    ENERGY   4.8419E+05 TO  2.0000E+07
                          MAT = 5635 , MF =  3 , MT =  54    ENERGY   5.9230E+05 TO  2.0000E+07
                          MAT = 5635 , MF =  3 , MT =  55    ENERGY   8.6139E+05 TO  2.0000E+07
                          MAT = 5635 , MF =  3 , MT =  56    ENERGY   8.8104E+05 TO  2.0000E+07
                          MAT = 5635 , MF =  3 , MT =  57    ENERGY   9.8733E+05 TO  2.0000E+07
                          MAT = 5635 , MF =  3 , MT =  91    ENERGY   1.1788E+06 TO  2.0000E+07
                          MAT = 5635 , MF =  3 , MT = 102    ENERGY   1.0000E+00 TO  2.0000E+07
                          MAT = 5635 , MF =  3 , MT = 251    ENERGY   1.0000E+00 TO  2.0000E+07
                          MAT = 5635 , MF =  3 , MT = 999    ENERGY   1.0000E+00 TO  2.0000E+07
                          MAT = 5635 , MF =  4 , MT =   2    ENERGY   1.0000E-05 TO  2.0000E+07
                          MAT = 5635 , MF =  4 , MT =  51    ENERGY   2.2265E+05 TO  2.0000E+07
                          MAT = 5635 , MF =  4 , MT =  52    ENERGY   2.7021E+05 TO  2.0000E+07
                          MAT = 5635 , MF =  4 , MT =  53    ENERGY   4.8419E+05 TO  2.0000E+07
                          MAT = 5635 , MF =  4 , MT =  54    ENERGY   5.9230E+05 TO  2.0000E+07
                          MAT = 5635 , MF =  4 , MT =  55    ENERGY   8.6139E+05 TO  2.0000E+07
                          MAT = 5635 , MF =  4 , MT =  56    ENERGY   8.8104E+05 TO  2.0000E+07
                          MAT = 5635 , MF =  4 , MT =  57    ENERGY   9.8733E+05 TO  2.0000E+07
                          MAT = 5635 , MF =  4 , MT =  91    ENERGY   1.1788E+06 TO  2.0000E+07

     DELETE     (5635, 1,451:451)

     DELETE     (5635, 2,  0:  0)

     READ ( 2)  (5635, 2,151)
                          MAT = 5635 , MF =  2 , MT = 151    ENERGY   1.0000E-05 TO  1.0000E+05

     MAT NUMBER (1000)        = (    0)

     READ ( 3)  (5635, 0,  0)
                          MAT = 5635 , MF =  3 , MT =   2    ENERGY   1.0000E-05 TO  2.0000E+07
                          MAT = 5635 , MF =  3 , MT =  16    ENERGY   7.0303E+06 TO  2.0000E+07
```

Fig. 4.1(1) Output on logical unit of 6 from the example 1

```
                    MAT = 5635 , MF =  3 , MT =  17   ENERGY   1.6576E+07 TO  2.0000E+07
                    MAT = 5635 , MF =  3 , MT =  22   ENERGY   1.8849E+06 TO  2.0000E+07
                    MAT = 5635 , MF =  3 , MT =  28   ENERGY   8.3164E+06 TO  2.0000E+07
                    MAT = 5635 , MF =  3 , MT =  32   ENERGY   1.2937E+07 TO  2.0000E+07
                    MAT = 5635 , MF =  3 , MT =  91   ENERGY   1.0000E-05 TO  2.0000E+07
                    MAT = 5635 , MF =  3 , MT = 102   ENERGY   1.0000E-05 TO  2.0000E+07
                    MAT = 5635 , MF =  3 , MT = 103   ENERGY   1.0000E-05 TO  2.0000E+07
                    MAT = 5635 , MF =  3 , MT = 104   ENERGY   5.9890E+06 TO  2.0000E+07
                    MAT = 5635 , MF =  3 , MT = 105   ENERGY   6.7052E+06 TO  2.0000E+07
                    MAT = 5635 , MF =  3 , MT = 106   ENERGY   7.1167E+06 TO  2.0000E+07
                    MAT = 5635 , MF =  3 , MT = 107   ENERGY   1.0000E-05 TO  2.0000E+07
                    MAT = 5635 , MF =  3 , MT = 999   ENERGY   1.0000E-05 TO  2.0000E+07
                    MAT = 5635 , MF =  5 , MT =  16   ENERGY   7.0303E+06 TO  2.0000E+07
                    MAT = 5635 , MF =  5 , MT =  17   ENERGY   1.6576E+07 TO  2.0000E+07
                    MAT = 5635 , MF =  5 , MT =  22   ENERGY   1.8849E+06 TO  2.0000E+07
                    MAT = 5635 , MF =  5 , MT =  28   ENERGY   8.3164E+06 TO  2.0000E+07
                    MAT = 5635 , MF =  5 , MT =  32   ENERGY   1.2937E+07 TO  2.0000E+07
                    MAT = 5635 , MF =  5 , MT =  91   ENERGY   1.1788E+06 TO  2.0000E+07
DELETE      (5635, 3,   2:  2)
DELETE      (5635, 3,  91: 91)
DELETE      (5635, 3,102:102)
DELETE      (5635, 3,999:999)
OPERATE     (5635, 3,  16) = (5635, 3,  16) * 8.9120E-01 ENERGY RANGE  0.0000E+00 TO  1.0000E+20
OPERATE     (5635, 3,103) = (5635, 3,103) * 6.0010E-01 ENERGY RANGE  0.0000E+00 TO  1.0000E+20
OPERATE     (5635, 3,107) = (5635, 3,107) * 7.4700E-01 ENERGY RANGE  0.0000E+00 TO  1.0000E+20
MAT NUMBER (1000)          = (    0)
READ (10)   (5635, 3,102)
                    MAT = 5635 , MF =  3 , MT = 102   ENERGY   1.0000E+05 TO  2.0000E+07
OPERATE     (1000, 3,102) = (1000, 3,102) + (5635, 3,102)  ENERGY RANGE  0.0000E+00 TO  1.0000E+20
DELETE      (5635, 0,   0:  0)
MAT NUMBER (5635)          = (1000)
CORRECT     (5635, 3,103)
                    INSERT   ENERGY     0.00000E+00 TO     2.00000E+07
CORRECT     (5635, 3,107)
                    INSERT   ENERGY     0.00000E+00 TO     2.00000E+07
```

Fig. 4.1(2) Output on logical unit of 6 from the example 1

```
MAKE       (5635, 3,   4)
           (5635, 3,   4) = (5635, 3,  51) + (5635, 3,  52)
           (5635, 3,   4) = (5635, 3,   4) + (5635, 3,  53)
           (5635, 3,   4) = (5635, 3,   4) + (5635, 3,  54)
           (5635, 3,   4) = (5635, 3,   4) + (5635, 3,  55)
           (5635, 3,   4) = (5635, 3,   4) + (5635, 3,  56)
           (5635, 3,   4) = (5635, 3,   4) + (5635, 3,  57)
           (5635, 3,   4) = (5635, 3,   4) + (5635, 3,  91)

MAKE       (5635, 3,101)
           (5635, 3,101) = (5635, 3,102) + (5635, 3,103)
           (5635, 3,101) = (5635, 3,101) + (5635, 3,104)
           (5635, 3,101) = (5635, 3,101) + (5635, 3,105)
           (5635, 3,101) = (5635, 3,101) + (5635, 3,106)
           (5635, 3,101) = (5635, 3,101) + (5635, 3,107)

SUM-UP     (5635, 3,   5) = FROM (5635, 3,   4) TO (5635, 3, 50)
           (5635, 3,   5) = (5635, 3,   4) + (5635, 3,  16)
           (5635, 3,   5) = (5635, 3,   5) + (5635, 3,  17)
           (5635, 3,   5) = (5635, 3,   5) + (5635, 3,  22)
           (5635, 3,   5) = (5635, 3,   5) + (5635, 3,  28)
           (5635, 3,   5) = (5635, 3,   5) + (5635, 3,  32)

OPERATE    (5635, 3,   3) = (5635, 3,   5) + (5635, 3,101)  ENERGY RANGE  0.0000E+00 TO  1.0000E+20

OPERATE    (5635, 3,   2) = (5635, 3,   1) - (5635, 3,   3)  ENERGY RANGE  0.0000E+00 TO  1.0000E+20

CORRECT    (5635, 3,   2)
                     REPLACE  ENERGY     1.00000E-05 TO     1.00000E+05

CORRECT    (5635, 3,102)
                     REPLACE  ENERGY     1.00000E-05 TO     1.00000E+05

MAKE       (5635, 3,101)
           (5635, 3,101) = (5635, 3,102) + (5635, 3,103)
           (5635, 3,101) = (5635, 3,101) + (5635, 3,104)
           (5635, 3,101) = (5635, 3,101) + (5635, 3,105)
           (5635, 3,101) = (5635, 3,101) + (5635, 3,106)
           (5635, 3,101) = (5635, 3,101) + (5635, 3,107)

OPERATE    (5635, 3,   1) = (5635, 3,   2) + (5635, 3,   5)  ENERGY RANGE  0.0000E+00 TO  1.0000E+20

OPERATE    (5635, 3,   1) = (5635, 3,   1) + (5635, 3,101)  ENERGY RANGE  0.0000E+00 TO  1.0000E+20

DELETE     (5635, 3,   3:  3)

DELETE     (5635, 3,   5:  5)

DELETE     (5635, 3,101:101)
```

Fig. 4.1(3) Output on logical unit of 6 from the example 1

```
DELETE     (5635, 3,999:999)

MAKE       (5635, 4,  0)
           (5635, 4,  2) SAME DATA SET FOUND IN TABLE
           (5635, 4, 16)
           (5635, 4, 17)
           (5635, 4, 22)
           (5635, 4, 28)
           (5635, 4, 32)
           (5635, 4, 51) SAME DATA SET FOUND IN TABLE
           (5635, 4, 52) SAME DATA SET FOUND IN TABLE
           (5635, 4, 53) SAME DATA SET FOUND IN TABLE
           (5635, 4, 54) SAME DATA SET FOUND IN TABLE
           (5635, 4, 55) SAME DATA SET FOUND IN TABLE
           (5635, 4, 56) SAME DATA SET FOUND IN TABLE
           (5635, 4, 57) SAME DATA SET FOUND IN TABLE
           (5635, 4, 91) SAME DATA SET FOUND IN TABLE

CORRECT    (5635, 3,251)
                        INSERT   ENERGY     0.00000E+00 TO    2.00000E+07

MOD NUMBER IS SET TO BE  2

MOD NUMBER (   0, 0,  0:  0) =   1

MOD NUMBER (   0, 2,  0:  0) =   2

END  ( 4)   5604
                        MF =  1 , MT = 451 , MOD =   1 , CARDS =  51
                        MF =  2 , MT = 151 , MOD =   2 , CARDS = 458
                        MF =  3 , MT =   1 , MOD =   1 , CARDS =  25
                        MF =  3 , MT =   2 , MOD =   1 , CARDS =  25
                        MF =  3 , MT =   4 , MOD =   1 , CARDS =  14
                        MF =  3 , MT =  16 , MOD =   1 , CARDS =  10
                        MF =  3 , MT =  17 , MOD =   1 , CARDS =   5
                        MF =  3 , MT =  22 , MOD =   1 , CARDS =  13
                        MF =  3 , MT =  28 , MOD =   1 , CARDS =   9
                        MF =  3 , MT =  32 , MOD =   1 , CARDS =   7
                        MF =  3 , MT =  51 , MOD =   1 , CARDS =  14
                        MF =  3 , MT =  52 , MOD =   1 , CARDS =  14
                        MF =  3 , MT =  53 , MOD =   1 , CARDS =  13
                        MF =  3 , MT =  54 , MOD =   1 , CARDS =  12
                        MF =  3 , MT =  55 , MOD =   1 , CARDS =  11
                        MF =  3 , MT =  56 , MOD =   1 , CARDS =  11
                        MF =  3 , MT =  57 , MOD =   1 , CARDS =  10
                        MF =  3 , MT =  91 , MOD =   1 , CARDS =  10
                        MF =  3 , MT = 102 , MOD =   1 , CARDS =  20
                        MF =  3 , MT = 103 , MOD =   1 , CARDS =  15
                        MF =  3 , MT = 104 , MOD =   1 , CARDS =  12
                        MF =  3 , MT = 105 , MOD =   1 , CARDS =  11
```

Fig. 4.1(4) Output on logical unit of 6 from the example 1

```
MF =  3 , MT = 106 , MOD =   1 , CARDS =   10
MF =  3 , MT = 107 , MOD =   1 , CARDS =   15
MF =  3 , MT = 251 , MOD =   1 , CARDS =   22
MF =  4 , MT =   2 , MOD =   1 , CARDS =  240
MF =  4 , MT =  16 , MOD =   1 , CARDS =    2
MF =  4 , MT =  17 , MOD =   1 , CARDS =    2
MF =  4 , MT =  22 , MOD =   1 , CARDS =    2
MF =  4 , MT =  28 , MOD =   1 , CARDS =    2
MF =  4 , MT =  32 , MOD =   1 , CARDS =    2
MF =  4 , MT =  51 , MOD =   1 , CARDS =   27
MF =  4 , MT =  52 , MOD =   1 , CARDS =   25
MF =  4 , MT =  53 , MOD =   1 , CARDS =   27
MF =  4 , MT =  54 , MOD =   1 , CARDS =   27
MF =  4 , MT =  55 , MOD =   1 , CARDS =   26
MF =  4 , MT =  56 , MOD =   1 , CARDS =   26
MF =  4 , MT =  57 , MOD =   1 , CARDS =   26
MF =  4 , MT =  91 , MOD =   1 , CARDS =   24
MF =  5 , MT =  16 , MOD =   1 , CARDS =   79
MF =  5 , MT =  17 , MOD =   1 , CARDS =   27
MF =  5 , MT =  22 , MOD =   1 , CARDS =  221
MF =  5 , MT =  28 , MOD =   1 , CARDS =  104
MF =  5 , MT =  32 , MOD =   1 , CARDS =   46
MF =  5 , MT =  91 , MOD =   1 , CARDS =  134
                   TOTAL CARDS = 1936

END OF THE MATERIAL ******

START OF NEW MATERIAL *****

FINISH( 4) TAPE END RECORD WRITTEN.

END OF THE MATERIAL ******

START OF NEW MATERIAL *****
```

Fig. 4.1(5) Output on logical unit of 6 from the example 1

```
BA135                                                                        0      0
5.61350+ 4 1.33747+ 2          1          0          0       25604 1451     1
0.00000+ 0 0.00000+ 0          0          0          0       65604 1451     2
1.00000+ 0 0.00000+ 0          0          0         10       05604 1451     3
0.00000+ 0 0.00000+ 0          0          0          2      455604 1451     4
                                                               5604 1451     5
                                                               5604 1451     6
                               1        451         51       15604 1451     6
                               2        151        458       25604 1451     7
                               3          1         25       15604 1451     8
                               3          2         25       15604 1451     9
                               3          4         14       15604 1451    10
                               3         16         10       15604 1451    11
                               3         17          5       15604 1451    12
                               3         22         13       15604 1451    13
                               3         28          9       15604 1451    14
                               3         32          7       15604 1451    15
                               3         51         14       15604 1451    16
                               3         52         14       15604 1451    17
                               3         53         13       15604 1451    18
                               3         54         12       15604 1451    19
                               3         55         11       15604 1451    20
                               3         56         11       15604 1451    21
                               3         57         10       15604 1451    22
                               3         91         10       15604 1451    23
                               3        102         20       15604 1451    24
                               3        103         15       15604 1451    25
                               3        104         12       15604 1451    26
                               3        105         11       15604 1451    27
                               3        106         10       15604 1451    28
                               3        107         15       15604 1451    29
                               3        251         22       15604 1451    30
                               4          2        240       15604 1451    31
                               4         16          2       15604 1451    32
                               4         17          2       15604 1451    33
                               4         22          2       15604 1451    34
                               4         28          2       15604 1451    35
                               4         32          2       15604 1451    36
                               4         51         27       15604 1451    37
                               4         52         25       15604 1451    38
                               4         53         27       15604 1451    39
                               4         54         27       15604 1451    40
                               4         55         26       15604 1451    41
                               4         56         26       15604 1451    42
                               4         57         26       15604 1451    43
                               4         91         24       15604 1451    44
                               5         16         79       15604 1451    45
                               5         17         27       15604 1451    46
                               5         22        221       15604 1451    47
                               5         28        104       15604 1451    48
                               5         32         46       15604 1451    49
                               5         91        134       15604 1451    50
                                                               5604 1  0    51
                                                               5604 0  0    52
5.61350+ 4 1.33747+ 2          0          0          1       05604 2151    53
5.61350+ 4 1.00000+ 0          0          0          2       05604 2151    54
1.00000- 5 5.96000+ 3          1          2          0       05604 2151    55
1.50000+ 0 5.15000- 1          0          0          2       05604 2151    56
1.33747+ 2 0.00000+ 0          0          0       1230     2055604 2151    57
-5.10000+ 1 2.00000+ 0 2.83000- 1 1.36000- 1 1.47000- 1 0.00000+ 05604 2151    58
2.42000+ 1 1.00000+ 0 1.21000- 1 3.00000- 2 9.10000- 2 0.00000+ 05604 2151    59
8.15000+ 1 2.00000+ 0 2.57000- 1 1.50000- 1 1.07000- 1 0.00000+ 05604 2151    60
8.72000+ 1 2.00000+ 0 1.72000- 1 7.10000- 2 1.01000- 1 0.00000+ 05604 2151    61
1.04000+ 2 1.00000+ 0 2.70000- 1 1.67000- 1 1.03000- 1 0.00000+ 05604 2151    62
1.04400+ 2 2.00000+ 0 1.22000- 1 1.15000- 2 1.10500- 1 0.00000+ 05604 2151    63
2.19000+ 2 1.00000+ 0 1.56469- 1 6.46900- 3 1.50000- 1 0.00000+ 05604 2151    64
2.24000+ 2 2.00000+ 0 1.78800- 1 2.88000- 2 1.50000- 1 0.00000+ 05604 2151    65
2.43000+ 2 2.00000+ 0 1.52549- 1 2.54900- 3 1.50000- 1 0.00000+ 05604 2151    66
```

Fig. 4.2(1) Output to logical unit of 4 from the example 1

```
2.82500+ 2 2.00000+ 0 4.10000- 1 3.10000- 1 1.00000- 1 0.00000+ 05604 2151    67
3.15500+ 2 2.00000+ 0 1.73000- 1 7.90000- 2 9.40000- 2 0.00000+ 05604 2151    68
3.77000+ 2 1.00000+ 0 3.00000- 1 1.93000- 1 1.07000- 1 0.00000+ 05604 2151    69
4.06000+ 2 2.00000+ 0 6.43000- 1 5.00000- 1 1.43000- 1 0.00000+ 05604 2151    70
4.35000+ 2 2.00000+ 0 1.67000- 1 1.70000- 2 1.50000- 1 0.00000+ 05604 2151    71
4.67000+ 2 2.00000+ 0 2.22000- 1 7.20000- 2 1.50000- 1 0.00000+ 05604 2151    72
5.40000+ 2 2.00000+ 0 1.57200- 1 7.20000- 3 1.50000- 1 0.00000+ 05604 2151    73
5.69000+ 2 2.00000+ 0 1.72000- 1 2.20000- 2 1.50000- 1 0.00000+ 05604 2151    74
6.49000+ 2 1.00000+ 0 3.13000- 1 1.63000- 1 1.50000- 1 0.00000+ 05604 2151    75
6.50600+ 2 2.00000+ 0 2.53000- 1 1.03000- 1 1.50000- 1 0.00000+ 05604 2151    76
```

(Skipped)

```
4.00000+ 4 1.89940+ 1 0.00000+ 0 1.27670- 3 1.50000- 1 0.00000+ 05604 2151   504
5.00000+ 4 1.89940+ 1 0.00000+ 0 1.23410- 3 1.50000- 1 0.00000+ 05604 2151   505
6.00000+ 4 1.89940+ 1 0.00000+ 0 1.16610- 3 1.50000- 1 0.00000+ 05604 2151   506
7.00000+ 4 1.89940+ 1 0.00000+ 0 1.10940- 3 1.50000- 1 0.00000+ 05604 2151   507
8.00000+ 4 1.89940+ 1 0.00000+ 0 1.20050- 3 1.50000- 1 0.00000+ 05604 2151   508
9.00000+ 4 1.89940+ 1 0.00000+ 0 1.15310- 3 1.50000- 1 0.00000+ 05604 2151   509
1.00000+ 5 1.89940+ 1 0.00000+ 0 1.08270- 3 1.50000- 1 0.00000+ 05604 2151   510
                                                                  5604 2  0   511
                                                                  5604 0  0   512
5.61350+ 4 1.33747+ 2          0          0          0          05604 3  1   513
0.00000+ 0 0.00000+ 0          0          0          2        645604 3  1   514
         3          2         64          5          0          05604 3  1   515
1.00000- 5 0.00000+ 0 2.53000- 2 0.00000+ 0 1.00000+ 5 0.00000+ 05604 3  1   516
1.00000+ 5 4.58359+ 0 1.50000+ 5 4.67133+ 0 2.00000+ 5 4.81580+ 05604 3  1   517
2.22652+ 5 4.88980+ 0 2.50000+ 5 4.98334+ 0 2.70205+ 5 5.05389+ 05604 3  1   518
3.00000+ 5 5.15888+ 0 4.84193+ 5 5.77751+ 0 5.00000+ 5 5.82620+ 05604 3  1   519
5.92296+ 5 6.09419+ 0 7.00000+ 5 6.37268+ 0 8.00000+ 5 6.59997+ 05604 3  1   520
8.61393+ 5 6.72535+ 0 8.81038+ 5 6.76321+ 0 9.00000+ 5 6.79870+ 05604 3  1   521
9.87327+ 5 6.94884+ 0 1.00000+ 6 6.96879+ 0 1.17875+ 6 7.19973+ 05604 3  1   522
1.25000+ 6 7.26533+ 0 1.50000+ 6 7.38280+ 0 1.75000+ 6 7.34989+ 05604 3  1   523
1.88489+ 6 7.26392+ 0 2.00000+ 6 7.19601+ 0 3.00000+ 6 6.00708+ 05604 3  1   524
4.00000+ 6 5.07929+ 0 5.00000+ 6 4.51834+ 0 5.47723+ 6 4.41690+ 05604 3  1   525
5.98897+ 6 4.31972+ 0 6.00000+ 6 4.31774+ 0 6.30296+ 6 4.33424+ 05604 3  1   526
6.48074+ 6 4.34358+ 0 6.70524+ 6 4.35505+ 0 7.00000+ 6 4.36958+ 05604 3  1   527
7.03028+ 6 4.37258+ 0 7.11666+ 6 4.38106+ 0 7.23762+ 6 4.39281+ 05604 3  1   528
7.48331+ 6 4.41616+ 0 7.73734+ 6 4.43963+ 0 8.00000+ 6 4.46323+ 05604 3  1   529
8.23907+ 6 4.48569+ 0 8.31636+ 6 4.49284+ 0 8.48528+ 6 4.50827+ 05604 3  1   530
9.00000+ 6 4.55377+ 0 9.48683+ 6 4.60758+ 0 1.00000+ 7 4.66202+ 05604 3  1   531
1.04881+ 7 4.72723+ 0 1.10000+ 7 4.79335+ 0 1.20000+ 7 4.91647+ 05604 3  1   532
1.29366+ 7 4.99457+ 0 1.30000+ 7 4.99969+ 0 1.34907+ 7 5.03869+ 05604 3  1   533
1.40000+ 7 5.07800+ 0 1.45000+ 7 5.09145+ 0 1.50000+ 7 5.10447+ 05604 3  1   534
1.57626+ 7 5.10581+ 0 1.60000+ 7 5.10621+ 0 1.65762+ 7 5.09487+ 05604 3  1   535
1.70000+ 7 5.08680+ 0 1.80000+ 7 5.06856+ 0 1.90000+ 7 5.03095+ 05604 3  1   536
2.00000+ 7 4.99553+ 0                                             5604 3  1   537
                                                                  5604 3  0   538
5.61350+ 4 1.33747+ 2          0          0          0          05604 3  2   539
0.00000+ 0 0.00000+ 0          0          0          2        645604 3  2   540
         3          2         64          5          0          05604 3  2   541
1.00000- 5 0.00000+ 0 2.53000- 2 0.00000+ 0 1.00000+ 5 0.00000+ 05604 3  2   542
1.00000+ 5 4.33154+ 0 1.50000+ 5 4.45692+ 0 2.00000+ 5 4.61885+ 05604 3  2   543
2.22652+ 5 4.69754+ 0 2.50000+ 5 4.76458+ 0 2.70205+ 5 4.82488+ 05604 3  2   544
3.00000+ 5 4.91723+ 0 4.84193+ 5 5.48148+ 0 5.00000+ 5 5.49955+ 05604 3  2   545
5.92296+ 5 5.68977+ 0 7.00000+ 5 5.85552+ 0 8.00000+ 5 6.01177+ 05604 3  2   546
8.61393+ 5 6.09624+ 0 8.81038+ 5 6.11156+ 0 9.00000+ 5 6.11855+ 05604 3  2   547
9.87327+ 5 6.18281+ 0 1.00000+ 6 6.18612+ 0 1.17875+ 6 6.24984+ 05604 3  2   548
1.25000+ 6 6.24898+ 0 1.50000+ 6 6.11749+ 0 1.75000+ 6 5.84501+ 05604 3  2   549
1.88489+ 6 5.64681+ 0 2.00000+ 6 5.48909+ 0 3.00000+ 6 3.98175+ 05604 3  2   550
4.00000+ 6 2.99703+ 0 5.00000+ 6 2.47965+ 0 5.47723+ 6 2.37726+ 05604 3  2   551
5.98897+ 6 2.27790+ 0 6.00000+ 6 2.27587+ 0 6.30296+ 6 2.27858+ 05604 3  2   552
6.48074+ 6 2.28004+ 0 6.70524+ 6 2.28169+ 0 7.00000+ 6 2.28373+ 05604 3  2   553
7.03028+ 6 2.29306+ 0 7.11666+ 6 2.31945+ 0 7.23762+ 6 2.32777+ 05604 3  2   554
7.48331+ 6 2.34427+ 0 7.73734+ 6 2.36080+ 0 8.00000+ 6 2.37739+ 05604 3  2   555
8.23907+ 6 2.42477+ 0 8.31636+ 6 2.43980+ 0 8.48528+ 6 2.45198+ 05604 3  2   556
9.00000+ 6 2.48782+ 0 9.48683+ 6 2.54236+ 0 1.00000+ 7 2.59740+ 05604 3  2   557
1.04881+ 7 2.62674+ 0 1.10000+ 7 2.65683+ 0 1.20000+ 7 2.79005+ 05604 3  2   558
```

Fig. 4.2(2) Output to logical unit of 4 from the example 1

```
1.29366+ 7 2.83948+ 0 1.30000+ 7 2.84422+ 0 1.34907+ 7 2.87687+ 05604 3  2  559
1.40000+ 7 2.90940+ 0 1.45000+ 7 2.92006+ 0 1.50000+ 7 2.93339+ 05604 3  2  560
1.57626+ 7 2.93468+ 0 1.60000+ 7 2.93572+ 0 1.65762+ 7 2.92365+ 05604 3  2  561
1.70000+ 7 2.91643+ 0 1.80000+ 7 2.89066+ 0 1.90000+ 7 2.84828+ 05604 3  2  562
2.00000+ 7 2.80193+ 0                                            5604 3  2  563
                                                                 5604 3  0  564
5.61350+ 4 1.33747+ 2          0          0          0          05604 3  4  565
0.00000+ 0-2.21000+ 5          0          0          1        335604 3  4  566
        33          3          0          0          0          05604 3  4  567
2.22652+ 5 0.00000+ 0 2.50000+ 5 3.63229- 2 2.70205+ 5 5.07249- 25604 3  4  568
3.00000+ 5 6.90985- 2 4.84193+ 5 1.38239- 1 5.00000+ 5 1.77865- 15604 3  4  569
5.92296+ 5 2.69451- 1 7.00000+ 5 3.93642- 1 8.00000+ 5 4.67485- 15604 3  4  570
8.61393+ 5 5.08748- 1 8.81038+ 5 5.32247- 1 9.00000+ 5 5.64529- 15604 3  4  571
9.87327+ 5 6.54818- 1 1.00000+ 6 6.72200- 1 1.17875+ 6 8.40355- 15604 3  4  572
1.25000+ 6 9.06592- 1 1.50000+ 6 1.15847+ 0 1.75000+ 6 1.40465+ 05604 3  4  573
2.00000+ 6 1.61646+ 0 3.00000+ 6 1.97802+ 0 4.00000+ 6 2.05883+ 05604 3  4  574
5.00000+ 6 2.02768+ 0 6.00000+ 6 2.03661+ 0 7.00000+ 6 2.08298+ 05604 3  4  575
8.00000+ 6 1.88879+ 0 9.00000+ 6 1.34735+ 0 1.00000+ 7 9.45546- 15604 3  4  576
1.20000+ 7 6.49471- 1 1.40000+ 7 5.48431- 1 1.50000+ 7 5.12758- 15604 3  4  577
1.60000+ 7 4.83036- 1 1.80000+ 7 4.32197- 1 2.00000+ 7 3.43313- 15604 3  4  578
                                                                 5604 3  0  579
5.61350+ 4 1.33747+ 2          0          0          0          05604 3 16  580
0.00000+ 0-6.97811+ 6          0          0          1        205604 3 16  581
        20          2          0          0          0          05604 3 16  582
7.03028+ 6 0.00000+ 0 7.11666+ 6 0.00000+ 0 8.00000+ 6 1.95123- 15604 3 16  583
8.31636+ 6 3.40752- 1 9.00000+ 6 7.16836- 1 1.00000+ 7 1.11689+ 05604 3 16  584
1.10000+ 7 1.34265+ 0 1.20000+ 7 1.47242+ 0 1.29366+ 7 1.54845+ 05604 3 16  585
1.30000+ 7 1.55189+ 0 1.40000+ 7 1.61063+ 0 1.45000+ 7 1.62965+ 05604 3 16  586
1.50000+ 7 1.64460+ 0 1.57626+ 7 1.66326+ 0 1.60000+ 7 1.66798+ 05604 3 16  587
1.65762+ 7 1.67985+ 0 1.70000+ 7 1.68436+ 0 1.80000+ 7 1.61417+ 05604 3 16  588
1.90000+ 7 1.39281+ 0 2.00000+ 7 1.13632+ 0                      5604 3 16  589
                                                                 5604 3  0  590
5.61350+ 4 1.33747+ 2          0          0          0          05604 3 17  591
0.00000+ 0-1.64532+ 7          0          0          1         55604 3 17  592
         5          2          0          0          0          05604 3 17  593
1.65762+ 7 0.00000+ 0 1.70000+ 7 2.12463- 3 1.80000+ 7 9.51972- 25604 3 17  594
1.90000+ 7 3.55968- 1 2.00000+ 7 6.54325- 1                      5604 3 17  595
                                                                 5604 3  0  596
5.61350+ 4 1.33747+ 2          0          0          0          05604 3 22  597
0.00000+ 0-1.87090+ 6          0          0          2        305604 3 22  598
         3          2         30          4          0          05604 3 22  599
1.88489+ 6 0.00000+ 0 2.00000+ 6 0.00000+ 0 3.00000+ 6 1.64164-175604 3 22  600
4.00000+ 6 7.03689-16 5.00000+ 6 2.11559-14 5.98897+ 6 5.76316-135604 3 22  601
6.00000+ 6 6.00177-13 6.30296+ 6 1.58445-12 6.70524+ 6 6.07474-125604 3 22  602
7.00000+ 6 1.63895-11 7.03028+ 6 1.82895-11 7.11666+ 6 2.44426-115604 3 22  603
8.00000+ 6 2.82389-10 8.31636+ 6 6.16240-10 9.00000+ 6 4.29977- 95604 3 22  604
```

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```
2.00000+ 6 1.03207- 1 3.00000+ 6 5.31413- 2 4.00000+ 6 1.48833- 25604 3 57  715
5.00000+ 6 3.58669- 3 6.00000+ 6 7.69522- 4 7.00000+ 6 1.60533- 45604 3 57  716
8.00000+ 6 3.13742- 5 9.00000+ 6 5.15023- 6 1.00000+ 7 8.85329- 75604 3 57  717
1.20000+ 7 4.40211- 8 1.40000+ 7 3.40347- 9 1.50000+ 7 1.02888- 95604 3 57  718
1.60000+ 7 3.24734-10 1.80000+ 7 3.58360-11 2.00000+ 7 3.93370-125604 3 57  719
                                                                 5604 3  0  720
5.61350+ 4 1.33747+ 2          0          0          0          05604 3 91  721
0.00000+ 0-1.17000+ 6          0          0          1        195604 3 91  722
        19          3          0          0          0          05604 3 91  723
1.17875+ 6 0.00000+ 0 1.25000+ 6 1.29474- 2 1.50000+ 6 1.47085- 15604 3 91  724
1.75000+ 6 3.67981- 1 2.00000+ 6 6.44467- 1 3.00000+ 6 1.58796+ 05604 3 91  725
4.00000+ 6 1.95305+ 0 5.00000+ 6 2.00219+ 0 6.00000+ 6 2.03099+ 05604 3 91  726
7.00000+ 6 2.08176+ 0 8.00000+ 6 1.88855+ 0 9.00000+ 6 1.34731+ 05604 3 91  727
1.00000+ 7 9.45539- 1 1.20000+ 7 6.49471- 1 1.40000+ 7 5.48431- 15604 3 91  728
1.50000+ 7 5.12758- 1 1.60000+ 7 4.83036- 1 1.80000+ 7 4.32197- 15604 3 91  729
2.00000+ 7 3.43313- 1                                            5604 3 91  730
                                                                 5604 3  0  731
5.61350+ 4 1.33747+ 2          0          0          0          05604 3102  732
9.10740+ 6 9.10740+ 6          0          0          2        515604 3102  733
```

Fig. 4.2(3) Output to logical unit of 4 from the example 1

```
          3          2         51          5          0          05604 3102  734
1.00000- 5 0.00000+ 0 2.53000- 2 0.00000+ 0 1.00000+ 5 0.00000+ 05604 3102  735
1.00000+ 5 2.52049- 1 1.50000+ 5 2.14409- 1 2.00000+ 5 1.96950- 15604 3102  736
2.22652+ 5 1.92260- 1 2.50000+ 5 1.82437- 1 2.70205+ 5 1.78282- 15604 3102  737
3.00000+ 5 1.72554- 1 4.84193+ 5 1.57791- 1 5.00000+ 5 1.48783- 15604 3102  738
5.92296+ 5 1.34973- 1 7.00000+ 5 1.23520- 1 8.00000+ 5 1.20711- 15604 3102  739
8.61393+ 5 1.20363- 1 8.81038+ 5 1.19402- 1 9.00000+ 5 1.15619- 15604 3102  740
9.87327+ 5 1.11212- 1 1.00000+ 6 1.10467- 1 1.17875+ 6 1.09530- 15604 3102  741
1.25000+ 6 1.09761- 1 1.50000+ 6 1.06833- 1 1.75000+ 6 1.00235- 15604 3102  742
2.00000+ 6 9.04595- 2 3.00000+ 6 4.73067- 2 4.00000+ 6 2.34056- 25604 3102  743
5.00000+ 6 1.09453- 2 5.47723+ 6 7.42140- 3 6.00000+ 6 5.16080- 35604 3102  744
6.48074+ 6 3.62098- 3 7.00000+ 6 2.70890- 3 7.23762+ 6 2.31291- 35604 3102  745
7.48331+ 6 2.01722- 3 7.73734+ 6 1.79910- 3 8.00000+ 6 1.64106- 35604 3102  746
8.23907+ 6 1.46925- 3 8.48528+ 6 1.34395- 3 9.00000+ 6 1.18695- 35604 3102  747
9.48683+ 6 1.09062- 3 1.00000+ 7 1.03187- 3 1.10000+ 7 9.79633- 45604 3102  748
1.20000+ 7 9.66420- 4 1.30000+ 7 9.76137- 4 1.40000+ 7 1.00183- 35604 3102  749
1.50000+ 7 1.03957- 3 1.60000+ 7 1.08733- 3 1.70000+ 7 1.14378- 35604 3102  750
1.80000+ 7 1.20800- 3 1.90000+ 7 1.27946- 3 2.00000+ 7 1.35784- 35604 3102  751
                                                                  5604 3  0  752
5.61350+ 4 1.33747+ 2          0          0          0          05604 3103  753
0.00000+ 0 5.77455+ 5          0          0          2        345604 3103  754
          3          2         34          4          0          05604 3103  755
1.00000- 5 0.00000+ 0 1.00000+ 5 0.00000+ 0 5.00000+ 5 5.12494-205604 3103  756
1.00000+ 6 3.03297-18 1.88489+ 6 4.58348-15 2.00000+ 6 1.11088-145604 3103  757
3.00000+ 6 3.54580-11 4.00000+ 6 1.11692- 7 5.00000+ 6 2.25435- 55604 3103  758
5.98897+ 6 5.40672- 5 6.00000+ 6 5.44086- 5 6.30296+ 6 6.51018- 55604 3103  759
6.70524+ 6 8.30298- 5 7.00000+ 6 1.00445- 4 7.03028+ 6 1.02375- 45604 3103  760
7.11666+ 6 1.08903- 4 8.00000+ 6 2.14215- 4 8.31636+ 6 2.75053- 45604 3103  761
9.00000+ 6 4.67097- 4 1.00000+ 7 9.21568- 4 1.10000+ 7 1.63365- 35604 3103  762
1.20000+ 7 2.60519- 3 1.29366+ 7 3.72173- 3 1.30000+ 7 3.80414- 35604 3103  763
1.40000+ 7 5.17967- 3 1.45000+ 7 5.88016- 3 1.50000+ 7 6.57049- 35604 3103  764
1.57626+ 7 7.56108- 3 1.60000+ 7 7.84979- 3 1.65762+ 7 8.45847- 35604 3103  765
1.70000+ 7 8.85099- 3 1.80000+ 7 9.51693- 3 1.90000+ 7 9.89451- 35604 3103  766
2.00000+ 7 1.00537- 2                                             5604 3103  767
                                                                  5604 3  0  768
5.61350+ 4 1.33747+ 2          0          0          0          05604 3104  769
0.00000+ 0-5.94453+ 6          0          0          2        255604 3104  770
          8          2         25          4          0          05604 3104  771
5.98897+ 6 0.00000+ 0 6.00000+ 6 0.00000+ 0 6.30296+ 6 0.00000+ 05604 3104  772
```

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```
1.40000+ 7 2.23632- 3 1.45000+ 7 2.63981- 3 1.50000+ 7 3.05507- 35604 3107  816
1.57626+ 7 3.68198- 3 1.60000+ 7 3.87263- 3 1.65762+ 7 4.27210- 35604 3107  817
1.70000+ 7 4.56953- 3 1.80000+ 7 5.02080- 3 1.90000+ 7 5.27736- 35604 3107  818
2.00000+ 7 5.36226- 3                                             5604 3107  819
                                                                  5604 3  0  820
5.61350+ 4 1.33747+ 2          0          0          0          05604 3251  821
0.00000+ 0 0.00000+ 0          0          0          1        555604 3251  822
         55          3          0          0          0          05604 3251  823
1.00000- 5 4.98453- 3 1.00000+ 0 4.98453- 3 3.00000+ 0 4.98453- 35604 3251  824
1.00000+ 1 4.99635- 3 3.00000+ 1 5.02342- 3 1.00000+ 2 5.13301- 35604 3251  825
3.00000+ 2 5.50333- 3 1.00000+ 3 7.06699- 3 2.00000+ 3 9.62148- 35604 3251  826
3.00000+ 3 1.23697- 2 5.00000+ 3 1.81802- 2 8.00000+ 3 2.72812- 25604 3251  827
1.00000+ 4 3.34574- 2 1.50000+ 4 4.89470- 2 2.00000+ 4 6.42366- 25604 3251  828
2.50000+ 4 7.91697- 2 3.00000+ 4 9.36725- 2 5.00000+ 4 1.47070- 15604 3251  829
8.00000+ 4 2.13878- 1 1.00000+ 5 2.50612- 1 1.50000+ 5 3.20472- 15604 3251  830
2.00000+ 5 3.66522- 1 2.22652+ 5 3.81582- 1 2.50000+ 5 3.98501- 15604 3251  831
2.70205+ 5 4.07982- 1 3.00000+ 5 4.18821- 1 4.84193+ 5 4.37471- 15604 3251  832
5.00000+ 5 4.39029- 1 5.92296+ 5 4.37280- 1 7.00000+ 5 4.34233- 15604 3251  833
8.00000+ 5 4.29685- 1 8.61393+ 5 4.27998- 1 8.81038+ 5 4.28379- 15604 3251  834
9.00000+ 5 4.29345- 1 9.87327+ 5 4.32390- 1 1.00000+ 6 4.33367- 15604 3251  835
1.17875+ 6 4.48814- 1 1.25000+ 6 4.57835- 1 1.50000+ 6 4.98364- 15604 3251  836
1.75000+ 6 5.42029- 1 2.00000+ 6 5.81214- 1 3.00000+ 6 6.60924- 15604 3251  837
4.00000+ 6 6.45123- 1 5.00000+ 6 6.14034- 1 6.00000+ 6 6.02617- 15604 3251  838
7.00000+ 6 6.34356- 1 8.00000+ 6 6.89679- 1 9.00000+ 6 7.41768- 15604 3251  839
1.00000+ 7 7.83729- 1 1.20000+ 7 8.42946- 1 1.40000+ 7 8.79666- 15604 3251  840
1.50000+ 7 8.91683- 1 1.60000+ 7 9.00648- 1 1.80000+ 7 9.12881- 15604 3251  841
```

Fig. 4.2(4) Output to logical unit of 4 from the example 1

```
2.00000+ 7 9.21345- 1                                               5604 3251  842
                                                                    5604 3  0  843
                                                                    5604 0  0  844
5.61350+ 4 1.33747+ 2          1          1          0             05604 4  2  845
0.00000+ 0 1.33747+ 2          0          2        441            205604 4  2  846
1.00000+ 0 4.98453- 3 1.11806- 5-1.29502-18 0.00000+ 0 0.00000+ 05604 4  2  847
0.00000+ 0 0.00000+ 0 0.00000+ 0 0.00000+ 0 0.00000+ 0 0.00000+ 05604 4  2  848
0.00000+ 0 0.00000+ 0 0.00000+ 0 0.00000+ 0 0.00000+ 0 0.00000+ 05604 4  2  849
0.00000+ 0 0.00000+ 0 0.00000+ 0 0.00000+ 0 9.99966- 1 8.97202- 35604 4  2  850
3.83332- 5 7.96149- 8 8.92875-11-1.63600-13 0.00000+ 0 0.00000+ 05604 4  2  851
0.00000+ 0 0.00000+ 0 0.00000+ 0 0.00000+ 0 0.00000+ 0 0.00000+ 05604 4  2  852
0.00000+ 0 0.00000+ 0 0.00000+ 0 0.00000+ 0 0.00000+ 0 0.00000+ 05604 4  2  853
0.00000+ 0-4.98429- 3 9.99912- 1 1.28168- 2 7.98592- 5 2.89504- 75604 4  2  854
6.55480-10 5.25823-13 0.00000+ 0 0.00000+ 0 0.00000+ 0 0.00000+ 05604 4  2  855
```

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```
4.18229- 1 3.46406- 1 2.73703- 1 2.02236- 1 1.33329- 1 8.19399- 25604 4  2 1077
4.83072- 2 2.49498- 2 1.13158- 2 3.84838- 3 1.28076- 3 3.69142- 45604 4  2 1078
1.01135- 4 2.95668- 5                                               5604 4  2 1079
0.00000+ 0 2.00000+ 7          0          0         20             05604 4  2 1080
9.20589- 1 8.47044- 1 7.66101- 1 6.91880- 1 6.07718- 1 5.30720- 15604 4  2 1081
4.51152- 1 3.77481- 1 3.03176- 1 2.32636- 1 1.64148- 1 1.07476- 15604 4  2 1082
6.87581- 2 4.08325- 2 2.13499- 2 8.84915- 3 3.23928- 3 1.00499- 35604 4  2 1083
2.92122- 4 8.96295- 5                                               5604 4  2 1084
                                                                    5604 4  0 1085
5.61350+ 4 1.33747+ 2          0          0          0             05604 4 16 1086
0.00000+ 0 1.33747+ 2          1          1          0             05604 4 16 1087
                                                                    5604 4  0 1088
5.61350+ 4 1.33747+ 2          0          0          0             05604 4 17 1089
0.00000+ 0 1.33747+ 2          1          1          0             05604 4 17 1090
                                                                    5604 4  0 1091
5.61350+ 4 1.33747+ 2          0          0          0             05604 4 22 1092
0.00000+ 0 1.33747+ 2          1          1          0             05604 4 22 1093
                                                                    5604 4  0 1094
5.61350+ 4 1.33747+ 2          0          0          0             05604 4 28 1095
0.00000+ 0 1.33747+ 2          1          1          0             05604 4 28 1096
                                                                    5604 4  0 1097
5.61350+ 4 1.33747+ 2          0          0          0             05604 4 32 1098
0.00000+ 0 1.33747+ 2          1          1          0             05604 4 32 1099
                                                                    5604 4  0 1100
5.61350+ 4 1.33747+ 2          0          1          0             05604 4 51 1101
0.00000+ 0 1.33747+ 2          0          2          0             05604 4 51 1102
0.00000+ 0 0.00000+ 0          0          0          1             65604 4 51 1103
         6          2          0          0          0             05604 4 51 1104
0.00000+ 0 2.22652+ 5          0          0          2             05604 4 51 1105
0.00000+ 0 0.00000+ 0                                               5604 4 51 1106
0.00000+ 0 1.00000+ 6          0          0          8             05604 4 51 1107
0.00000+ 0 3.18724- 2 0.00000+ 0-5.29282- 3 0.00000+ 0-1.36013- 55604 4 51 1108
0.00000+ 0-6.87983- 6                                               5604 4 51 1109
0.00000+ 0 5.00000+ 6          0          0         14             05604 4 51 1110
0.00000+ 0 9.53777- 2 0.00000+ 0 8.35093- 3 0.00000+ 0-1.74543- 35604 4 51 1111
0.00000+ 0-4.30013- 4 0.00000+ 0-4.73294- 5 0.00000+ 0-1.90327- 75604 4 51 1112
0.00000+ 0-6.94496- 8                                               5604 4 51 1113
0.00000+ 0 1.00000+ 7          0          0         18             05604 4 51 1114
0.00000+ 0 1.30912- 1 0.00000+ 0 2.79347- 2 0.00000+ 0 3.00109- 35604 4 51 1115
0.00000+ 0-1.44303- 3 0.00000+ 0-6.73305- 4 0.00000+ 0-5.36975- 55604 4 51 1116
0.00000+ 0-5.51283- 6 0.00000+ 0-5.73259- 7 0.00000+ 0-1.14405- 95604 4 51 1117
0.00000+ 0 1.50000+ 7          0          0         20             05604 4 51 1118
0.00000+ 0 1.48673- 1 0.00000+ 0 4.02414- 2 0.00000+ 0 9.41973- 35604 4 51 1119
0.00000+ 0 5.94982- 4 0.00000+ 0-8.69203- 4 0.00000+ 0-4.30613- 45604 4 51 1120
0.00000+ 0-8.65855- 5 0.00000+ 0-2.20275- 5 0.00000+ 0-8.64076- 75604 4 51 1121
0.00000+ 0-5.28758- 9                                               5604 4 51 1122
0.00000+ 0 2.00000+ 7          0          0         20             05604 4 51 1123
0.00000+ 0 1.60723- 1 0.00000+ 0 5.00657- 2 0.00000+ 0 1.54281- 25604 4 51 1124
```

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Fig. 4.2(5) Output to logical unit of 4 from the example 1

```
0.00000+ 0 5.17162- 4 0.00000+ 0 3.77162- 5 0.00000+ 0 2.90128- 65604 4 91 1313
0.00000+ 0 9.03795- 7 0.00000+ 0 2.24896- 8 0.00000+ 0 4.22827-105604 4 91 1314
0.00000+ 0 3.24034-12                                          5604 4 91 1315
                                                               5604 4  0 1316
                                                               5604 0  0 1317
5.61350+ 4 1.33747+ 2          0          0          1        05604 5 16 1318
0.00000+ 0 0.00000+ 0          0          1          1        25604 5 16 1319
         2          2          0          0          0        05604 5 16 1320
7.03028+ 6 1.00000+ 0 2.00000+ 7 1.00000+ 0                    5604 5 16 1321
0.00000+ 0 0.00000+ 0          0          0          1        85604 5 16 1322
         8          2          0          0          0        05604 5 16 1323
0.00000+ 0 7.03028+ 6          0          0          3        75604 5 16 1324
         2          2          6          4          7        25604 5 16 1325
0.00000+ 0 0.00000+ 0 1.25000+ 5 1.48280- 6 2.50000+ 5 1.78074- 65604 5 16 1326
3.75000+ 5 1.71049- 6 5.00000+ 5 1.46392- 6 7.50000+ 5 6.34801- 75604 5 16 1327
8.75000+ 5 0.00000+ 0                                          5604 5 16 1328
0.00000+ 0 8.00000+ 6          0          0          3        75604 5 16 1329
         2          2          6          4          7        25604 5 16 1330
0.00000+ 0 0.00000+ 0 1.25000+ 5 1.48280- 6 2.50000+ 5 1.78074- 65604 5 16 1331
3.75000+ 5 1.71049- 6 5.00000+ 5 1.46392- 6 7.50000+ 5 6.34801- 75604 5 16 1332
8.75000+ 5 0.00000+ 0                                          5604 5 16 1333
0.00000+ 0 1.00000+ 7          0          0          3       185604 5 16 1334
         2          2         17          4         18        25604 5 16 1335
0.00000+ 0 0.00000+ 0 1.25000+ 5 2.81119- 7 2.50000+ 5 4.17648- 75604 5 16 1336
3.75000+ 5 4.94903- 7 5.00000+ 5 5.49001- 7 7.50000+ 5 6.04710- 75604 5 16 1337
8.75000+ 5 6.10643- 7 1.00000+ 6 6.03090- 7 1.25000+ 6 5.41808- 75604 5 16 1338
1.50000+ 6 4.44116- 7 1.75000+ 6 3.37409- 7 2.00000+ 6 2.36698- 75604 5 16 1339
2.12500+ 6 1.89295- 7 2.25000+ 6 1.46865- 7 2.37500+ 6 1.09914- 75604 5 16 1340
```

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```
1.51250+ 7 5.26420- 8 1.53750+ 7 4.18452- 8 1.55000+ 7 3.63490- 85604 5 91 1914
1.56250+ 7 3.07826- 8 1.57500+ 7 2.51422- 8 1.58750+ 7 1.94237- 85604 5 91 1915
1.60000+ 7 1.36232- 8 1.61250+ 7 7.73786- 9 1.62500+ 7 1.75958- 95604 5 91 1916
1.63750+ 7 1.25326-14 1.67500+ 7 6.73518-15 1.68212+ 7 0.00000+ 05604 5 91 1917
0.00000+ 0 2.00000+ 7          0          0          3       415604 5 91 1918
         2          2         40          4         41        25604 5 91 1919
0.00000+ 0 0.00000+ 0 1.25000+ 5 4.98558-10 2.50000+ 5 8.74369-105604 5 91 1920
3.75000+ 5 1.21696- 9 5.00000+ 5 1.58487- 9 7.50000+ 5 2.41219- 95604 5 91 1921
1.00000+ 6 3.35535- 9 1.25000+ 6 4.26460- 9 1.50000+ 6 5.04230- 95604 5 91 1922
1.75000+ 6 5.67992- 9 2.00000+ 6 6.16203- 9 3.62500+ 6 7.58481- 95604 5 91 1923
4.62500+ 6 9.25463- 9 5.37500+ 6 1.13386- 8 7.75000+ 6 2.32033- 85604 5 91 1924
9.00000+ 6 3.13395- 8 1.03750+ 7 4.20318- 8 1.10000+ 7 5.09041- 85604 5 91 1925
1.13750+ 7 6.03427- 8 1.17500+ 7 7.62466- 8 1.20000+ 7 9.35121- 85604 5 91 1926
1.23750+ 7 1.36211- 7 1.26250+ 7 1.79598- 7 1.28750+ 7 2.19920- 75604 5 91 1927
1.42500+ 7 1.68367- 7 1.52500+ 7 1.29459- 7 1.60000+ 7 9.96272- 85604 5 91 1928
1.65000+ 7 7.92113- 8 1.68750+ 7 6.34526- 8 1.71250+ 7 5.26929- 85604 5 91 1929
1.73750+ 7 4.17026- 8 1.75000+ 7 3.61133- 8 1.76250+ 7 3.04570- 85604 5 91 1930
1.77500+ 7 2.47304- 8 1.78750+ 7 1.89300- 8 1.80000+ 7 1.30525- 85604 5 91 1931
1.81250+ 7 7.09580- 9 1.82500+ 7 1.05203- 9 1.83750+ 7 1.62266-155604 5 91 1932
1.87500+ 7 8.70485-16 1.88212+ 7 0.00000+ 0                    5604 5 91 1933
                                                               5604 5  0 1934
                                                               5604 0  0 1935
                                                                  0 0  0 1936
                                                                 -1 0  0    0
```

Fig. 4.2(6) Output to logical unit of 4 from the example 1

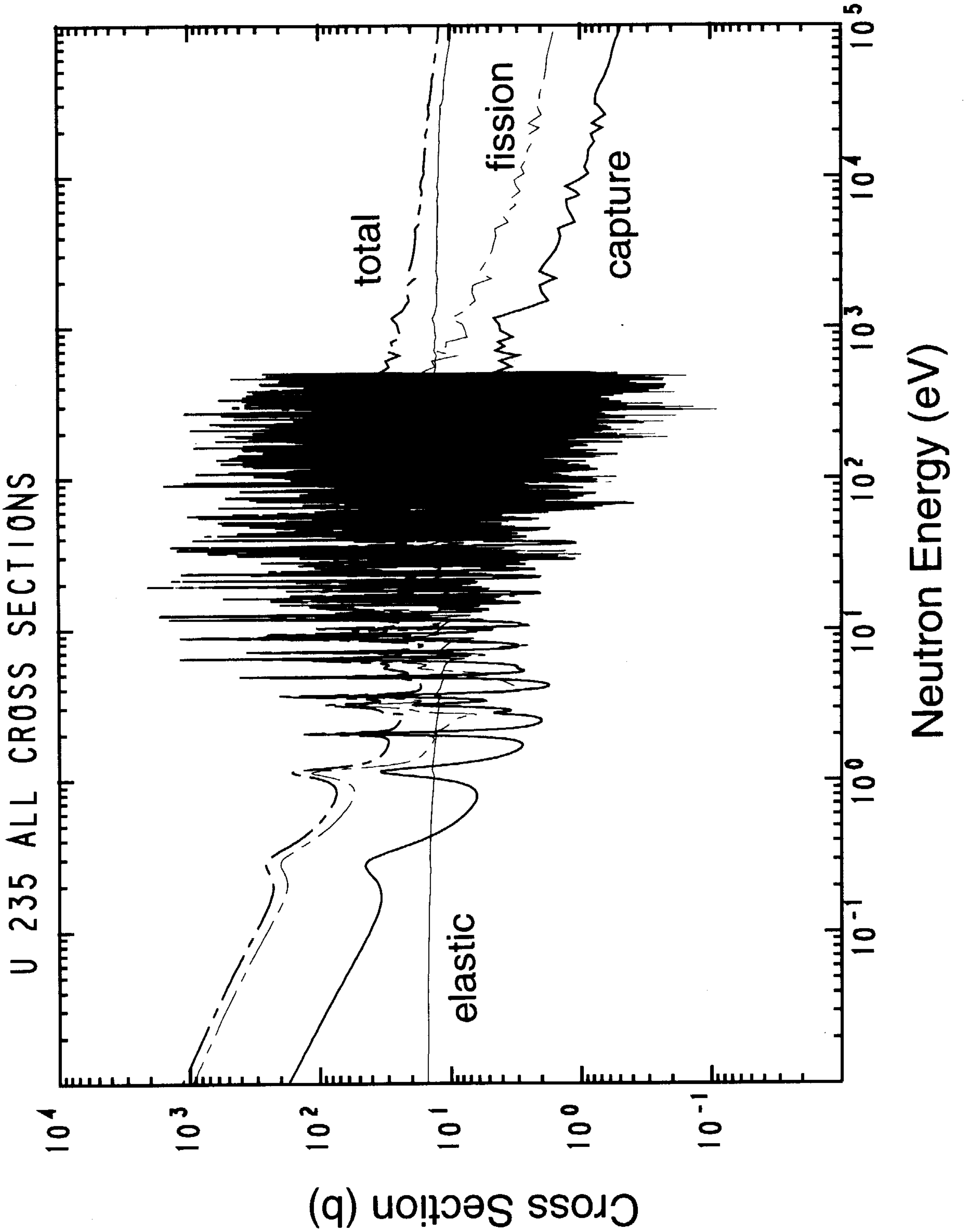

Fig. 4.3 Pointwise cross sections used in the example 2.

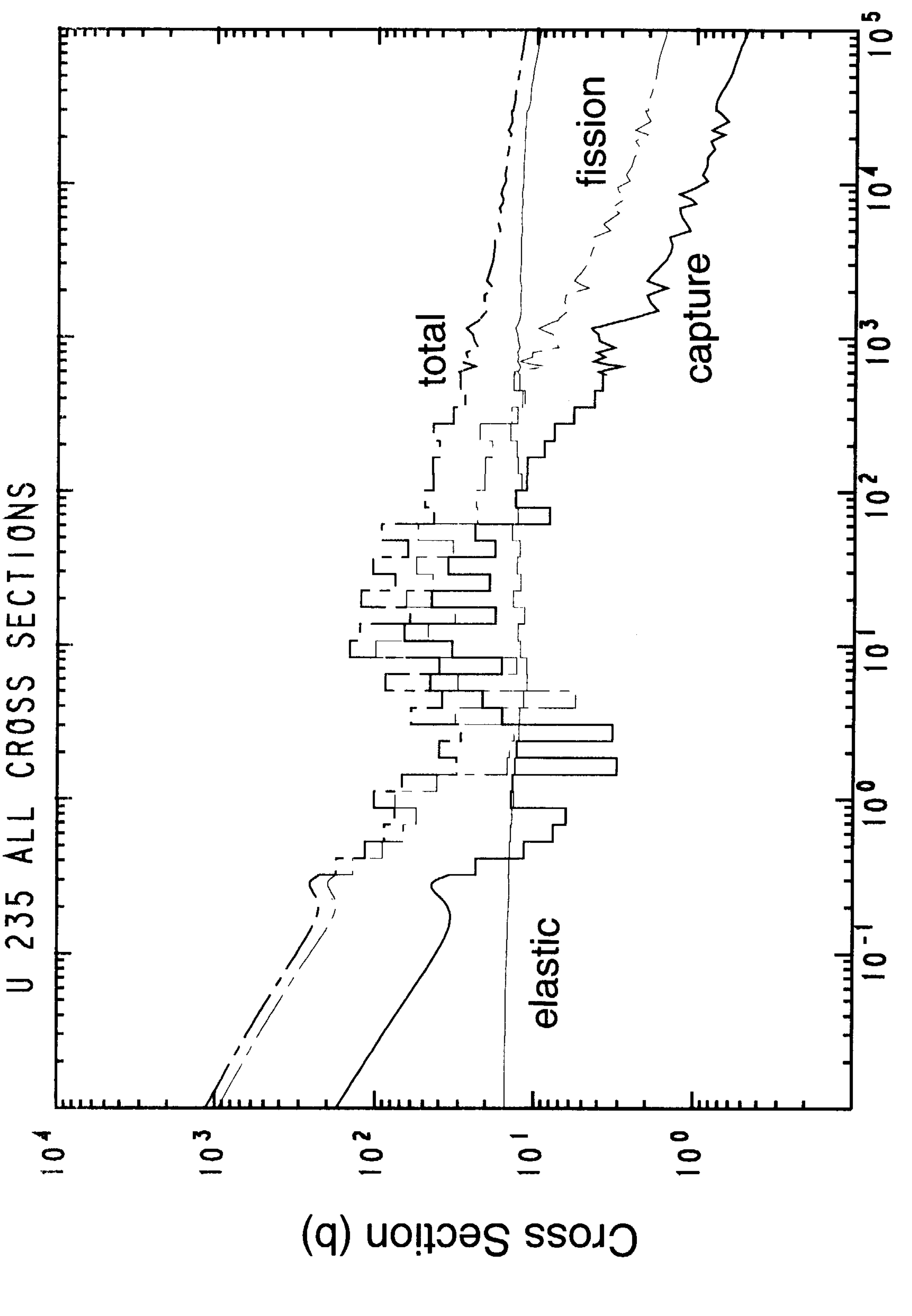

Fig. 4.4 Results of the example 2. The cross section data in the energy range from 0.32242 to 582.95 eV were replaced with averaged cross sections.

```
 EXAMPLE 3                                                            0         0
5.01000+ 3 9.92690+ 0         -1          0          0          02051 1451    1
0.00000+ 0 0.00000+ 0          0          0          0          62051 1451    2
1.00000+ 0 0.00000+ 0          0          0         10          02051 1451    3
0.00000+ 0 0.00000+ 0          0          0          2          52051 1451    4
                                                                 2051 1451    5
                                                                 2051 1451    6
                               1        451         11          12051 1451    6
                               3        107         80          02051 1451    7
                               3        800         92          02051 1451    8
                               3        801         92          02051 1451    9
                               3        999         61          02051 1451   10
                                                                 2051 1  0   11
                                                                 2051 0  0   12
5.01000+ 3 9.92690+ 0          0          0          0          02051 3107   13
0.00000+ 0 2.79000+ 6          0          0          2        2312051 3107   14
       133          5        231          2          0          02051 3107   15
1.00000- 5 1.92985+ 5 1.00000- 4 6.10271+ 4 1.00000- 3 1.92983+ 42051 3107   16
2.53000- 2 3.83645+ 3 1.00000- 1 1.92939+ 3 1.00000+ 0 6.09963+ 22051 3107   17
2.00000+ 0 4.31218+ 2 3.00000+ 0 3.52032+ 2 4.00000+ 0 3.04827+ 22051 3107   18
5.00000+ 0 2.72613+ 2 6.00000+ 0 2.48833+ 2 7.00000+ 0 2.30352+ 22051 3107   19
8.00000+ 0 2.15455+ 2 9.00000+ 0 2.03115+ 2 1.00000+ 1 1.92676+ 22051 3107   20
2.00000+ 1 1.36153+ 2 3.00000+ 1 1.11113+ 2 4.00000+ 1 9.61861+ 12051 3107   21
5.00000+ 1 8.59997+ 1 6.00000+ 1 7.84805+ 1 7.00000+ 1 7.26366+ 12051 3107   22
8.00000+ 1 6.79261+ 1 9.00000+ 1 6.40244+ 1 1.00000+ 2 6.07237+ 12051 3107   23
2.00000+ 2 4.28526+ 1 3.00000+ 2 3.49365+ 1 4.00000+ 2 3.02182+ 12051 3107   24
5.00000+ 2 2.69988+ 1 6.00000+ 2 2.46226+ 1 7.00000+ 2 2.27761+ 12051 3107   25
8.00000+ 2 2.12787+ 1 9.00000+ 2 2.00553+ 1 1.00000+ 3 1.90127+ 12051 3107   26
2.00000+ 3 1.33713+ 1 3.00000+ 3 1.08758+ 1 4.00000+ 3 9.39041+ 02051 3107   27
5.00000+ 3 8.37828+ 0 6.00000+ 3 7.63234+ 0 7.00000+ 3 7.05353+ 02051 3107   28
8.00000+ 3 6.58774+ 0 9.00000+ 3 6.20258+ 0 1.00000+ 4 5.87732+ 02051 3107   29
1.50000+ 4 4.77956+ 0 2.00000+ 4 4.13188+ 0 2.50000+ 4 3.69495+ 02051 3107   30
```

(Skipped)

```
1.00000+ 7 5.97500- 2 1.05000+ 7 5.90650- 2 1.10000+ 7 5.84800- 22051 3107   86
1.15000+ 7 5.81950- 2 1.20000+ 7 5.81600- 2 1.25000+ 7 5.84250- 22051 3107   87
1.30000+ 7 5.87900- 2 1.35000+ 7 5.93550- 2 1.40000+ 7 6.02200- 22051 3107   88
1.45000+ 7 6.04350- 2 1.50000+ 7 5.97500- 2 1.55000+ 7 5.82940- 22051 3107   89
1.60000+ 7 5.68170- 2 1.65000+ 7 5.53400- 2 1.70000+ 7 5.38630- 22051 3107   90
1.75000+ 7 5.23860- 2 1.80000+ 7 5.09080- 2 1.85000+ 7 4.94310- 22051 3107   91
1.90000+ 7 4.79540- 2 1.95000+ 7 4.64770- 2 2.00000+ 7 4.50000- 22051 3107   92
                                                                 2051 3  0   93
5.01000+ 3 9.92690+ 0          0          0          0          02051 3800   94
2.79000+ 6 2.79000+ 6          0          0          2        2652051 3800   95
       162          5        265          2          0          02051 3800   96
1.00000- 5 1.21277+ 4 1.00000- 4 3.83504+ 3 1.00000- 3 1.21271+ 32051 3800   97
2.53000- 2 2.41076+ 2 1.00000- 1 1.21238+ 2 1.00000+ 0 3.83280+ 12051 3800   98
2.00000+ 0 2.70961+ 1 3.00000+ 0 2.21203+ 1 4.00000+ 0 1.91541+ 12051 3800   99
5.00000+ 0 1.71299+ 1 6.00000+ 0 1.56356+ 1 7.00000+ 0 1.44743+ 12051 3800  100
8.00000+ 0 1.35382+ 1 9.00000+ 0 1.27628+ 1 9.40000+ 0 1.24879+ 12051 3800  101
1.00000+ 1 1.21068+ 1 2.00000+ 1 8.55463+ 0 3.00000+ 1 6.98107+ 02051 3800  102
4.00000+ 1 6.04307+ 0 5.00000+ 1 5.40298+ 0 6.00000+ 1 4.93049+ 02051 3800  103
7.00000+ 1 4.56329+ 0 8.00000+ 1 4.26730+ 0 9.00000+ 1 4.02214+ 02051 3800  104
1.00000+ 2 3.81475+ 0 1.50000+ 2 3.11098+ 0 2.00000+ 2 2.69174+ 02051 3800  105
2.50000+ 2 2.40543+ 0 3.00000+ 2 2.19414+ 0 3.50000+ 2 2.02985+ 02051 3800  106
4.00000+ 2 1.89780+ 0 4.50000+ 2 1.78836+ 0 5.00000+ 2 1.69559+ 02051 3800  107
5.50000+ 2 1.61575+ 0 6.00000+ 2 1.54597+ 0 6.50000+ 2 1.48440+ 02051 3800  108
7.00000+ 2 1.42968+ 0 7.50000+ 2 1.38021+ 0 8.00000+ 2 1.33554+ 02051 3800  109
8.50000+ 2 1.29542+ 0 9.00000+ 2 1.25899+ 0 9.50000+ 2 1.22522+ 02051 3800  110
1.00000+ 3 1.19370+ 0 1.50000+ 3 9.71006- 1 2.00000+ 3 8.38856- 12051 3800  111
2.50000+ 3 7.48596- 1 3.00000+ 3 6.81876- 1 3.50000+ 3 6.30029- 12051 3800  112
4.00000+ 3 5.88401- 1 4.50000+ 3 5.53930- 1 5.00000+ 3 5.24804- 12051 3800  113
5.50000+ 3 4.99760- 1 6.00000+ 3 4.77939- 1 6.50000+ 3 4.58701- 12051 3800  114
7.00000+ 3 4.41576- 1 7.50000+ 3 4.26208- 1 8.00000+ 3 4.12300- 12051 3800  115
8.50000+ 3 3.99652- 1 9.00000+ 3 3.88152- 1 9.50000+ 3 3.77583- 12051 3800  116
1.00000+ 4 3.67808- 1 1.50000+ 4 2.99100- 1 2.00000+ 4 2.58893- 12051 3800  117
```

Fig. 4.5(1) Output to logical unit of 3 from the example 3

```
2.40000+ 4 2.36745- 1 2.50000+ 4 2.32090- 1 3.00000+ 4 2.12647- 12051 3800  118
```

(Skipped)

```
1.10000+ 7 2.63840- 2 1.15000+ 7 2.41719- 2 1.20000+ 7 2.21985- 22051 3800  179
1.25000+ 7 2.06012- 2 1.30000+ 7 1.92955- 2 1.35000+ 7 1.80066- 22051 3800  180
1.40000+ 7 1.67436- 2 1.45000+ 7 1.56456- 2 1.50000+ 7 1.53055- 22051 3800  181
1.55000+ 7 1.51228- 2 1.60000+ 7 1.49823- 2 1.65000+ 7 1.48358- 22051 3800  182
1.70000+ 7 1.46775- 2 1.75000+ 7 1.45267- 2 1.80000+ 7 1.43774- 22051 3800  183
1.85000+ 7 1.42327- 2 1.90000+ 7 1.40956- 2 1.95000+ 7 1.39671- 22051 3800  184
2.00000+ 7 1.38462- 2                                             2051 3800  185
                                                                  2051 3  0  186
5.01000+ 3 9.92690+ 0          0          0          0           02051 3801  187
2.79000+ 6 2.79000+ 6          0          0          2         2652051 3801  188
       162          5        265          2          0           02051 3801  189
1.00000- 5 1.80857+ 5 1.00000- 4 5.71921+ 4 1.00000- 3 1.80856+ 42051 3801  190
2.53000- 2 3.59537+ 3 1.00000- 1 1.80815+ 3 1.00000+ 0 5.71635+ 22051 3801  191
2.00000+ 0 4.04122+ 2 3.00000+ 0 3.29912+ 2 4.00000+ 0 2.85673+ 22051 3801  192
5.00000+ 0 2.55483+ 2 6.00000+ 0 2.33197+ 2 7.00000+ 0 2.15878+ 22051 3801  193
8.00000+ 0 2.01917+ 2 9.00000+ 0 1.90352+ 2 9.40000+ 0 1.86252+ 22051 3801  194
1.00000+ 1 1.80569+ 2 2.00000+ 1 1.27598+ 2 3.00000+ 1 1.04132+ 22051 3801  195
4.00000+ 1 9.01430+ 1 5.00000+ 1 8.05967+ 1 6.00000+ 1 7.35500+ 12051 3801  196
7.00000+ 1 6.80733+ 1 8.00000+ 1 6.36588+ 1 9.00000+ 1 6.00023+ 12051 3801  197
1.00000+ 2 5.69090+ 1 1.50000+ 2 4.64119+ 1 2.00000+ 2 4.01609+ 12051 3801  198
2.50000+ 2 3.58914+ 1 3.00000+ 2 3.27424+ 1 3.50000+ 2 3.02935+ 12051 3801  199
4.00000+ 2 2.83204+ 1 4.50000+ 2 2.66854+ 1 5.00000+ 2 2.53032+ 12051 3801  200
5.50000+ 2 2.41136+ 1 6.00000+ 2 2.30766+ 1 6.50000+ 2 2.21615+ 12051 3801  201
7.00000+ 2 2.13464+ 1 7.50000+ 2 2.06095+ 1 8.00000+ 2 1.99432+ 12051 3801  202
8.50000+ 2 1.93445+ 1 9.00000+ 2 1.87963+ 1 9.50000+ 2 1.82881+ 12051 3801  203
1.00000+ 3 1.78190+ 1 1.50000+ 3 1.45036+ 1 2.00000+ 3 1.25324+ 12051 3801  204
2.50000+ 3 1.11858+ 1 3.00000+ 3 1.01939+ 1 3.50000+ 3 9.42278+ 02051 3801  205
4.00000+ 3 8.80201+ 0 4.50000+ 3 8.28788+ 0 5.00000+ 3 7.85348+ 02051 3801  206
5.50000+ 3 7.47990+ 0 6.00000+ 3 7.15440+ 0 6.50000+ 3 6.86740+ 02051 3801  207
7.00000+ 3 6.61195+ 0 7.50000+ 3 6.38269+ 0 8.00000+ 3 6.17544+ 02051 3801  208
8.50000+ 3 5.98694+ 0 9.00000+ 3 5.81443+ 0 9.50000+ 3 5.65590+ 02051 3801  209
1.00000+ 4 5.50951+ 0 1.50000+ 4 4.48046+ 0 2.00000+ 4 3.87299+ 02051 3801  210
```

(Skipped)

```
1.10000+ 7 3.20960- 2 1.15000+ 7 3.40231- 2 1.20000+ 7 3.59615- 22051 3801  272
1.25000+ 7 3.78238- 2 1.30000+ 7 3.94945- 2 1.35000+ 7 4.13484- 22051 3801  273
1.40000+ 7 4.34764- 2 1.45000+ 7 4.47894- 2 1.50000+ 7 4.44445- 22051 3801  274
1.55000+ 7 4.31712- 2 1.60000+ 7 4.18347- 2 1.65000+ 7 4.05042- 22051 3801  275
1.70000+ 7 3.91855- 2 1.75000+ 7 3.78593- 2 1.80000+ 7 3.65306- 22051 3801  276
1.85000+ 7 3.51983- 2 1.90000+ 7 3.38584- 2 1.95000+ 7 3.25099- 22051 3801  277
2.00000+ 7 3.11538- 2                                             2051 3801  278
                                                                  2051 3  0  279
5.01000+ 3 9.92692+ 0          0          0          0           02051 3999  280
2.79000+ 6 2.79000+ 6          0          0          2         1742051 3999  281
       120          5        174          2          0           02051 3999  282
1.00000- 5 6.28429- 2 2.53000- 2 6.28384- 2 9.40000+ 0 6.28355- 22051 3999  283
1.50000+ 2 6.28189- 2 2.50000+ 2 6.28101- 2 3.50000+ 2 6.27982- 22051 3999  284
4.50000+ 2 6.28074- 2 5.50000+ 2 6.27978- 2 6.50000+ 2 6.27762- 22051 3999  285
7.50000+ 2 6.27660- 2 8.50000+ 2 6.27625- 2 9.50000+ 2 6.27887- 22051 3999  286
1.50000+ 3 6.27482- 2 2.50000+ 3 6.27258- 2 3.50000+ 3 6.26719- 22051 3999  287
4.50000+ 3 6.26490- 2 5.50000+ 3 6.26292- 2 6.50000+ 3 6.26119- 22051 3999  288
7.50000+ 3 6.25957- 2 8.50000+ 3 6.25768- 2 9.50000+ 3 6.25812- 22051 3999  289
1.50000+ 4 6.25791- 2 2.00000+ 4 6.26574- 2 2.40000+ 4 6.27758- 22051 3999  290
3.00000+ 4 6.29783- 2 4.50000+ 4 6.39578- 2 5.50000+ 4 6.49092- 22051 3999  291
6.50000+ 4 6.61199- 2 7.50000+ 4 6.75494- 2 8.50000+ 4 6.91590- 22051 3999  292
9.50000+ 4 7.10234- 2 1.00000+ 5 7.20870- 2 1.20000+ 5 7.65602- 22051 3999  293
1.50000+ 5 8.46122- 2 1.70000+ 5 9.06606- 2 1.80000+ 5 9.38484- 22051 3999  294
1.90000+ 5 9.70624- 2 2.00000+ 5 1.00461- 1 2.10000+ 5 1.03854- 12051 3999  295
2.20000+ 5 1.07300- 1 2.30000+ 5 1.10846- 1 2.35000+ 5 1.12555- 12051 3999  296
2.40000+ 5 1.14445- 1 2.45000+ 5 1.16215- 1 2.50000+ 5 1.18014- 12051 3999  297
2.60000+ 5 1.21806- 1 2.70000+ 5 1.25526- 1 2.80000+ 5 1.29467- 12051 3999  298
3.00000+ 5 1.37949- 1 3.20000+ 5 1.47232- 1 3.40000+ 5 1.56898- 12051 3999  299
```

Fig. 4.5(2) Output to logical unit of 3 from the example 3

```
3.60000+ 5 1.67892- 1 3.80000+ 5 1.80575- 1 4.00000+ 5 1.94584- 12051 3999  300
4.20000+ 5 2.09398- 1 4.40000+ 5 2.24120- 1 4.60000+ 5 2.37696- 12051 3999  301
4.80000+ 5 2.49318- 1 5.00000+ 5 2.58775- 1 5.20000+ 5 2.66392- 12051 3999  302
5.40000+ 5 2.72745- 1 5.60000+ 5 2.78455- 1 5.80000+ 5 2.83935- 12051 3999  303
6.00000+ 5 2.89497- 1 6.50000+ 5 3.04555- 1 7.00000+ 5 3.21602- 12051 3999  304
7.50000+ 5 3.40307- 1 8.00000+ 5 3.60247- 1 8.50000+ 5 3.81011- 12051 3999  305
9.00000+ 5 4.02353- 1 9.50000+ 5 4.23998- 1 1.00000+ 6 4.45879- 12051 3999  306
1.05000+ 6 4.69727- 1 1.10000+ 6 4.96078- 1 1.15000+ 6 5.24437- 12051 3999  307
1.20000+ 6 5.54300- 1 1.25000+ 6 5.85155- 1 1.30000+ 6 6.15425- 12051 3999  308
1.35000+ 6 6.43695- 1 1.40000+ 6 6.69778- 1 1.45000+ 6 6.93599- 12051 3999  309
1.50000+ 6 7.15164- 1 1.55000+ 6 7.25882- 1 1.60000+ 6 7.24826- 12051 3999  310
1.65000+ 6 7.21434- 1 1.70000+ 6 7.23506- 1 1.75000+ 6 7.37270- 12051 3999  311
1.80000+ 6 7.50968- 1 1.85000+ 6 7.57804- 1 1.90000+ 6 7.59498- 12051 3999  312
1.95000+ 6 7.57679- 1 2.00000+ 6 7.52611- 1 2.05000+ 6 7.44405- 12051 3999  313
2.10000+ 6 7.34373- 1 2.15000+ 6 7.21336- 1 2.20000+ 6 7.07188- 12051 3999  314
2.25000+ 6 6.91288- 1 2.30000+ 6 6.71135- 1 2.35000+ 6 6.49491- 12051 3999  315
2.40000+ 6 6.28019- 1 2.45000+ 6 6.10980- 1 2.50000+ 6 6.07939- 12051 3999  316
2.55000+ 6 6.16229- 1 2.60000+ 6 6.25000- 1 2.65000+ 6 6.30835- 12051 3999  317
2.70000+ 6 6.36663- 1 2.75000+ 6 6.58570- 1 2.80000+ 6 6.75000- 12051 3999  318
2.85000+ 6 6.78192- 1 2.90000+ 6 6.84932- 1 2.95000+ 6 6.91566- 12051 3999  319
3.00000+ 6 6.96970- 1 3.05000+ 6 6.96967- 1 3.10000+ 6 6.92457- 12051 3999  320
3.15000+ 6 6.83172- 1 3.20000+ 6 6.73759- 1 3.30000+ 6 6.72906- 12051 3999  321
3.40000+ 6 6.75676- 1 3.60000+ 6 6.66667- 1 3.70000+ 6 6.62132- 12051 3999  322
3.80000+ 6 6.57534- 1 4.00000+ 6 6.28571- 1 4.20000+ 6 5.35426- 12051 3999  323
4.30000+ 6 5.25053- 1 4.40000+ 6 5.18367- 1 4.60000+ 6 4.85000- 12051 3999  324
4.80000+ 6 4.84550- 1 5.00000+ 6 5.07442- 1 5.20000+ 6 5.62365- 12051 3999  325
5.40000+ 6 6.40051- 1 5.50000+ 6 6.63797- 1 5.60000+ 6 6.69045- 12051 3999  326
5.80000+ 6 6.60947- 1 6.00000+ 6 6.58386- 1 6.20000+ 6 6.55837- 12051 3999  327
6.40000+ 6 6.65026- 1 6.60000+ 6 6.82252- 1 6.80000+ 6 6.95330- 12051 3999  328
7.00000+ 6 7.01667- 1 7.20000+ 6 7.01680- 1 7.40000+ 6 6.98477- 12051 3999  329
7.60000+ 6 6.93692- 1 7.80000+ 6 6.88749- 1 8.00000+ 6 6.84901- 12051 3999  330
8.20000+ 6 6.76991- 1 8.40000+ 6 6.65276- 1 8.60000+ 6 6.50829- 12051 3999  331
8.80000+ 6 6.34644- 1 9.00000+ 6 6.17664- 1 9.20000+ 6 6.00354- 12051 3999  332
9.40000+ 6 5.82601- 1 9.60000+ 6 5.64461- 1 9.80000+ 6 5.45993- 12051 3999  333
1.00000+ 7 5.27258- 1 1.05000+ 7 4.88635- 1 1.10000+ 7 4.51162- 12051 3999  334
1.15000+ 7 4.15360- 1 1.20000+ 7 3.81679- 1 1.25000+ 7 3.52610- 12051 3999  335
1.30000+ 7 3.28211- 1 1.35000+ 7 3.03371- 1 1.40000+ 7 2.78041- 12051 3999  336
1.45000+ 7 2.58883- 1 1.50000+ 7 2.56160- 1 1.55000+ 7 2.59423- 12051 3999  337
1.60000+ 7 2.63694- 1 1.65000+ 7 2.68084- 1 1.70000+ 7 2.72496- 12051 3999  338
1.75000+ 7 2.77302- 1 1.80000+ 7 2.82420- 1 1.85000+ 7 2.87930- 12051 3999  339
1.90000+ 7 2.93940- 1 1.95000+ 7 3.00516- 1 2.00000+ 7 3.07692- 12051 3999  340
                                                                  2051 3  0  341
                                                                  2051 0  0  342
                                                                     0 0  0  343
                                                                    -1 0  0    0
```

Fig. 4.5(3) Output to logical unit of 3 from the example 3

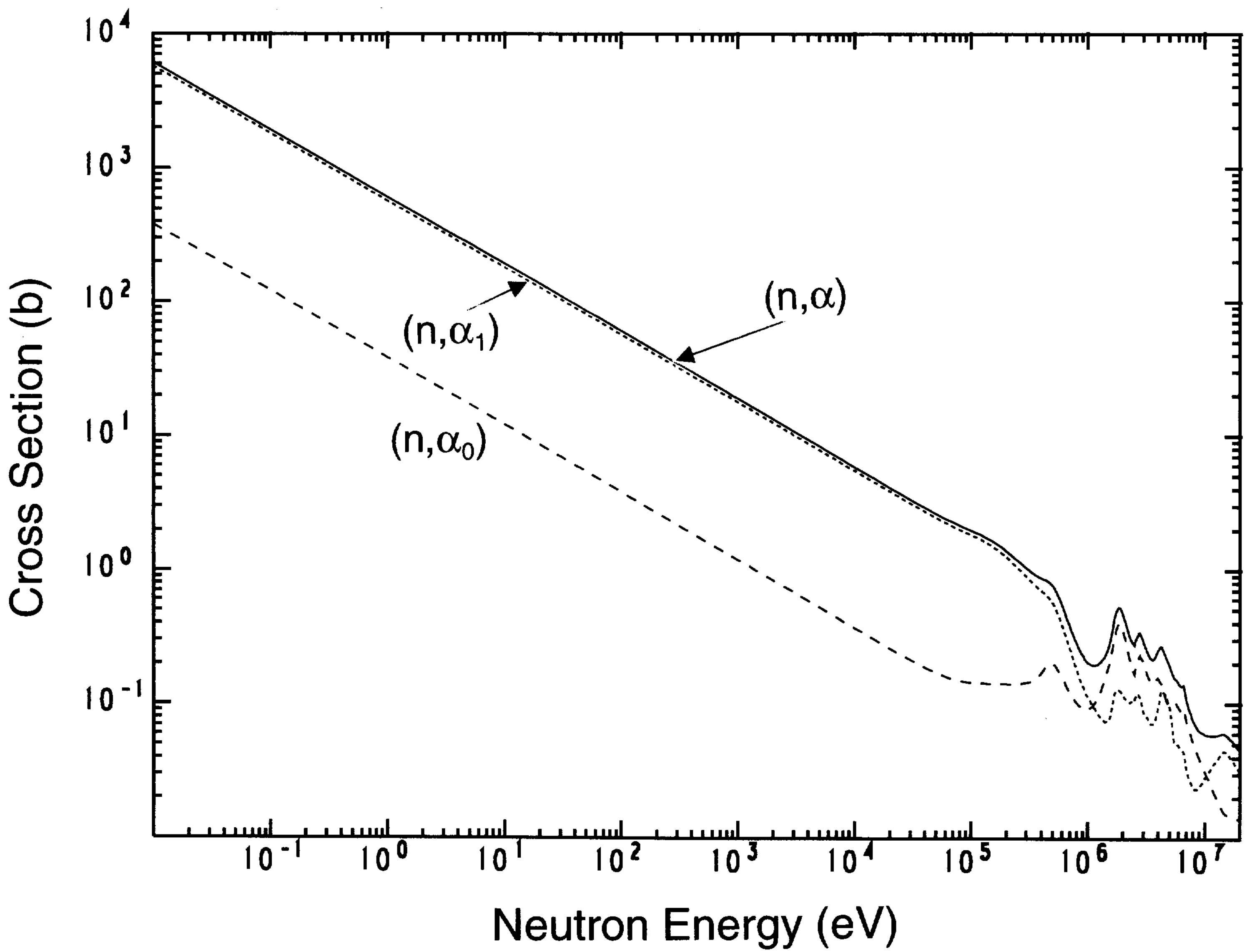

Fig. 4.6 Results of the example 3. The ^{10}B(n,α_1) and (n,α_0) cross sections (dotted and dashed line, respectively) were calculated from the ^{10}B(n,α) cross section (solid line).

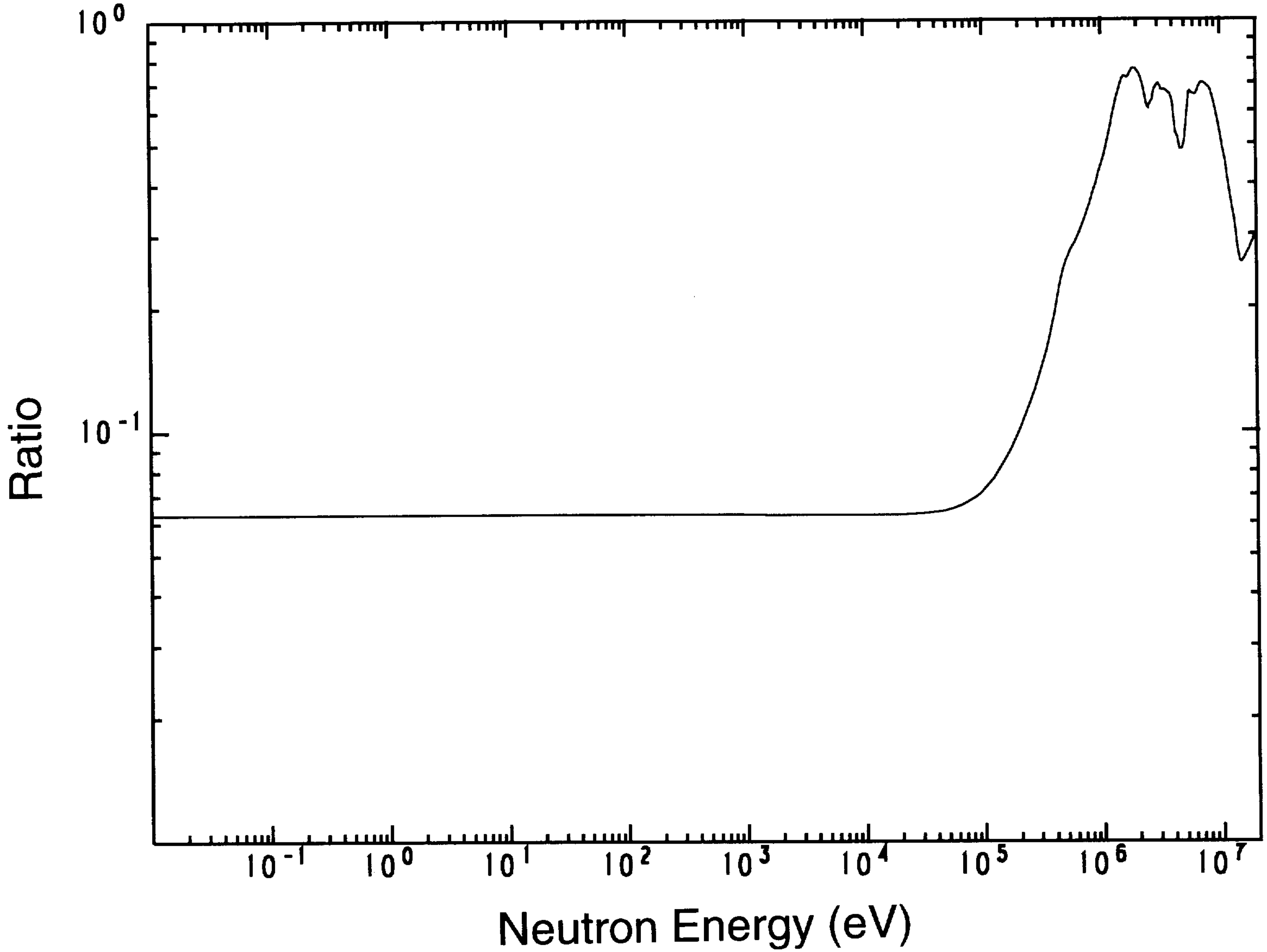

Fig. 4.7 Results of the example 3. The solid line is the ratio of $^{10}B(n,\alpha_0)$ to $^{10}B(n,\alpha_1)$ cross sections.

```
NATURAL      (2900, 0,   0) FROM  2 ISOTOPES
             ISOTOPE MAT=2925 , ABANDANCE= 6.91000E-01
             ISOTOPE MAT=2931 , ABANDANCE= 3.09000E-01

    ** MF=2 **

             (2925, 2,151) FOUND.
             (2931, 2,151) FOUND.

    ** MF=3  **

     SET-UP TENTATIVE DATA SETS.

             (  -1, 3,   1) = (2925, 3,   1) * 6.91000E-01
             (  -2, 3,   1) = (2931, 3,   1) * 3.09000E-01
             (  -1, 3,   2) = (2925, 3,   2) * 6.91000E-01
             (  -2, 3,   2) = (2931, 3,   2) * 3.09000E-01
             (  -1, 3,   4) = (2925, 3,   4) * 6.91000E-01
             (  -2, 3,   4) = (2931, 3,   4) * 3.09000E-01
             (  -1, 3,  16) = (2925, 3,  16) * 6.91000E-01
             (  -2, 3,  16) = (2931, 3,  16) * 3.09000E-01
             (  -1, 3,  22) = (2925, 3,  22) * 6.91000E-01
             (  -2, 3,  22) = (2931, 3,  22) * 3.09000E-01
             (  -1, 3,  28) = (2925, 3,  28) * 6.91000E-01
             (  -2, 3,  28) = (2931, 3,  28) * 3.09000E-01
             (  -1, 3,  32) = (2925, 3,  32) * 6.91000E-01
```

(Skipped)

```
             (  -2, 3,104) = (2931, 3,104) * 3.09000E-01
             (  -1, 3,107) = (2925, 3,107) * 6.91000E-01
             (  -2, 3,107) = (2931, 3,107) * 3.09000E-01
             (  -1, 3,251) = (2925, 3,251) * 6.91000E-01
             (  -2, 3,251) = (2931, 3,251) * 3.09000E-01
             (  -1, 3,251) = (  -1, 3,251) * (2925, 3,   2)
             (  -2, 3,251) = (  -2, 3,251) * (2931, 3,   2)

     MT=    1
             (2900, 3,   1) = (  -1, 3,   1)
             (2900, 3,   1) = (2900, 3,   1) + (  -2, 3,   1)

     MT=    2
             (2900, 3,   2) = (  -1, 3,   2)
             (2900, 3,   2) = (2900, 3,   2) + (  -2, 3,   2)

     MT=    4
             (2900, 3,   4) = (  -1, 3,   4)
```

Fig 4.8(1) Output of example 4

```
     (2900, 3,  4) = (2900, 3,  4) + (  -2, 3,  4)

MT=  16
     (2900, 3, 16) = (  -1, 3, 16)
     (2900, 3, 16) = (2900, 3, 16) + (  -2, 3, 16)
```

(Skipped)

```
INELASTIC CROSS SECTION (LEVELS)
     (2900, 3, 51) = (  -1, 3, 51)
     (2900, 3, 52) = (  -2, 3, 51)
     (2900, 3, 53) = (  -1, 3, 52)
     (2900, 3, 54) = (  -2, 3, 52)
     (2900, 3, 55) = (  -1, 3, 53)
     (2900, 3, 56) = (  -1, 3, 54)
     (2900, 3, 57) = (  -2, 3, 53)
     (2900, 3, 58) = (  -1, 3, 55)
     (2900, 3, 59) = (  -2, 3, 54)
     (2900, 3, 60) = (  -2, 3, 55)
```

(Skipped)

```
     (2900, 3, 85) = (  -2, 3, 68)
     (2900, 3, 86) = (  -2, 3, 69)
     (2900, 3, 87) = (  -2, 3, 70)

MT= 251
     (2900, 3,251) = (2900, 3,251) / (2900, 3,  2)

** MF=4 **

     (2900, 4,  2)
             MF =4 , MAT=2925 DEFINED   1.0000E-05 TO  2.0000E+07
             MF =4 , MAT=2931 DEFINED   1.0000E-05 TO  2.0000E+07
             ENERGY POINTS ARE  71 .
              1.0000E-05   2.5000E-02   1.0000E+03   2.0000E+03   5.0000E+03
              1.0000E+04   2.0000E+04   5.0000E+04   1.0000E+05   2.0000E+05
              5.0000E+05   6.8043E+05   7.8257E+05   9.7752E+05   1.0000E+06
              1.1333E+06   1.2500E+06   1.3483E+06   1.4346E+06   1.5000E+06
              1.5050E+06   1.5718E+06   1.6482E+06   1.7518E+06   1.8908E+06
              2.0000E+06   2.0432E+06   2.0951E+06   2.1144E+06   2.1265E+06
              2.1266E+06   2.1397E+06   2.2434E+06   2.2474E+06   2.3134E+06
              2.3652E+06   2.3745E+06   2.4436E+06   2.4444E+06   2.5000E+06
              2.5370E+06   2.5452E+06   2.5523E+06   2.5652E+06   2.5724E+06
              2.5734E+06   2.5767E+06   2.5807E+06   2.6333E+06   2.6851E+06
              2.6912E+06   2.6963E+06   2.7105E+06   2.7958E+06   2.8435E+06
              3.0000E+06   4.0000E+06   5.0000E+06   6.0000E+06   7.0000E+06
```

Fig 4.8(2) Output of example 4

```
            8.0000E+06    9.0000E+06    1.0000E+07    1.1000E+07    1.2000E+07
            1.3000E+07    1.4000E+07    1.5000E+07    1.6000E+07    1.8000E+07
            2.0000E+07
           ENERGY=     1.0000E-05  CROSS SECTION IS ZERO.  CANNOT DETERMINE CORRECT VALUES.
           ENERGY=     2.5000E-02  CROSS SECTION IS ZERO.  CANNOT DETERMINE CORRECT VALUES.
           ENERGY=     1.0000E+03  CROSS SECTION IS ZERO.  CANNOT DETERMINE CORRECT VALUES.
           ENERGY=     2.0000E+03  CROSS SECTION IS ZERO.  CANNOT DETERMINE CORRECT VALUES.
           ENERGY=     5.0000E+03  CROSS SECTION IS ZERO.  CANNOT DETERMINE CORRECT VALUES.
           ENERGY=     1.0000E+04  CROSS SECTION IS ZERO.  CANNOT DETERMINE CORRECT VALUES.
           ENERGY=     2.0000E+04  CROSS SECTION IS ZERO.  CANNOT DETERMINE CORRECT VALUES.
           ENERGY=     5.0000E+04  CROSS SECTION IS ZERO.  CANNOT DETERMINE CORRECT VALUES.
 (2900, 4, 16)
           MF =4 , MAT=2925 DEFINED   1.1028E+07 TO  2.0000E+07
           MF =4 , MAT=2931 DEFINED   1.0059E+07 TO  2.0000E+07
           ENERGY POINTS ARE  12 .
            1.0059E+07    1.1000E+07    1.1028E+07    1.2000E+07    1.3000E+07
            1.4000E+07    1.5000E+07    1.6000E+07    1.7000E+07    1.8000E+07
            1.9000E+07    2.0000E+07
           ENERGY=     1.0059E+07  CROSS SECTION IS ZERO.  CANNOT DETERMINE CORRECT VALUES.
```

(Skipped)

```
 (2900, 4, 91)
           MF =4 , MAT=2925 DEFINED   2.5807E+06 TO  2.0000E+07
           MF =4 , MAT=2931 DEFINED   2.8435E+06 TO  2.0000E+07
           ENERGY POINTS ARE  20 .
            2.5807E+06    2.8435E+06    3.0000E+06    4.0000E+06    5.0000E+06
            6.0000E+06    7.0000E+06    8.0000E+06    9.0000E+06    1.0000E+07
            1.1000E+07    1.2000E+07    1.3000E+07    1.4000E+07    1.5000E+07
            1.6000E+07    1.7000E+07    1.8000E+07    1.9000E+07    2.0000E+07
           ENERGY=     2.5807E+06  CROSS SECTION IS ZERO.  CANNOT DETERMINE CORRECT VALUES.

** MF=5 **

 (2900, 5, 16)
           MAT=2925 MF= 5 K= 1 LF= 1 DEFINED    1.1028E+07 TO  2.0000E+07
           MAT=2931 MF= 5 K= 1 LF= 1 DEFINED    1.0059E+07 TO  2.0000E+07
 (2900, 5, 22)
           MAT=2925 MF= 5 K= 1 LF= 1 DEFINED    5.8692E+06 TO  2.0000E+07
           MAT=2931 MF= 5 K= 1 LF= 1 DEFINED    6.8749E+06 TO  2.0000E+07
 (2900, 5, 28)
           MAT=2925 MF= 5 K= 1 LF= 1 DEFINED    6.2229E+06 TO  2.0000E+07
           MAT=2931 MF= 5 K= 1 LF= 1 DEFINED    7.5604E+06 TO  2.0000E+07
 (2900, 5, 32)
           MAT=2925 MF= 5 K= 1 LF= 1 DEFINED    1.4729E+07 TO  2.0000E+07
           MAT=2931 MF= 5 K= 1 LF= 1 DEFINED    1.5111E+07 TO  2.0000E+07
 (2900, 5, 91)
           MAT=2925 MF= 5 K= 1 LF= 1 DEFINED    2.5807E+06 TO  2.0000E+07
```

Fig 4.8(3) Output of example 4

```
                   MAT=2931 MF= 5 K= 1 LF= 1 DEFINED   2.8435E+06 TO  2.0000E+07
DELETE     (2925, 0,  0:  0)

DELETE     (2931, 0,  0:  0)

MAKE       (2900, 4,   0)
           (2900, 4,   2) SAME DATA SET FOUND IN TABLE
           (2900, 4,  16) SAME DATA SET FOUND IN TABLE
           (2900, 4,  22) SAME DATA SET FOUND IN TABLE
           (2900, 4,  28) SAME DATA SET FOUND IN TABLE
           (2900, 4,  32) SAME DATA SET FOUND IN TABLE
           (2900, 4,  51)
           (2900, 4,  52)
```

(Skipped)

```
           (2900, 4,  85)
           (2900, 4,  86)
           (2900, 4,  87)
           (2900, 4,  91) SAME DATA SET FOUND IN TABLE

END  ( 3)   2900
                   MF =  1 , MT = 451 , MOD =   1 , CARDS =  106
                   MF =  2 , MT = 151 , MOD =   0 , CARDS =  467
                   MF =  3 , MT =   1 , MOD =   0 , CARDS =  106
                   MF =  3 , MT =   2 , MOD =   0 , CARDS =  105
                   MF =  3 , MT =   4 , MOD =   0 , CARDS =   26
                   MF =  3 , MT =  16 , MOD =   0 , CARDS =    7
                   MF =  3 , MT =  22 , MOD =   0 , CARDS =    8
                   MF =  3 , MT =  28 , MOD =   0 , CARDS =    9
                   MF =  3 , MT =  32 , MOD =   0 , CARDS =    6
                   MF =  3 , MT =  51 , MOD =   0 , CARDS =   18
                   MF =  3 , MT =  52 , MOD =   0 , CARDS =   19
```

(Skipped)

```
                   MF =  4 , MT =  86 , MOD =   0 , CARDS =    2
                   MF =  4 , MT =  87 , MOD =   0 , CARDS =    2
                   MF =  4 , MT =  91 , MOD =   0 , CARDS =   44
                   MF =  5 , MT =  16 , MOD =   0 , CARDS =  397
                   MF =  5 , MT =  22 , MOD =   0 , CARDS =  505
                   MF =  5 , MT =  28 , MOD =   0 , CARDS =  590
                   MF =  5 , MT =  32 , MOD =   0 , CARDS =  203
                   MF =  5 , MT =  91 , MOD =   0 , CARDS =  851
                                           TOTAL CARDS = 4613

END OF THE MATERIAL ******
```

Fig 4.8(4) Output of example 4

Appendix 1: Important Error Messages

INPUT DATA ERROR

Input data are not correct.

(ERROR) ..... COMMAND IS NOT AVAILABLE.

The entered command cannot be used.

(ERROR) ..... DATA SECTION, MAT=*mat* MF=*mf* MT=*mt* CANNOT BE PROCESSED.

The data of (*mat*,*mf*,*mt*) cannot be read by CRECTJ.

(ERROR) ..... DIVISION BY ZERO. *f* / 0.0 RESULT = *ff*

During division, if a denominator is zero, this message is written. The result of this operation is *ff*.

(ERROR) ..... DIVISION BY ZERO. MORE THAN 20 TIMES.

If "DIVISION BY ZERO" occurred twenty-one times, this message is written, and the message of "DIVISON BY ZERO" is no longer printed out.

(ERROR) ..... ENERGY POINTS n TOO LARGE.

The number of energy points n exceeds the limit of 500 in the probability table of MF=5.

(ERROR) ..... ILLEGAL INTERPOLATION SCHEME. *i*

Interpolation scheme has to be from 1 to 5. However the interpolation scheme *i* is not in this range.

(ERROR) ..... INCORRECT OPERATION.

The specified operation cannot be curried out for MF=4.

(ERROR) ..... INPUT DATA ERROR FOR ISOTOPE, THIS PROCESS SKIPPED.

After the NATURAL command, the ISOTOPE sub-command is not given.

(ERROR) ..... MAT NUMBERS ARE DIFFERENT.

In the case of the SUM command, two MAT numbers in the command must be the same.

(ERROR) ..... MF=3 DATA WERE NOT FOUND.

The MAKE (*mat*,4,*mt*) command was entered. However the corresponding cross section data (MF=3, MT=*mt*) are not in the scratch disks. The energy range of (*mat*,4,*mt*), therefore, cannot be determined.

(ERROR) ..... NO DATA (*mat,mf,mt*) IN THE INPUT FILE.

The data specified by the READ command are not found in the input file.

(ERROR) ..... NO DATA FOR THIS MAKE COMMAND.

The data needed to perform this MAKE command have not yet been in the scratch disks. The READ command must be entered for the data before this MAKE command.

(ERROR) ..... NO DATA POINT AT e.

The DELETE sub-command is entered for the data point at *e* eV. However no data point exists at *e* eV.

(ERROR) ..... NO DATA WERE NORMALIZED.

The NORMALIZE command has not been performed.

(ERROR) ..... NO SPECTRUM DATA.

In the AVERAGE command, weight is greater than 10, while no spectrum was defined yet.

(ERROR) ..... NORMALIZATION CANNOT BE DONE FOR MF=*mf*.

The NORMALIZE command is available only for MF=4 and 5. However this NORMALIZE command specifies other MF number.

(ERROR) ..... NOT TAB1 RECORD IN MF=4 DATA.

During the normalization of angular-distribution data, a record that is not TAB1 is found.

(ERROR) ..... NUMBER OF ENERGIES EXCEEDED THE LIMIT.

The number of energy points of a probability table in MF=5 is greater than 40.

(ERROR) ..... NUMBER OF SUBSECTIONS EXCEEDED THE LIMIT.

During the NARURAL command for MF=5, the number of subsections exceeded the limit of 30.

(ERROR) ..... NUMBER OF TOTAL ENERGIES EXCEEDED THE LIMIT.

The number of incident neutron energy points of MF=5 is greater than 100.

(ERROR) ..... TABLE TYPE DATA CANNOT BE PROCESSED.

The angular-distribution data for a natural element cannot be constructed from table-type data.

(ERROR) ..... SAME ENERGY POINT AT *e*. REPLACED WITH NEW DATA.

INSERT command is entered for the data point at *e* eV. However the data is already existing at *e* eV. If two values are needed at the same energy, they can be entered by using REPLACE command.

(ERROR) ..... SUM OF PROBABILITIES IS ZERO AT *f* MEV.

During the NARURAL command for MF=5, the summation of probabilities of each spectrum becomes zero at *f* MeV.

(ERROR) ..... THE DATA (*mat,mf,mt*) ARE NOT IN THE DATA SET TABLE.

Specified data (*mat,mf,mt*) have not yet been stored in the scratch disks. The READ command should be entered before this command, or this specification of MAT, MF and MT numbers is not correct.

(ERROR) ..... THE SAME AS BEFORE CASE IS REQUIRED. BUT THIS IS THE FIRST CASE. THE CURRENT JOB IS TERMINATED.

In the AVERAGE command, *nint* = 0 is specified. However, this is the first case. Job cannot be continued.

(ERROR) ..... THIS MAKE COMMAND IS NOT DEFINED.

An incorrect MAKE command has been entered. The data (*mat,mf,mt*) cannot be created by the MAKE command.

(ERROR) ..... TOO MANY DATA POINTS GENERATED. ENERGY RANGE e_1 TO e_2

In the case of the OPERATE command, in order to represent a curve within accuracy of 1.0 %, new energy points are automatically generated. However, if the number of the new energies exceeds the limit of 300, this error message is written, and the energy-point generation is terminated.

(ERROR) ..... TOO MANY DATA SETS FOR (*mat,mf,mt*)

During the process of NATURAL command for (*mat,mf,mt*), the number of sections tentatively generated exceeded the limit of 500.

(ERROR) ..... TOO MANY ENERGY POINTS (*n* > 400)

During process of the NATURAL command for MF=4, the number of incident neutron energy points exceeded the limit of 400.

(ERROR) ..... THE NUMBER OF ENERGIES EXCEEDED THE LIMIT OF 3000.

In the SPECTRUM command, the number of energy points of the spectrum is exceeded the limit of 3000.

(ERROR) ..... TWO ANG DISTRIBUTIONS ARE DIFFRENT IN LCT.

The frame of reference (LCT) should be the same as each other in the case of the OPERATE command for MF=4. However, the LCT is different.

(ERROR) ..... TYPE = *xxxx* CANNOT BE OUTPUT. MF=*mf*, MT=*mt*.

During output of results, an invalid record type is found.

(ERROR) ..... X IS OUT OF ORDER. x_1, x_2

Neutron energies must be in increasing order, but incorrect order is found in the subroutine for integration.

(ERROR) ..... X VALUES ARE OUT OF ORDER. X1= x_1 X=x X2=x_2

The order of neutron energies is not correct. Therefore interpolation cannot be performed at x.

Appendix 2: MF Numbers

The MF numbers that can be read with CRECTJ are as follows:

MF	Meaning
1	General information.
2	Resonance parameters.
3	Reaction cross sections.
4	Angular distributions of secondary neutrons.
5	Energy distributions of secondary neutrons.
6	Energy-angular distributions for secondary particles.
7	Thermal neutron scattering law data.
8	Radioactive decay and fission product yield data.
9	Multiplicities for production of radioactive nuclides.
10	Cross sections for production of radioactive nuclides.
12	Photon production multiplicities and transition probability arrays.
13	Photon production cross sections.
14	Photon angular distributions.
15	Continuous photon energy spectra.
16	Photon energy-angle distributions. [ENDF/B-V only]
17	Discrete delayed gamma rays. [ENDF/B-V only]
18	Continuous spectra of delayed-photon emission. [ENDF/B-V only]
19	Electron multiplicities and transition probability array. [ENDF/B-V only]
20	Electron production cross sections. [ENDF/B-V only]
21	Electron angular distributions. [ENDF/B-V only]
22	Continuous electron energy spectra. [ENDF/B-V only]
23	Smooth photon interaction cross sections.
24	Secondary angular distributions for photon interaction. [ENDF/B-V only]
25	Secondary energy distributions for photon interaction. [ENDF/B-V only]
26	Secondary energy-angle distributions for photon interaction. [ENDF/B-V only]
27	Atomic form factors or scattering functions.
31	Covariances of the average number of neutrons per fission.
32	Covariances of resonance.
33	Covariances of neutron cross sections.
34	Covariances for angular distributions of secondary particles.
35	Covariances for energy distributions of secondary particles.
40	Covariances for production of radioactive nuclei.
63	[JENDL PKA/KERMA file[6] only]
66	[JENDL PKA/KERMA file only]

Appendix3: An Auxiliary Program DESEP

An auxiliary program DESEP has been provided to modify output data from CRECTJ. If there exist more than one same energy point in the CRECTJ output, this program is useful to delete the extra energy points. The current version of DESEP can treat the data of MF=3, 9, 10, 12 and 13. When the extra energy points are deleted, the number of records consisting earch data section written in a directory part is also modified.

The input data file must be allocated on the logical unit number of 1 and the output one on 2. Two scratch files on the logical unit numbers of 3 and 4 are required.

When DESEP is executed in the batch mode, no input data from the logical unit number of 5 is needed.

```
//JOBPROC DD DSN=J2608.PROCLIB.CNTL,DISP=SHR
// EXEC DESEP
//FT01F001 DD DSN=J2608.TEST01.DATA,DISP=SHR,LABEL=(,,,IN)
//FT02F001 DD DSN=J2608.TEST01.OUT,DISP=(NEW,CATLG),
//        SPACE=(TRK,(10,10)),UNIT=TSSWK,
//        DCB=(LRECL=80,BLKSIZE=11440)
//
```

By the above example, modified data are written on J2608.TEST01.OUT. The scratch files of 3 and 4 are defined in the procedure J2608.PROCLIB.CNTL(DESEP).

In the case of the interactive mode, the names of input and output data files are required:

```
INPUT FILE =
OUTPUT FILE =
```

The version of ENDF format is automatically detected from NFOR on the second HEAD record of MF=1, MT=451. Therefore the flag NFOR must be correct.

国際単位系（SI）と換算表

表1　SI基本単位および補助単位

量	名　称	記　号
長　さ	メートル	m
質　量	キログラム	kg
時　間	秒	s
電　流	アンペア	A
熱力学温度	ケルビン	K
物質量	モル	mol
光　度	カンデラ	cd
平面角	ラジアン	rad
立体角	ステラジアン	sr

表2　SIと併用される単位

名　称	記　号
分，時，日	min, h, d
度，分，秒	°, ′, ″
リットル	l, L
トン	t
電子ボルト	eV
原子質量単位	u

1 eV=1.60218×10^{-19}J

1 u=1.66054×10^{-27}kg

表5　SI接頭語

倍数	接頭語	記　号
10^{18}	エクサ	E
10^{15}	ペタ	P
10^{12}	テラ	T
10^{9}	ギガ	G
10^{6}	メガ	M
10^{3}	キロ	k
10^{2}	ヘクト	h
10^{1}	デカ	da
10^{-1}	デシ	d
10^{-2}	センチ	c
10^{-3}	ミリ	m
10^{-6}	マイクロ	μ
10^{-9}	ナノ	n
10^{-12}	ピコ	p
10^{-15}	フェムト	f
10^{-18}	アト	a

表3　固有の名称をもつSI組立単位

量	名　称	記号	他のSI単位による表現
周波数	ヘルツ	Hz	s^{-1}
力	ニュートン	N	m·kg/s^2
圧力，応力	パスカル	Pa	N/m^2
エネルギー,仕事,熱量	ジュール	J	N·m
工率，放射束	ワット	W	J/s
電気量，電荷	クーロン	C	A·s
電位，電圧，起電力	ボルト	V	W/A
静電容量	ファラド	F	C/V
電気抵抗	オーム	Ω	V/A
コンダクタンス	ジーメンス	S	A/V
磁束	ウェーバ	Wb	V·s
磁束密度	テスラ	T	Wb/m^2
インダクタンス	ヘンリー	H	Wb/A
セルシウス温度	セルシウス度	℃	
光束	ルーメン	lm	cd·sr
照度	ルクス	lx	lm/m^2
放射能	ベクレル	Bq	s^{-1}
吸収線量	グレイ	Gy	J/kg
線量当量	シーベルト	Sv	J/kg

表4　SIと共に暫定的に維持される単位

名　称	記　号
オングストローム	Å
バーン	b
バール	bar
ガル	Gal
キュリー	Ci
レントゲン	R
ラド	rad
レム	rem

1 Å=0.1nm=10^{-10}m

1 b=100fm²=10^{-28}m²

1 bar=0.1MPa=10^5Pa

1 Gal=1cm/s²=10^{-2}m/s²

1 Ci=3.7×10^{10}Bq

1 R=2.58×10^{-4}C/kg

1 rad=1cGy=10^{-2}Gy

1 rem=1cSv=10^{-2}Sv

（注）

1．表1－5は「国際単位系」第5版，国際度量衡局1985年刊行による。ただし，1 eVおよび1 uの値はCODATAの1986年推奨値によった。

2．表4には海里，ノット，アール，ヘクタールも含まれているが日常の単位なのでここでは省略した。

3．barは，JISでは流体の圧力を表わす場合に限り表2のカテゴリーに分類されている。

4．EC閣僚理事会指令ではbar，barnおよび「血圧の単位」mmHgを表2のカテゴリーに入れている。

換　算　表

力	N(=10^5dyn)	kgf	lbf
	1	0.101972	0.224809
	9.80665	1	2.20462
	4.44822	0.453592	1

粘　度　1 Pa·s(N·s/m²)=10 P(ポアズ)(g/(cm·s))

動粘度　1m²/s=10^4St(ストークス)(cm²/s)

圧力	MPa(=10bar)	kgf/cm²	atm	mmHg(Torr)	lbf/in²(psi)
	1	10.1972	9.86923	7.50062×10^3	145.038
	0.0980665	1	0.967841	735.559	14.2233
	0.101325	1.03323	1	760	14.6959
	1.33322×10^{-4}	1.35951×10^{-3}	1.31579×10^{-3}	1	1.93368×10^{-2}
	6.89476×10^{-3}	7.03070×10^{-2}	6.80460×10^{-2}	51.7149	1

エネルギー・仕事・熱量	J(=10^7 erg)	kgf·m	kW·h	cal(計量法)	Btu	ft·lbf	eV
	1	0.101972	2.77778×10^{-7}	0.238889	9.47813×10^{-4}	0.737562	6.24150×10^{18}
	9.80665	1	2.72407×10^{-6}	2.34270	9.29487×10^{-3}	7.23301	6.12082×10^{19}
	3.6×10^6	3.67098×10^5	1	8.59999×10^5	3412.13	2.65522×10^6	2.24694×10^{25}
	4.18605	0.426858	1.16279×10^{-6}	1	3.96759×10^{-3}	3.08747	2.61272×10^{19}
	1055.06	107.586	2.93072×10^{-4}	252.042	1	778.172	6.58515×10^{21}
	1.35582	0.138255	3.76616×10^{-7}	0.323890	1.28506×10^{-3}	1	8.46233×10^{18}
	1.60218×10^{-19}	1.63377×10^{-20}	4.45050×10^{-26}	3.82743×10^{-20}	1.51857×10^{-22}	1.18171×10^{-19}	1

1 cal＝4.18605J（計量法）

＝4.184J（熱化学）

＝4.1855J（15℃）

＝4.1868J（国際蒸気表）

仕事率　1 PS(仏馬力)

＝75 kgf·m/s

＝735.499W

放射能	Bq	Ci
	1	2.70270×10^{-11}
	3.7×10^{10}	1

吸収線量	Gy	rad
	1	100
	0.01	1

照射線量	C/kg	R
	1	3876
	2.58×10^{-4}	1

線量当量	Sv	rem
	1	100
	0.01	1

（86年12月26日現在）

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