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**DIRECT: A Neutron-Transport Cross-Section
and Trial-Solution Data Retrieval System**

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R. E. Alcouffe

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DIRECT: A NEUTRON-TRANSPORT CROSS-SECTION AND TRIAL-SOLUTION DATA RETRIEVAL SYSTEM

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ABSTRACT

The generalized diffusion method for studying transport of particles in a multidimensional system requires extensive cross-section and trial-solution data. Through the use of numerous computer filesets, DIRECT supplies the needed data base, provides software protection for both itself and the data, and eliminates cross-section and trial-solution data tapes. Additional software protection is provided through extensive FORTRAN STOP statements and through fileset manipulation via the control card deck. The master data base can be updated easily through a variety of input options, but only the number and location of individual data sets can be changed. No alterations of any kind are performed on the data sets.

I. INTRODUCTION

When using the generalized diffusion equation method (GDE)¹ to study the transport of particles in a multidimensional system, it is convenient to have a library of multigroup cross sections plus a library of one-dimensional trial solutions consisting of the fluxes and currents. For complex systems, these data are extensive, so there is need for a method for cataloguing and updating them, as well as for a data directory to help the user select the proper cross sections and trial solutions. To this end, the program DIRECT has been written to store and update the required data and associated directories on both the CDC 6600 and 7600 computers.

DIRECT allows for diskfile storage and manipulation of large blocks of cross-section and trial-solution data. Requiring less than 1 minute of central processor time and 61,000 octal words of storage, DIRECT manipulates the master fileset STORE which can then be used in place of cross-section and trial-solution magnetic tapes normally used by the GDE method. No alterations of any kind are performed on the data sets; only their number and position can be changed.

II. DISK STORAGE

DIRECT uses several filesets stored on disks to perform the necessary manipulations. Their purpose and construction are as follows.

A. PSTORE. Fileset PSTORE contains the computer code in UPDATE format,² complete with a slightly altered version of the LASL routine CRØS76.³ The alteration consists of a dummy variable instead of the normal numerical reference to the physical-record unit size. This allows the code to convert the disk-stored equivalent to CDC 7600 tape or tapes without becoming confused by the numerical reference to the magnetic tape physical-record size normally found in CRØS76. The need for this conversion will be discussed in detail later.

B. STORE. Fileset STORE contains the cross-section and trial-solution data sets along with the associated directories on which PSTORE operates in the following order: (1) cross-section directory, (2) cross-section data, (3) trial-solution directory, and (4) trial-solution data. Each of these blocks is followed by a filemark to facilitate file manipulation. Because the directories are built from data blocks (2) and (4), STORE can be constructed

from empty files for blocks (1) and (3), and the first program execution for each major option (see Section V, A.1) will generate the appropriate directory. The exact nature of the manipulations for the cross-section and trial-solution data sets differs; therefore, two sets of control cards are required, depending on which kind of data is being handled. (Most file manipulation is handled externally by the use of appropriate control cards.)

Directories are constructed by extracting title portions from the respective data blocks. Cross-section data are read, and the title portion is then copied to both the new directory, tape 7, and the new data block, tape 6. Cross-section data blocks are copied to tape 6. Each cross-section portion consists of two records, one single card title and one large cross-section data record. Trial-solution data also use this scheme, with titles being transcribed to both tape 3, the directory, and tape 5, the data set. Here, however, three records, containing in order (1) a single card title, (2) flux data, and (3) current data, are used.

C. WHYNOT. Fileset WHYNOT contains the disk-file equivalent of one or more CDC 7600 trial-solution magnetic tapes generated by the GDE code. This is done for several reasons. First, because the tape or tapes must be mounted once anyway, this eliminates any future mountings and can be done by a short, simple, tape-copying job (see Appendix A). Second, because the diskfile equivalent of the tape is readily available, one can make a preliminary run with DIRECT as a test and verification without making the changes permanent on STORE. This allows one to inspect the changes requested and to double check that the actual changes requested were those desired, an option that is particularly useful to the new user. Finally, because the code was originally intended primarily for a CDC 6600, where it now resides, allowance had to be made for the 7600 data tapes.

D. GLITCH. Fileset GLITCH contains the cross-section data sets from which data are to be added or transferred to STORE. GLITCH serves the same basic function for cross-section data that WHYNOT does for trial-solution information.

Actual fileset construction, both of binary filesets like STORE and GLITCH, and UPDATE filesets like PSTORE, depends on the computer system being

used. In the specific case of the LASL filesets mentioned, details can be obtained from the LASL Programmer's Information Manuals. The method for constructing WHYNOT is shown in Appendix A.

Note that DIRECT tries to guard the master file-set STORE against operator error. This was briefly alluded to in the discussion of the data filesets WHYNOT and GLITCH and will be expanded now.

III. SOFTWARE PROTECTION

Two forms of disk-file software protection are provided to aid the user. The first is the use of temporary filesets to handle all intermediate processing, as mentioned previously. Thus, by removing one of the control cards, as pointed out in the appendixes, one makes all required changes without effecting any permanent changes in the disk filesets. Though this increases the complexity of the control card deck, it guards against undesirable changes and is strongly recommended for all but the continuous user.

The second form of software protection is provided through extensive use of octal stops to cease program execution when an error is detected. (Octal numbers are used on FORTRAN STOP statements on CDC 6600 and 7600 computers.) Because proper fileset positioning is critical, 63 octal STOP statements are provided to block execution of paths known not to conform to expected execution routes. These stops are used to indicate several possible errors, such as trying to overstore a dimensioned variable, improperly leaving a DO loop, and encountering an end of file mark in a read where none was expected. The approximate location of all stops is indicated in the comment part of the code (see Appendix E), along with some indication of the potential trouble. If, for instance, one encounters a STOP 15, he can easily determine that the location is in the subsection of the subroutine CROSS following the title CAUSING DATA SET DELETION. With this technique and the use of the temporary filesets, the code attempts to guard its disk filesets from damage.

IV. CONTROL CARDS

Execution of DIRECT to alter the cross-section data sets or the trial-solution data blocks involves fundamentally different operations, as indicated earlier. Therefore, two different sets of control

cards are required. The significance of the master filesets involved has already been discussed. The comments added to the individual control cards illustrate their purpose (see Appendixes B and C). In addition, a brief discussion follows.

In updating a cross-section data set, numerous temporary filesets are used to protect the master filesets. In addition to filesets 8 and 11 used by the code software directly, six others, Nos. 6, 7, 9, 10, 12, and 30, are referenced in the control card deck. Their use is as follows.

Temporary filesets 6 and 7 are produced during program execution, and contain the new cross-section data set and directory, respectively. Fileset 10 is a composite of 6 and 7 in final format, and is assembled totally through the control card deck from the various other files. Tape 12 is simply the working copy of GLITCH, and tape 30 is a dummy file used for proper positioning of the other filesets.

Tape 30 deserves special consideration. As can be seen from the example in Appendix B, its first real use is to position STORE past the old cross-section directory before execution. This allows DIRECT to construct the new cross-section directory from the new data. Thus if a mistake was made in the old directory it will not be saved in the new version.

The trial-solution update procedure uses temporary filesets 3, 5, 9, 10, 30, and 40. Three and five, produced by the code, contain the trial-solution directory and data set. Ten and thirty serve as before, and forty is the temporary copy of WHYNOT.

Two other data files, OUTPUT and tape 9, are of interest. Tape 9 is best explained after discussion of the Input Parameters. OUTPUT contains a partial indication of job progress followed by a copy of the various directories and the contents of tape 9. If printing is done at a remote terminal, this allows examination of the initial portion to ensure proper code execution, with the bulk of the printing then being diverted to the central printers.

V. INPUT PARAMETERS

Because two basically different operations are being performed on STORE, the exact nature of the input parameters depends on what options are being executed, as well as whether cross-section or

trial-solution information is being manipulated. The input parameters are discussed in the next four subsections; those in the first are common to any execution.

A. Input Cards Common to All Decks. The first three sets of cards specify (1) which major part of the code is being executed, (2) a job title, and (3) the ISKIP (I) and IOPTIØN (I) parameters needed.

1. Card 1, FORMAT 15. A number of 1 or less causes execution of the trial-solution data manipulator. Any value equal to or greater than 2 causes manipulation of cross-section data.

2. Card 2, FORMAT 8A10. Title desired. Printed at the beginning of the output file.

3. Sequence of cards 3, 4, ..., FORMAT (1X, I4, I5, 2X, I3). ISKIP (I), IOPTIØN (I), and TAPENØ parameters. ISKIP is the sequence number of the cross-section or trial-solution entry to be altered. Entries must occur in increasing number to avoid a STOP 4. IOPTIØN values indicate which of the four possible changes is to occur at the corresponding ISKIP number. (CAUTION: IOPTIØN = 4 will mismatch directory entries and data unless used correctly. This is primary reason for making preliminary check-out runs.) Reading is terminated when both ISKIP and IOPTIØN are blank. On this card, TAPENØ is entered. For cross-section manipulations using data obtained from GLITCH, as well as any trial-solution execution, TAPENØ must be set equal to 12. Only when cross-section changes are desired and all the necessary information is in the input stack should TAPENØ be set equal to 2.

Four basic operations can be performed on data fileset STORE as specified by input parameters ISKIP (I) and IOPTIØN (I). The significance of the allowable IOPTIØN values is as indicated below, with any other value resulting in an octal stop.

ISKIP (I) specifies the sequential position of the information contained in fileset STORE, either cross-section or trial-solution data, to be changed. IOPTIØN (I) indicates which type of change is desired at the corresponding ISKIP (I) value. Up to 49 ISKIP/IOPTIØN pairs can be specified sequentially (see Appendix B) using essentially a 1X, I4, I5 format.

Data set deletions at a specific ISKIP (I) value are obtained by setting IOPTIØN (I) = 1. The sub-routine section entitled CAUSING DATA SET DELETION

removes data by positioning STORE past indicated sets without transcription to any of the important temporary filesets. (Filesets 3, 5, 7, and 6 contain trial-solution and cross-section directories and data blocks to be saved.)

Title changes at a specific ISKIP (I) value are obtained by setting IØPTION (I) = 2. The subroutine section entitled CAUSING TITLE CHANGE positions STORE past the title to be dropped and matches the new title to the old data set.

New cross-section titles can be supplied from physical tapes by setting TAPENØ = 12 and specifying through the RECORD (I) parameter the new title's sequential position in the physical tape. Alternatively, for cross-section titles from cards, TAPENØ is set equal to 2 and the title card (singular) is put in the appropriate position in the input deck. Trial-solution titles must be supplied from cards with TAPENØ = 12. Detailed examples are shown in Appendixes B, C, and D.

Data set replacements at a specific ISKIP (I) value are obtained by setting IØPTION (I) = 3. The subroutine section entitled CAUSING DATA SET REPLACEMENT simply positions STORE past the information to be dropped and inserts the new title and data at this position. A new cross-section title and data can be supplied from the input deck by setting TAPENØ = 2 and appropriately positioning the new data in the input stream (see Appendix D). Either type of input data can be supplied from physical tapes by specifying through the RECORD (I) parameter the desired data's sequential position on the tape and setting TAPENØ = 12 (see Appendixes B and C).

Addition of new data sets at a specific ISKIP (I) value is obtained by setting IØPTION (I) = 4. The subroutine section entitled CAUSING ADDITION OF DATA SET AT THE END OF THE OLD DIRECTORY simply transmits the new data to the next position in the temporary fileset. (CAUTION: IØPTION = 4 will mismatch directory entries and data unless used correctly. As the resulting error is not immediately obvious, one should make a preliminary checkout first.) Data additions here are done exactly like those just discussed.

B. Cross-Section Interaction with Input File.

If all changes to be made on STORE are from data contained in the program data deck, the sequence of information required after TAPENØ is specified is

that implied in the changes requested. Consider, for example, ISKIP (I) = 1, 10, 15, and 24 with corresponding IØPTION (I) = 1, 2, 3, 4 (Appendix D). This sequence of instructions indicates (1) a data-set deletion at position 1, (2) a title change at position 10, (3) a data-set replacement at position 15, and (4) an addition at (new) position 24. The corresponding data cards must therefore be (1) the new title for position 10, (2) the new title and data set to replace position 15, and (3) the new title and data set added at position 24. All titles are read using an 8A10 format with 6E12.5 formats for the data.

C. Cross-Section Interaction with Fileset

GLITCH. As all required information is to be supplied from GLITCH, the sequence of information required after TAPENØ is specified is the position of the data sets in GLITCH from which information is to be taken. Read in by a 2X, I3 format and terminated by a blank card, the parameter RECØRD (I) accomplishes the desired changes.

RECØRD (I) when germane specifies up to 50 sequential positions of information contained on GLITCH or WHYNOT from which data are to be taken for changes to STORE. Examples are shown in Appendixes B and C, and corresponding text description is given here and in Section D. Note that all changes are performed in subroutine CROSS, and that section headings in the following discussion correspond to comment card captions therein.

Consider the following example. ISKIP (I) = 12, 13, 18, 24; IØPTION (I) = 1, 2, 3, 4; and RECØRD (I) = 2, 10, 20. From this input, data set 12 is dropped. The new title for position 13 comes from GLITCH position 2. The new replacement data for position 18 come from GLITCH position 10, and the new position 24 comes from GLITCH position 20 (Appendix B).

D. Trial-Solution Changes. In changing the trial-solution data sets, a combination of the previous changes is used. Deletions are as before, but new single card titles, IØPTION (I) = 2 with 8A10 formats, are assumed to come from the input deck. Data replacements and additions at the end are obtained from WHYNOT at the RECORD (I) values referenced (Appendix C). TAPENØ is always set equal to 12 for trial-solution changes. Here again, except as noted above for titles, I/Ø is taken from the G. D. E. method.

E. Temporary Fileset Nine. A negative TAPENØ value causes a complete printout of this fileset containing all trial-solution or cross-section data present on STØRE at the end of job execution. In addition, some of the IØPTIØN parameters cause partial printout of this information. For trial-solution data, either a replacement or addition will cause the printout of that particular trial-solution data set on tape 9. In cross-section sets, title changes, replacements, or additions are printed out for the particular element referenced. If these data are not wanted, the corresponding control cards can be removed.

REFERENCES

1. R. E. Alcouffe, "Generalized Finite-Differenced Diffusion Equation for Neutron-Transport Computations," Los Alamos Scientific Laboratory report LA-4938-MS (July 1972).
2. A. M. Salem, Los Alamos Scientific Laboratory, personal communication, May 1971.
3. J. F. Bem, Los Alamos Scientific Laboratory, personal communication, May 1971.

APPENDIX A

FILESET WHYNOT

Fileset WHYNOT contains the diskfile equivalent of one or more CDC 7600 trial-solution magnetic tapes. Constructed as indicated below, WHYNOT requires that the first record on each tape, the tape label, be copied to a dummy file so that only

the actual data are transmitted. Note that the alphanumerics, B13, B14, B15, and B16, on the right of the assigned cards are comments indicating the sequence number of the problem from which the data originated.

```
$JOB (NAME=KKWALT,CL=U,TL=5M,PL=100,UA=81110463,CAT=02,AC=C11KLW,SC=*600008)
ASSIGN AB,WHYNOT(,C11WHYNOT)
REWIND(DUMMY)
ASSIGN MT,TAPE1(PUL,XX004894,SM8)  B 13
COPYCF(TAPE1,DUMMY)
COPYBF(TAPE1,WHYNOT)
RELTAPE(TAPE1)
ASSIGN MT,TAPE3(PUL,XX005568,SM8)  B15
COPYCF(TAPE3,DUMMY)
COPYBF(TAPE3,WHYNOT)
RELTAPE(TAPE3)
ASSIGN MT,TAPE4(PUL,XX006242,SM8)  B16
COPYCF(TAPE4,DUMMY)
COPYBF(TAPE4,WHYNOT)
RELTAPE(TAPE4)
ASSIGN MT,TAPE5(PUL,XX003031,SM8)  B17
COPYCF(TAPE5,DUMMY)
COPYBF(TAPE5,WHYNOT)
RELTAPE(TAPE5)
REWIND(WHYNOT)
CATALOG(WHYNOT,,0)
000000000000000000000000
000000000000000000000000
```


APPENDIX B
FILESET GLITCH

The control card deck used in changing the cross-section data from fileset GLITCH is as follows. Comments added to the individual control cards illustrate their respective purposes.

```

$JOB(NAME=C11DIRECT,CL=U,TL=1M,PL=50,UA=8111D463,AC=C11KLW,SC=61000R)
ASSIGN AB,PSTORE(,C11PSTORE)      ASSIGNING AND
UPDATE(F,P=PSTORE,L=DUM)          UPDATING PROGRAM FILESET.
ASSIGN AB,STORE(,C11STORE)         ASSIGNING MASTER DATA FILESET.
ASSIGN AB,GLITCH(,C11GLITCH)      ASSIGNING CROSS-SECTIONS.
REWIND(TAPE30)                     ASSIGNING TEMPORARY
REWIND(TAPE12)                     WORKING FILESETS.
COPYCR(GLITCH,TAPE12)              SETTING UP WORKING COPY
REWIND(TAPE12)                     OF CROSS-SECTIONS.
COPYBF(STORE,TAPE30,1)             SKIPPING OLD CROSS-SECTION DIRECTORY.
MAP(OFF)
RUN(G,I=COMPILE)
REWIND(STORE)
COPYBF(STORE,OUTPUT,1)             LISTING OLD CROSS-SECTION DIRECTORY.
COPYBF(STORE,TAPE30,1)             SKIPPING OLD CROSS-SECTIONS.
REWIND(TAPE7)                     POSITIONING NEW CROSS-SECTION DIRECTORY AND
REWIND(TAPE10)                     MASTER TEMPORARY FILESET.
COPYBF(TAPE7,TAPE10,1)             SAVING NEW DIRECTORY.
COPYBF(TAPE6,TAPE10,1)             SAVING NEW CROSS-SECTION DATA SET.
COPYBF(STORE,TAPE10,1)             SECOND (UNALTERED) DIRECTORY AND
COPYBF(STORE,TAPE10,1)             DATA SET SAVED.
REWIND(TAPE10)
COPYSBF(TAPE10,OUTPUT,1)           TO EXAMINE NEW CROSS-SECTION DIRECTORY.
COPYBF(TAPE10,TAPE30,1)           OMITTS FIRST DATA SET FROM LISTING ONLY.
COPYSBF(TAPE10,OUTPUT,1)           PRINTS OUT SECOND DIRECTORY.
REWIND(TAPE10)                     SETTING UP FILESETS TO SAVE TEMPORARY
REWIND(STORE)                     COPY IN TAPE10.
COPYBF(TAPE10,STORE,4)             PULL THIS CARD DURING TESTING.
REWIND(TAPE9)
COPYSBF(TAPE9,OUTPUT)
EXIT.
REWIND(TAPE7) *****
REWIND(STORE)      CROSS-SECTION DATA CONTROL CARDS
COPYSBF(STORE,OUTPUT,1) *****
COPYSBF(TAPE7,OUTPUT)
REWIND(TAPE9)
COPYSBF(TAPE9,OUTPUT)
000000000000000000000000
000000000000000000000000
  2
TAPE/PERMFILE EXAMPLE PROBLEM.
 12   1
 13   2
 18   3
 24   4
      -12
  2
 10
 20

000000000000000000000000
000000000000000000000000

```

APPENDIX C

CHANGES TO TRIAL SOLUTION DATA

The control card deck used in changing the trial-solution data is as follows. Comments added to the individual control cards illustrate their respective purposes.

```

$JOB(NAME=C11DIRECT,CL=U,TL=1M,PL=50,UA=8111D463,AC=C11KLW,SC=61000R)
ASSIGN AB,WHYNOT(,C11WHYNOT)      SETTING UP
REWIND(TAPE40)                    TEMPORARY COPY
COPYBF(WHYNOT,TAPE40,30)          OF PERMFILE
REWIND(TAPE40)                    WHYNOT.
ASSIGN AB,PSTORE(,C11PSTORE)      ASSIGNING AND UPDATING
UPDATE(F,P=PSTORE,L=DUM)          PROGRAM FILESET.
REWIND(TAPE3)                    ASSIGNING TEMPORARY
REWIND(TAPE30)                   WORKING FILESETS.
ASSIGN AB,STORE(,C11STORE)        ASSIGNING AND POSITIONING
COPYBF(STORE,TAPE30,3)            MASTER DATA FILESET.
MAP(OFF)
RUN(G,I=COMPILE)
REWIND(TAPE3)                    INSURING
REWIND(TAPE5)                    PROPER
REWIND(TAPE10)                   FILESET
REWIND(STORE)                    POSITIONING.
COPYBF(STORE,TAPE10,2)           SAVING UNALTERED CROSS-SECTION VALUES.
COPYBF(TAPE3,TAPE10,1)           SAVING NEW TRIAL SOLUTION DIRECTORY AND
COPYBF(TAPE5,TAPE10,1)           ASSOCIATED DATA SETS.
REWIND(TAPE10)                   PRINTING UNALTERED
COPYSBF(TAPE10,OUTPUT)           CROSS-SECTION DIRECTORY.
COPYBF(TAPE10,TAPE30)            SKIPPING UNALTERED DATA SET.
REWIND(STORE)
COPYBF(STORE,TAPE30,?)           PRINTING OLD
COPYSBF(STORE,OUTPUT)            TRIAL SOLUTION DIRECTORY.
COPYSBF(TAPE10,OUTPUT)           PRINTING NEW DIRECTORY.
REWIND(TAPE10)                   SETTING UP FILESETS TO SAVE TEMPORARY
REWIND(STORE)                    COPY IN TAPE10.
COPYBF(TAPE10,STORE,4)           PULL THIS CARD DURING TESTING.
REWIND(TAPE9)
COPYSBF(TAPE9,OUTPUT)
EXIT.
REWIND(TAPE3) *****
COPYSBF(TAPE3,OUTPUT)            TRIAL SOLUTION DATA CONTROL CARDS
REWIND(TAPE9) *****
COPYSBF(TAPE9,OUTPUT)           PULL TO ELIMINATE FILESET NINE PRINTOUT.
00000000000000000000000000
00000000000000000000000000
1
TRIAL SOLUTION EXAMPLE PROBLEM.
2 1
3 2
4 3
5 4
6 4
7 4
-12
1
2
3
4

NEW TITLE FOR DIRECTORY ENTRY NUMBER 3.
00000000000000000000000000
00000000000000000000000000

```

APPENDIX D
CHANGES TO CROSS-SECTION DATA

The control card deck used to change the cross-section data from the input file is as follows.

```

$JOB(NAME=KKWALT,CL=U,TL=01M,PL=5,UA=81110463,CAT=02,AC=C11KLW,SC=610008)
ASSIGN AB,PSTORE(,C11PSTORE)
UPDATE(F,P=PSTORE,L=DUM)
ASSIGN AB,STORE(,C11STORE)
ASSIGN AB,GLITCH(,C11GLITCH)
REWIND(TAPE30)
REWIND(TAPE12)
COPYCR(GLITCH,TAPE12)
REWIND(TAPE12)
COPYBF(STORE,TAPE30,1)
MAP(OFF)
RUN(G,I=COMPILE)
REWIND(STORE)
COPYBF(STORE,OUTPUT,1)
COPYBF(STORE,TAPE30,1)
REWIND(TAPE7)
REWIND(TAPE10)
COPYBF(TAPE7,TAPE10)  SAVING NEW DIRECTORY.
COPYBF(TAPE6,TAPE10)  SAVING FIRST DATA SET.
COPYBF(STORE,TAPE10)  SECOND (UNALTERED) DIRECTORY SAVED.
COPYBF(STORE,TAPE10)  SECOND (UNALTERED) DATA SET SAVED.
REWIND(TAPE10)  COMPLETED DIRECTORY WITH DATA SET.
COPYSBF(TAPE10,OUTPUT,1)  TO EXAMINE NEW CROSS-SECTION DIRECTORY.
COPYBF(TAPE10,TAPE30)  OMITTS FIRST DATA SET FROM OUTPUT LISTING.
COPYSBF(TAPE10,OUTPUT)  PRINTS OUT SECOND DIRECTORY.
REWIND(TAPE9)
COPYSBF(TAPE9,OUTPUT)
EXIT.
REWIND(TAPE7)  *****
REWIND(STORE)  CROSS-SECTION DATA
COPYSBF(STORE,OUTPUT,1)  *****
COPYSBF(TAPE7,OUTPUT)
REWIND(TAPE9)
COPYSBF(TAPE9,OUTPUT)
00000000000000000000000000000000
00000000000000000000000000000000
      2
  ATTEMPTING TO CHECK ALL CROSS-SECTION DATA SET OPTIONS.
      1      1
     10      2
     15      3
     24      4
      -2
  NEW TITLE FOR MN CROSS-SECTION SET.
  ATTEMPTING TO REPLACE U238R CROSS-SECTION DATA WITH SM.
0.      -4.28993E-01 0.      2.91842E+00 0.      0.
0.      0.      0.      8.76561E-01 0.      0.
0.      0.      0.      0.      3.74210E-02 0.
3.90487E+00 0.      0.      0.      0.      0.
2.28502E+00 6.87018E-01 0.      0.      0.      0.
0.      9.28300E-02 0.      5.34422E+00 0.      0.
0.      0.      0.      3.22301E+00 1.36013E+00 5.82052E-01
0.      0.      0.      0.      1.96240E-01 0.
6.96221E+00 0.      0.      0.      0.      0.
5.32686E+00 1.83798E+00 2.22290E-01 7.89150E-01 0.      0.
0.      5.34890E-01 0.      8.67875E+00 0.      0.
0.      0.      0.      7.78168E+00 1.23362E+00 1.87950E-01
0.      3.76522E-01 0.      0.      1.22140E+00 0.
1.17949E+01 0.      0.      0.      0.      0.
1.04734E+01 3.38304E-01 1.98350E-01 2.45450E-03 0.      3.61102E-02
0.      2.93960E+00 0.      1.71257E+01 0.      0.
0.      0.      0.      1.41161E+01 8.78800E-02 2.36460E-02
7.14250E-03 0.      1.15117E-03 0.      6.34840E+00 0.
2.89713E+01 0.      0.      0.      0.      0.

```

2.21024E+01	7.00360E-02	5.30420E-03	2.29500E-04	0.	1.64406E-05
0.	9.48520E+00	0.	3.62604E+01	0.	0.
0.	0.	0.	2.61605E+01	5.20490E-01	0.
3.21870E-03	0.	0.	0.	1.40650E+01	0.
4.56290E+01	0.	0.	0.	0.	0.
3.08408E+01	6.14660E-01	0.	0.	1.95090E-03	0.
0.	2.06710E+01	0.	5.76597E+01	0.	0.
0.	0.	0.	3.61442E+01	7.23210E-01	0.
0.	0.	1.10380E-03	0.	3.00940E+01	0.
7.31162E+01	0.	0.	0.	0.	0.
4.20439E+01	8.44530E-01	0.	0.	0.	4.29510E-04
0.	4.33780E+01	0.	9.29702E+01	0.	0.
0.	0.	0.	4.84710E+01	9.78310E-01	0.
0.	0.	1.58120E-04	0.	6.18890E+01	0.
1.18475E+02	0.	0.	0.	0.	0.
5.53123E+01	1.12120E+00	0.	0.	0.	5.81190E-05
0.	1.85450E+02	0.	6.22867E+02	0.	0.
0.	0.	0.	4.26306E+02	1.27320E+00	0.
0.	0.	2.13880E-05	0.	2.01200E+02	0.
3.66122E+02	0.	0.	0.	0.	0.
1.64922E+02	1.11110E+01	0.	0.	0.	7.86620E-06
0.	1.31880E+02	0.	1.56479E+02	0.	0.
0.	0.	0.	2.45964E+01	0.	0.
0.	0.	0.	0.	1.28970E+02	0.
1.41760E+02	0.	0.	0.	0.	0.
1.27900E+01	2.45600E-03	0.	0.	0.	0.
0.	4.15600E+02	0.	4.76893E+02	0.	0.
0.	0.	0.	6.11940E+01	0.	0.
0.	0.	0.	0.	1.21290E+02	0.
1.24369E+02	0.	0.	0.	0.	0.
2.22563E+00	9.93330E-02	0.	0.	0.	0.
0.	3.86790E+02	0.	3.98251E+02	0.	0.
0.	0.	0.	1.13090E+01	8.53060E-01	0.
0.	0.	0.	0.	1.73600E+01	0.
2.61463E+01	0.	0.	0.	0.	0.
8.55754E+00	1.52080E-01	0.	0.	0.	0.
0.	9.15390E+01	0.	1.06546E+02	0.	0.
0.	0.	0.	1.45019E+01	2.28760E-01	0.
0.	0.	0.	0.	4.73100E+03	0.
4.80713E+03	0.	0.	0.	0.	0.
7.57367E+01	5.04860E-01	0.	0.	0.	0.
0.	1.12390E+03	0.	1.14956E+03	0.	0.
0.	0.	0.	2.47435E+01	3.97070E-01	0.
0.	0.	0.	0.	2.76430E+04	0.
2.79461E+04	0.	0.	0.	0.	0.
2.82702E+02	9.15077E-01	0.	0.	0.	0.
0.	7.98930E+04	0.	8.04505E+04	0.	0.
0.	0.	0.	5.52595E+02	2.04191E+01	0.
0.	0.	0.	0.	4.35321E+04	0.
4.37254E+04	0.	0.	0.	0.	0.
1.91833E+02	4.96761E+00	0.	0.	0.	0.
0.	5.38764E+04	0.	5.40035E+04	0.	0.
0.	0.	0.	1.27115E+02	1.39886E+00	0.
0.	0.	0.			
SM149					
0.	-4.28993E-01	0.	2.91842E+00	0.	0.
0.	0.	0.	8.76561E-01	0.	0.
0.	0.	0.	0.	3.74210E-02	0.
3.90487E+00	0.	0.	0.	0.	0.
2.28502E+00	6.87018E-01	0.	0.	0.	0.
0.	9.28300E-02	0.	5.34422E+00	0.	0.
0.	0.	0.	3.22301E+00	1.36013E+00	5.82052E-01
0.	0.	0.	0.	1.96240E-01	0.
6.96221E+00	0.	0.	0.	0.	0.
5.32686E+00	1.83798E+00	2.22290E-01	7.89150E-01	0.	0.
0.	5.34890E-01	0.	8.67875E+00	0.	0.
0.	0.	0.	7.78168E+00	1.23362E+00	1.87950E-01
0.	3.76522E-01	0.	0.	1.22140E+00	0.
1.17949E+01	0.	0.	0.	0.	0.

APPENDIX E
DIRECT CODE LISTING

```
PROGRAM DIRECT(INPUT=101,TAPE1=INPUT,STORE=101,TAPE2=STORE,TAPE3=1
101,OUTPUT=101,TAPE4=OUTPUT,TAPE5=101,TAPE6=101,TAPE7=101,TAPE8=101
2,TAPE9=101,TAPE11=101,TAPE12=513,TAPE40=513)
```

```
C
C CARD ONE. OPTION. FORMAT(I5).
C OPTION .LE. 1 FOR TRIAL SOLUTION DIRECTORY.
C .GE. 2 FOR CROSS-SECTION DIRECTORY.
C
```

```
C CARD TWO. TITLE. FORMAT(8A10)
C TITLE FOR PARTICULAR JOB, NOT FOR THE DIRECTORY.
C
```

```
C CARD THREE. ISKIP(IP), IOPTION(I), TAPENO. FORMAT(1X,I4,I5,2X,I3
C TAPENO TAKEN OFF LAST CARD WITH OTHER TWO ENTRIES BLANK.
C
```

```
C CARD FOUR. RECORD(I). FORMAT(2X,I3).
C ONLY IF TAPENO .GE. 12. USE BLANK CARD TO TERMINATE.
C
```

```
C CARD FIVE. TITLE. FORMAT(8A10). MAY NOT BE NEEDED.
C
```

```
C CARD SIX. DATA. FORMAT(6E12.5) MAY NOT BE NEEDED.
C
```

```
C STOP 1 = CROSS. CAUSING DATA SET TO BE SKIPPED OR MODIFIED.
C UNEXPECTED EOF.
C STOP 2 = CROSS. CAUSING DATA SET TO BE SKIPPED OR MODIFIED.
C IMPROPER EXIT.
C STOP 3 = CROSS. SETTING POSITION OF TAPE FILE.
C UNEXPECTED IOPTION VALUE ENCOUNTERED.
C STOP 4 = CROSS. CHECKING ISKIP(IP) ORDER.
C ERROR IN ORDER OF ISKIP PARAMETERS.
C STOP 5 = CROSS. SETTING UP RECORD OPTION.
C SEQUENCE ERROR.
C STOP 6 = CROSS. CAUSING ADDITION OF CROSS-SECTION SET.
C IMPROPER EXIT.
C STOP 7 = CROSS. SETTING UP RECORD OPTION.
C TO MANY VALUES.
C STOP 10 = CROSS. COMPLETE CROSS-SECTION DATA SET PRINTOUT.
C UNEXPECTED EOF IN TITLE READ.
C STOP 11 = CROSS. CAUSING PROPER CHANGE TO OCCUR.
C UNEXPECTED EOF IN TAPENO.
C STOP 12 = CROSS. CAUSING DATA SET TO BE SKIPPED OR MODIFIED.
C IMPROPER IOPTION.
C STOP 13 = CROSS. CAUSING DATA SET TO BE SKIPPED OR MODIFIED.
C UNEXPECTED TAPENO, TOO LARGE FOR PROGRAM CARD.
C STOP 14 = CROSS. CASE OF TAPENO = 2 AND NO CHANGE DESIRED.
C UNEXPECTED EOF.
C STOP 15 = CROSS. CAUSING DATA SET DELETION.
C UNEXPECTED EOF.
C STOP 16 = CROSS. CASE OF TAPENO = 2 AND NO CHANGE DESIRED.
C UNEXPECTED EOF IN TITLE READ.
C STOP 17 = CROSS. CASE OF TAPENO = 2 AND NO CHANGE DESIRED.
C UNEXPECTED EOF IN DATA READ.
C STOP 20 = CROSS. CAUSING DATA SET DELETION.
C UNEXPECTED EOF IN TITLE READ.
C STOP 21 = CROSS. CAUSING DATA SET DELETION.
C UNEXPECTED EOF IN TITLE READ.
C STOP 22 = CROSS. IF ALL INCOMING DATA COMING FROM ACTUAL TAPE.
C UNEXPECTED EOF IN TITLE READ.
C STOP 23 = CROSS. IF ALL INCOMING DATA COMING FROM ACTUAL TAPE.
C UNEXPECTED EOF IN TITLE READ.
C STOP 24 = CROSS. CAUSING PROPER CHANGE TO OCCUR.
C UNEXPECTED EOF IN DATA READ.
C
```

```

C   STOP 25 = CROSS. CAUSING TITLE CHANGE.
C           UNEXPECTED EOF IN TITLE READ.
C   STOP 26 = CROSS. CAUSING TITLE CHANGE.
C           UNEXPECTED EOF IN DATA READ.
C   STOP 27 = CROSS. CAUSING DATA SET REPLACEMENT.
C           UNEXPECTED EOF IN TITLE READ.
C   STOP 30 = CROSS. CAUSING DATA SET REPLACEMENT.
C           UNEXPECTED EOF IN DATA READ.
C   STOP 31 = CROSS. SETTING POSITION OF TAPE FILE.
C           UNNECESSARY POSITIONING OF TAPE FILE.
C   STOP 32 = CROSS. CROSS CHECKING ISKIP AND RECORD OPTIONS.
C           UNBALANCED INPUT.
C   STOP 33 = CROSS. CAUSING TITLE CHANGE.
C           UNEXPECTED EOF IN ATAPE TITLE READ.
C   STOP 34 = CROSS. CAUSING PROPER CHANGE TO OCCUR.
C           ERROR IN COMPUTED GO TO.
C   STOP 35 = CROSS. SETTING POSITION OF TAPE FILE.
C           UNEXPECTED EOF IN TITLE READ.
C   STOP 36 = CROSS. SETTING POSITION OF TAPE FILE.
C           UNEXPECTED EOF IN TITLE READ.
C   STOP 37 = CROSS. CAUSING PROPER CHANGE TO OCCUR.
C           ERROR IN RANGE OF COMPUTED GO TO STATEMENT.
C   STOP 40 = CROSS. CASE OF TAPENO = 2 AND NO CHANGE DESIRED.
C           UNEXPECTED EOF IN BINARY FLUX READ.
C   STOP 41 = CROSS. CASE OF TAPENO = 2 AND NO CHANGE DESIRED.
C           UNEXPECTED EOF IN BINARY CURRENT READ.
C   STOP 42 = CROSS. MULTIPLE ENTRIES.
C           CURRENT OR FLUX NUMBER LARGER THAN DIMENSION STATEMENT
C   STOP 43 = CROSS. MULTIPLE ENTRIES.
C           NUMBER OF GROUPS LARGER THAN DIMENSION STATEMENT.
C   STOP 44 = CROSS. CAUSING DATA SET REPLACEMENT.
C           UNEXPECTED EOF IN DATA(I) READ.
C   STOP 45 = CROSS. COMPLETE TRIAL SOLUTION DATA SET PRINTOUT.
C           UNDEFINED PATH IN PARTIAL PRINTOUT.
C   STOP 46 = CROSS. CAUSING DATA SET REPLACEMENT.
C           UNEXPECTED EOF IN FLUX READ.
C   STOP 47 = CROSS. CAUSING DATA SET REPLACEMENT.
C           UNEXPECTED EOF IN CURRENT READ.
C   STOP 50 = CROSS. CAUSING ADDITION OF DATA SET.
C           UNEXPECTED EOF IN DATA(I) READ.
C   STOP 51 = CROSS. CAUSING ADDITION OF DATA SET.
C           UNEXPECTED EOF IN FLUX READ.
C   STOP 52 = CROSS. CAUSING ADDITION OF DATA SET.
C           UNEXPECTED EOF IN CURRENT READ.
C   STOP 53 = CROSS. SETTING POSITION OF TAPE FILE.
C           UNEXPECTED EOF IN TITLE READ.
C   STOP 54 = CROSS. SETTING POSITION OF TAPE FILE.
C           INVALID POSITIONING OF TAPE FILE.
C   STOP 55 = CROSS. IF ALL INCOMING DATA FROM ACTUAL TAPE.
C           INVALID TAPENO VALUE ENCOUNTERED.
C   STOP 55 = CROSS. SETTING POSITION OF TAPE FILE.
C           INVALID POSITIONING OF TAPE FILE.
C   STOP 56 = CROSS. SETTING POSITION OF TAPE FILE.
C           TO MANY EOFS ENCOUNTERED BETWEEN DATA BLOCKS.
C   STOP 57 = CROSS. 7600 TAPE CONVERSION.
C           TO MANY EOFS ENCOUNTERED.
C   STOP 60 = CROSS. 7600 TAPE CONVERSION.
C           STRANGE PATH.
C   STOP 61 = CROSS. COMPLETE TRIAL SOLUTION DATA SET PRINTOUT.
C           UNEXPECTED EOF IN FLUX READ.
C   STOP 62 = CROSS. COMPLETE TRIAL SOLUTION DATA SET PRINTOUT
C           UNEXPECTED EOF IN DATA(I) READ.
C   STOP 63 = CROSS. COMPLETE TRIAL SOLUTION DATA SET PRINTOUT.
C           UNEXPECTED EOF IN CURRENT READ.
C   STOP 777 = NORMAL EXIT.
C

```

```

DIMENSION TITLE(8)
INTEGER OPTION
INTEGER ATAPE,TAPENO
READ(1,10) OPTION
IF(OPTION.LE.1) OPTION = 1
IF(OPTION.GE.2) OPTION = 2
WRITE(4,15) OPTION
READ(1,5) TITLE
WRITE(4,5) TITLE
CALL CROSS(OPTION)
STOP 777
5 FORMAT(8A10)
10 FORMAT(15)
15 FORMAT(1H1,/** OPTION = *,I3,**)
END
*****
C SUBROUTINE CROSS (OPTION)
C
C
C READ ALL MESH VALUES BY GROUP.
DIMENSION TITLE(1,8), C(1,15,29), ISKIP(50), IOPTION(50), RECORD(5
10), DATA(50), LABEL(50), FLUX(29,119), CURRENT(29,120), BUF(3500)
INTEGER TAPENO,ATAPE,RECORD,OPTION,DATASET
TAPE NUMBERS USED IN CROSS-SECTION DIRECTORY = 1,2,4,6,7,8,9,10,11
12,30.
C TAPE NUMBERS USED IN TRIAL SOLUTION DIRECTORY= 1,2,3,4,5,10,11,12,
30,40.
C IGM = THE NUMBER OF GROUPS PER DATA BLOCK. FIXED AT 29.
C IHM = THE NUMBER OF CROSS-SECTIONS PER DATA BLOCK. FIXED AT 15.
C IOPTION = 1 FOR DATA SET DELETION.
C = 2 FOR TITLE CHANGE.
C = 3 FOR DATA SET REPLACEMENT.
C = 4 FOR ADDITION OF NEW CROSS-SECTION SET AT THE END OF TH
CURRENT DATA SET.
C IP = INDEX FOR THE ISKIP(IP) OPTION.
C ISKIP(I) = NUMBER OF CROSS-SECTION ENTRY FOR WHICH ACTION IS NECESSARY.
C IZ = NUMBER OF THE DATA SET CURRENTLY UNDER CONSIDERATION.
C IZIP = THE NUMBER OF ISKIP CARDS READ.
C TAPENO = TAPE NUMBER FROM WHICH CROSS-SECTION DATA IS TO BE READ.
C = 1 FOR INPUT FILE. DEFAULT VALUE.
C = 2 FOR PERMFILE STORE.
C = 11 FOR ALL INCOMING DATA FROM ACTUAL TAPE.
C = ANYTHING GREATER THAN 11 FOR ACTUAL PHYSICAL TAPE FOR PATIAL
DATA ADDITION.
C TAPE(3) = TRIAL SOLUTION DIRECTORY.
C TAPE(5) = TRIAL SOLUTION DATA.
C TAPE(7) = CROSS-SECTION DIRECTORY.
C TAPE(6) = DATA SET FOR CROSS-SECTION DIRECTORY.
ITAPE=4
IGM=29 $ IHM=15
IZIP=ILOG=IPRINT=ILUCK=IREC=IZI=0
C
C CLEARING OUT OF ARRAYS.
C
C
DO 10 I=1,50
DATA(I)=0.0
IOPTION(I)=0
RECORD(I)=0
ISKIP(I)=0
10 CONTINUE
DO 20 I=1,100
DO 20 J=1,29
CURRENT(J,I)=0.00
20 CONTINUE
IF (OPTION.EQ.1) GO TO 30
C

```



```

C      CREATING CROSS-SECTION DIRECTORY TITLE.
C
      WRITE (7,1560)
C
C      CAUSING DATA SET TO BE SKIPPED OR MODIFIED.
C      EXECUTED REGARDLESS OF SPECIFIED VALUE OF TAPENO.
C
30     CONTINUE
      DO 50 I=1,50
      READ (1,1570)ISKIP(I),IOPTION(I),TAPENO
      IF (EOF,1) 60,40
40     CONTINUE
      IF (ISKIP(I).LE.0.AND.IOPTION(I).LE.0) GO TO 70
      IF (IOPTION.LE.0.OR.IOPTION.GT.4) STOP 12
      IZIP=IZIP+1
50     CONTINUE
      STOP 2
60     CONTINUE
      STOP 1
70     CONTINUE
      IF (TAPENO.GT.0) GO TO 80
      IPRINT=1
      WRITE (4,1900)IPRINT
80     CONTINUE
      TAPENO=IABS(TAPENO)
      IZI=IZIP-1
      IF (TAPENO.LE.0) TAPENO=2
      IP=1
      IZ=0
      IF (TAPENO.GT.12) STOP 13
      IF (IZI.LE.0) IZI=0
      IF (IZIP.LT.1) GO TO 110
      IF (IZI.EQ.0) GO TO 100
C
C      CHECKING ISKIP(IP) ORDER.
C
      DO 90 II=1,IZI
      IV=II+1
      IF (ISKIP(IV).LE.ISKIP(II)) STOP 4
90     CONTINUE
C
C      ECHO-CHECKING ISKIP AND IOPTION PARAMETERS.
C
      WRITE (4,1580)
      DO 100 I=1,IZI
      WRITE (4,1590)ISKIP(I),IOPTION(I)
100    CONTINUE
      IF (IZI.EQ.0) WRITE (4,1580)
      WRITE (4,1600)ISKIP(IZIP),IOPTION(IZIP),TAPENO
C
C      SETTING UP RECORD OPTION.
C
110    CONTINUE
      IF (TAPENO.LE.11) GO TO 160
      DO 140 I=1,50
      READ (1,1610)RECORD(I)
      IF (EOF,1) 120,130
120    CONTINUE
      STOP 5
130    CONTINUE
      IF (RECORD(I).LE.0) GO TO 150
      IREC=IREC+1
140    CONTINUE
      STOP 7
150    CONTINUE
      WRITE (4,1620)

```

```

WRITE (4,1630) (RECORD(I),I=1,IREC)
160 CONTINUE
   ATAPE=TAPENO
   IF (OPTION.EQ.1.AND.TAPENO.EQ.12) TAPENO=2
C
C   CROSS CHECKING ISKIP AND RECORD OPTIONS
C
   IF (ATAPE.EQ.12.AND.OPTION.EQ.1.AND.TAPENO.EQ.2) GO TO 170
   IF (ATAPE.LT.10) GO TO 190
170 CONTINUE
   IRECORD=IREC
   DO 180 IKLW=1,IZIP
   IF (IOPTION(IKLW).EQ.1) IRECORD=IRECORD+1
   IF (OPTION.EQ.1.AND.IOPTION(IKLW).EQ.2) IRECORD=IRECORD+1
180 CONTINUE
   IF (IZIP.EQ.IRECORD) GO TO 190
   WRITE (4,1550) IZIP,IRECORD,IREC
   STOP 32
190 CONTINUE
   IF (OPTION.NE.1.OR.(OPTION.EQ.1.AND.ATAPE.NE.12)) GO TO 230
C
C   7600 TAPE CONVERSION.
C
   REWIND 12
   ISTOP=0
   REWIND 40
   ITAPES=0
   DO 220 I=1,ITAPE
   CALL CROS76 (40,12,1,BUF,2)
   READ (40)
   IF (EOF,40) 200,210
200 CONTINUE
   ITAPES=ITAPES+1
   IF (ITAPES.GT.ITAPE) STOP 57
   GO TO 220
210 CONTINUE
   ISTOP=ISTOP+1
220 CONTINUE
   REWIND 12
   END FILE 40
   WRITE (4,1980) ISTOP
230 CONTINUE
C
C   CREATING DIRECTORY.
C
   DATASET=0
   DO 1260 I=1,100
   IST=IZAP=IRETURN=IWHY=IFLUX2=ICUR2=0
   IKK=ITAPE=IFLUX=ICUMENT=0
   KK=IZ+1
   DATASET=DATASET+1
   IF (I.EQ.ISKIP(IP)) GO TO 290
   IF (TAPENO.EQ.2) GO TO 990
   IF (TAPENO.EQ.1) GO TO 990
   IF (TAPENO.EQ.12) GO TO 980
C
C   IF ALL INCOMING CROSS-SECTION DATA COMING FROM ACTUAL TAPE
C
   IF (TAPENO.NE.11) STOP 55
   IF (OPTION.EQ.1) GO TO 280
   READ (TAPENO,1640) (TITLE(I,J),J=1,8)
   IF (EOF,TAPENO) 240,250
240 CONTINUE
   WRITE (4,1640) (TITLE(I,J),J=1,8)
   STOP 22
250 CONTINUE

```

```

      READ (TAPENO,1660)((C(1,K,J),K=1,IHM),J=1,IGM)
      IF (EOF,TAPENO) 260,270
260  CONTINUE
      WRITE (4,1700)I
      STOP 23
270  CONTINUE
      IZ=IZ+1
      WRITE (6)(TITLE(1,J),J=1,8)
      WRITE (6)((C(1,K,J),K=1,IHM),J=1,IGM)
      WRITE (7,1650)IZ,(TITLE(1,J),J=1,8)
      GO TO 1260
280  CONTINUE
      GO TO 1260
C
C   CAUSING PROPER CHANGE TO OCCUR.
C
290  CONTINUE
      IF (OPTION.EQ.1) GO TO 400
      TAPENO=1
      IF (ATAPE.EQ.12.AND.IOPTION(IP).GT.1) GO TO 490
300  CONTINUE
      IP=IP+1
      IF (IST.EQ.1) IP=IP-1
      IF (IOPTION(IP-1).EQ.1) GO TO 330
      READ (TAPENO,1640)(TITLE(1,J),J=1,8)
      IF (EOF,TAPENO) 310,320
310  CONTINUE
      WRITE (4,1640)(TITLE(1,J),J=1,8)
      STOP 11
320  CONTINUE
330  CONTINUE
      KLW=IOPTION(IP-1)
      IF (KLW.LT.1.OR.KLW.GT.4) GO TO 390
      GO TO (370,370,340,340), KLW
340  CONTINUE
      IF (OPTION.EQ.1) GO TO 360
      READ (TAPENO,1660)((C(1,K,J),K=1,IHM),J=1,IGM)
      IF (EOF,TAPENO) 350,380
350  CONTINUE
      WRITE (4,1700)I
      STOP 24
360  CONTINUE
370  CONTINUE
380  CONTINUE
      GO TO (410,680,780,1120), KLW
390  CONTINUE
      WRITE (4,1880)KLW,IOPTION(IP),IOPTION(IP-1),ISKIP(IP),ISKIP(IP)
      STOP 34
400  CONTINUE
      IP=IP+1
      KLW=IOPTION(IP-1)
      IF (KLW.GT.4.OR.KLW.LE.0) STOP 37
      GO TO (410,680,780,1120), KLW
C
C   CAUSING DATA SET DELETION.
C
410  CONTINUE
      TAPENO=ATAPE
      IF (TAPENO.EQ.12) TAPENO=2
      IF (OPTION.EQ.1) GO TO 460
      READ (TAPENO)(TITLE(1,J),J=1,8)
      IF (EOF,TAPENO) 420,430
420  CONTINUE
      WRITE (4,1640)(TITLE(1,J),J=1,8)
      STOP 20
430  CONTINUE

```

```

        WRITE (4,1870)
        WRITE (4,1840) (TITLE(1,J),J=1,8)
        READ (TAPENO) ((C(1,K,J),K=1,IHM),J=1,IGM)
        IF (EOF,TAPENO) 440,450
440    CONTINUE
        STOP 21
450    CONTINUE
        WRITE (8) (TITLE(1,J),J=1,8)
        WRITE (8) ((C(1,K,J),K=1,IHM),J=1,IGM)
        TAPENO=ATAPE
        GO TO 1260
460    CONTINUE
        READ (2) (DATA(I),I=1,12),I1,I2,I3,I4
        IF (EOF,2) 470,480
470    CONTINUE
        STOP 15
480    CONTINUE
        DATASET=DATASET-1
        READ (2)
        READ (2)
        IF (I5.GT.120) STOP 42
        IF (I4.GT.29) STOP 43
        GO TO 1260
C
C     SETTING POSITION OF TAPE FILE.
C
490    CONTINUE
        WRITE (4,1870)
        TAPENO=ATAPE
        ILUCK=ILUCK+1
        IF (ILUCK.GT.1) REWIND TAPENO
        ILOG=ILOG+1
        IF (ILOG.GT.1REC) GO TO 670
        ICOUNT=RECORD(ILOG)-1
        IF (OPTION.EQ.1) GO TO 560
        IF (ICOUNT.EQ.0) GO TO 550
        DO 540 IZZ=1,ICOUNT
        READ (TAPENO,1640) (TITLE(1,K),K=1,8)
        IF (EOF,TAPENO) 500,510
500    CONTINUE
        WRITE (4,1640) (TITLE(1,J),J=1,8)
        STOP 35
510    CONTINUE
        READ (TAPENO,1660) ((C(1,K,L),K=1,IHM),L=1,IGM)
        IF (EOF,TAPENO) 520,530
520    CONTINUE
        WRITE (4,1700) I
        STOP 36
530    CONTINUE
        WRITE (4,1640) (TITLE(1,K),K=1,8)
540    CONTINUE
550    CONTINUE
        IP=IP+1
        IST=1
        IF (IOPTION(IP-1).EQ.1) GO TO 660
        IF (IOPTION(IP-1).EQ.2) GO TO 690
        IF (IOPTION(IP-1).EQ.3) GO TO 300
        IF (IOPTION(IP-1).EQ.4) GO TO 300
        WRITE (4,1860) IOPTION(IP-1)
        STOP 3
560    CONTINUE
        IF (ICOUNT.EQ.0) GO TO 630
        DO 620 IZZ=1,ICOUNT
        READ (12) (DATA(I),I=1,12),I1,I2,I3,I4
        IF (EOF,12) 570,580
570    CONTINUE

```

```

      STOP 53
580  CONTINUE
      IS=I3+1
      IF (IS.GT.120) STOP 42
      IF (I4.GT.29) STOP 43
      WRITE (4,1720) (DATA(I),I=1,12)
      READ (12)
      READ (12)
      READ (12)
      IF (EOF,12) 590,590
590  CONTINUE
      READ (12)
      IF (EOF,12) 610,600
600  CONTINUE
      WRITE (4,1970)
610  CONTINUE
620  CONTINUE
630  CONTINUE
      NUT=IOPTION(IP-1)
      GO TO (640,650,850,1150), NUT
640  CONTINUE
      STOP 54
650  CONTINUE
      STOP 55
660  CONTINUE
      STOP 31
670  CONTINUE
      WRITE (4,1990) ILOG,IREC
      GO TO 1270
C
C      CAUSING TITLE CHANGE.
C
680  CONTINUE
      IF (OPTION.EQ.1) GO TO 770
      IF (ATAPE.EQ.12) GO TO 490
690  CONTINUE
      IF (ATAPE.NE.12) GO TO 710
      READ (ATAPE) (TITLE(1,J),J=1,8)
      IF (EOF,ATAPE) 700,710
700  CONTINUE
      STOP 33
710  CONTINUE
      WRITE (6) (TITLE(1,J),J=1,8)
      WRITE (7,1650) KK, (TITLE(1,J),J=1,8)
      TAPENO=ATAPE
      IF (ATAPE.EQ.12) TAPENO=2
      READ (TAPENO) (TITLE(1,J),J=1,8)
      IF (EOF,TAPENO) 720,730
720  CONTINUE
      WRITE (4,1640) (TITLE(1,J),J=1,8)
      STOP 25
730  CONTINUE
      WRITE (8) (TITLE(1,J),J=1,8)
      READ (TAPENO) ((C(1,K,J),K=1,IHM),J=1,IGM)
      IF (EOF,TAPENO) 740,750
740  CONTINUE
      WRITE (4,1700) I
      STOP 26
750  CONTINUE
      WRITE (6) ((C(1,K,J),K=1,IHM),J=1,IGM)
      IZ=IZ+1
      TAPENO=ATAPE
      WRITE (9,1890)
      IRETURN=1
      IZAP=1
      GO TO 1290

```

```

760  CONTINUE
      IRETURN=0
      IZAP=0
      GO TO 1260
770  CONTINUE
      READ (1,1720) (LABEL(I),I=1,12)
      WRITE (4,1680) I
      WRITE (3,1710) I
      WRITE (3,1720) (LABEL(I),I=1,12)
      READ (2) (DATA(I),I=1,12),I1,I2,I3,I4
      I5=I3+1
      IF (I5.GT.120) STOP 42
      IF (I4.GT.29) STOP 43
      WRITE (3,1730) I1,I2,I3,I4
      WRITE (5) (LABEL(I),I=1,12),I1,I2,I3,I4
      READ (2) ((FLUX(K,J),J=1,13),K=1,I4)
      WRITE (5) ((FLUX(K,J),J=1,13),K=1,I4)
      READ (2) ((CURRENT(K,J),J=1,15),K=1,I4)
      WRITE (5) ((CURRENT(K,J),J=1,15),K=1,I4)
      GO TO 1260

C
C      CAUSING DATA SET REPLACEMENT.
C
780  CONTINUE
      IF (OPTION.EQ.1) GO TO 840
      WRITE (6) (TITLE(I,J),J=1,8)
      WRITE (6) ((C(I,K,J),K=1,IHM),J=1,IGM)
      WRITE (7,1650) KK, (TITLE(I,J),J=1,8)
      WRITE (9,1690)
      IZAP=1
      GO TO 1290
790  CONTINUE
      IZAP=0
      IZ=IZ+1
      TAPENO=ATAPE
      IF (ATAPE.EQ.12) TAPENO=2
      READ (TAPENO) (TITLE(I,J),J=1,8)
      IF (EOF,TAPENO) 800,810
800  CONTINUE
      WRITE (4,1640) (TITLE(I,J),J=1,8)
      STOP 27
810  CONTINUE
      WRITE (8) (TITLE(I,J),J=1,8)
      READ (TAPENO) ((C(I,K,J),K=1,IHM),J=1,IGM)
      IF (EOF,TAPENO) 820,830
820  CONTINUE
      WRITE (4,1700) I
      STOP 30
830  CONTINUE
      WRITE (8) ((C(I,K,J),K=1,IHM),J=1,IGM)
      TAPENO=ATAPE
      GO TO 1260
840  CONTINUE
      GO TO 490
850  CONTINUE
      ITAPE=4
      READ (2) (DATA(I),I=1,12),I1,I2,I3,I4
      IF (EOF,2) 860,870
860  CONTINUE
      STOP 44
870  CONTINUE
      I5=I3+1
      IF (I5.GT.120) STOP 42
      IF (I4.GT.29) STOP 43
      IF (IKK.EQ.0) WRITE (4,1920)
      WRITE (ITAPE,1710) I

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```

      WRITE (ITAPE,1720) (DATA(I),I=1,12)
      WRITE (ITAPE,1730) I1,I2,I3,I4
      IF (ITAPE.EQ.3) GO TO 910
      IF (IKK.EQ.1) GO TO 900
      READ (12) (DATA(I),I=1,12),I1,I2,I3,I4
      IF (EOF,12) 890,880
880  CONTINUE
890  CONTINUE
      IF (IS.GT.120) STOP 42
      IF (I4.GT.29) STOP 43
      IKK=1
      GO TO 870
900  CONTINUE
      ITAPE=3
      GO TO 870
910  CONTINUE
      WRITE (5) (DATA(I),I=1,12),I1,I2,I3,I4
      WRITE (9,1710) I
      WRITE (9,1720) (DATA(I),I=1,12)
      WRITE (9,1730) I1,I2,I3,I4
      IKK=0
      READ (2)
      READ (2)
      READ (12) ((FLUX(K,J),J=1,I3),K=1,I4)
      IF (EOF,12) 920,930
920  CONTINUE
      STOP 46
930  CONTINUE
      IS=I3+1
      WRITE (5) ((FLUX(K,J),J=1,I3),K=1,I4)
      IFLUX=1
      GO TO 1430
940  CONTINUE
      IFLUX=0
      READ (12) ((CURRENT(K,J),J=1,IS),K=1,I4)
      IF (EOF,12) 950,960
950  CONTINUE
      STOP 47
960  CONTINUE
      WRITE (5) ((CURRENT(K,J),J=1,IS),K=1,I4)
      ICURRENT=1
      GO TO 1430
970  CONTINUE
      ICURRENT=0
      GO TO 1260

C
C   CASE OF TAPENO = 2 AND NO CHANGE DESIRED.
C
980  CONTINUE
      IF (OPTION.EQ.1) GO TO 1040
      TAPENO=2
990  CONTINUE
      IF (OPTION.EQ.1) GO TO 1040
      IF (I.GT.ISKIP(IZIP)) GO TO 1110
      READ (TAPENO) (TITLE(1,J),J=1,8)
      IF (EOF,TAPENO) 1000,1010
1000 CONTINUE
      WRITE (4,1640) (TITLE(1,J),J=1,8)
      STOP 16
1010 CONTINUE
      READ (TAPENO) ((C(1,K,J),K=1,IHM),J=1,IGM)
      IF (EOF,TAPENO) 1020,1030
1020 CONTINUE
      WRITE (4,1700) I
      STOP 17
1030 CONTINUE

```

```

      IZ=IZ+1
      WRITE (6) (TITLE(1,J),J=1,8)
      WRITE (6) ((C(1,K,J),K=1,IHM),J=1,IGM)
      WRITE (7,1650) IZ, (TITLE(1,J),J=1,8)
      IF (ATAPE.EQ.12) TAPENO=ATAPE
      GO TO 1260
1040  CONTINUE
      READ (2) (DATA(I),I=1,12),I1,I2,I3,I4
      IF (EOF,2) 1050,1060
1050  CONTINUE
      WRITE (4,2010)
      DATASET=DATASET-1
      GO TO 1270
1060  CONTINUE
      WRITE (3,1710) I
      WRITE (3,1720) (DATA(I),I=1,12)
      WRITE (3,1730) I1,I2,I3,I4
      I5=I3+1
      IF (I5.GT.120) STOP 42
      IF (I4.GT.29) STOP 43
      WRITE (5) (DATA(I),I=1,12),I1,I2,I3,I4
      READ (2) ((FLUX(K,J),J=1,I3),K=1,I4)
      IF (EOF,2) 1070,1080
1070  CONTINUE
      STOP 40
1080  CONTINUE
      WRITE (5) ((FLUX(K,J),J=1,I3),K=1,I4)
      READ (2) ((CURRENT(K,J),J=1,I5),K=1,I4)
      IF (EOF,2) 1090,1100
1090  CONTINUE
      STOP 41
1100  CONTINUE
      WRITE (5) ((CURRENT(K,J),J=1,I5),K=1,I4)
      GO TO 1260
1110  CONTINUE
      WRITE (4,2000) I,ISKIP(IZIP)
      GO TO 1270
C
C      CAUSING ADDITION OF DATA SET AT THE END OF THE OLD DIRECTORY.
C
1120  CONTINUE
      IF (OPTION.EQ.1) GO TO 1140
      WRITE (6) (TITLE(1,J),J=1,8)
      WRITE (6) ((C(1,K,J),K=1,IHM),J=1,IGM)
      WRITE (7,1650) KK, (TITLE(1,J),J=1,8)
      WRITE (9,1740)
      IZAP=1
      IRETURN=1
      GO TO 1290
1130  CONTINUE
      IRETURN=0
      IZAP=0
      IZ=IZ+1
      TAPENO=ATAPE
      GO TO 1260
1140  CONTINUE
      GO TO 490
1150  CONTINUE
      READ (12) (DATA(I),I=1,12),I1,I2,I3,I4
      IF (EOF,12) 1160,1170
1160  CONTINUE
      STOP 50
1170  CONTINUE
      IF (I5.GT.120) STOP 42
      IF (I4.GT.29) STOP 43
      ITAPE=4

```



```

        WRITE (4,1930)
1180  CONTINUE
        WRITE (ITAPE,1710) I
        WRITE (ITAPE,1720) (DATA(I),I=1,12)
        WRITE (ITAPE,1730) I1,I2,I3,I4
        IF (ITAPE.EQ.3) GO TO 1190
        ITAPE=3
        GO TO 1180
1190  CONTINUE
        WRITE (5) (DATA(I),I=1,12),I1,I2,I3,I4
        WRITE (9,1710) I
        WRITE (9,1720) (DATA(I),I=1,12)
        WRITE (9,1730) I1,I2,I3,I4
        READ (12) ((FLUX(K,J),J=1,I3),K=1,I4)
        IF (EOF,12) 1200,1210
1200  CONTINUE
        STOP 51
1210  CONTINUE
        WRITE (5) ((FLUX(K,J),J=1,I3),K=1,I4)
        IFLUX2=1
        GO TO 1430
1220  CONTINUE
        IFLUX2=0
        I5=I3+1
        READ (12) ((CURRENT(K,J),J=1,I5),K=1,I4)
        IF (EOF,12) 1230,1240
1230  CONTINUE
        STOP 52
1240  CONTINUE
        WRITE (5) ((CURRENT(K,J),J=1,I5),K=1,I4)
        ICUR2=1
        GO TO 1430
1250  CONTINUE
        ICUR2=0
        GO TO 1260
1260  CONTINUE
        STOP 6
1270  CONTINUE
        IF (OPTION.EQ.2) GO TO 1280
        WRITE (4,1910)
        GO TO 1390
1280  CONTINUE
        WRITE (4,1750)
C
C      COMPLETE CROSS-SECTION DATA SET PRINTOUT.
C
        IF (IPRINT.NE.1) GO TO 1380
        WRITE (9,1760)
        REWIND 6
        WRITE (9,1770)
1290  CONTINUE
        DO 1370 I=1,KK
        IF (IZAP.EQ.1) GO TO 1310
        READ (6) (TITLE(1,J),J=1,8)
        IF (EOF,6) 1300,1310
1300  CONTINUE
        STOP 10
1310  CONTINUE
        WRITE (9,1780) (TITLE(1,J),J=1,8)
        WRITE (9,1790)
        IF (IZAP.EQ.1) GO TO 1330
        READ (6) ((C(1,K,J),K=1,IHM),J=1,29)
        IF (EOF,6) 1320,1330
1320  CONTINUE
        WRITE (9,1800) KK
1330  CONTINUE

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```

      DO 1340 IQ=1,15
      WRITE (9,1810) IQ, (C(1,IQ,J), J=1,10)
1340  CONTINUE
      WRITE (9,1820)
      DO 1350 IQ=1,15
      WRITE (9,1810) IQ, (C(1,IQ,J), J=11,20)
1350  CONTINUE
      WRITE (9,1830)
      DO 1360 IQ=1,15
      WRITE (9,1840) IQ, (C(1,IQ,J), J=21,29)
1360  CONTINUE
      WRITE (4,1850)
      IF (IZAP.EQ.1.AND.IRETURN.EQ.1) GO TO 760
      IF (IRETURN.EQ.1) GO TO 1130
      IF (IZAP.EQ.1) GO TO 790
1370  CONTINUE
1380  CONTINUE
      WRITE (9,1850)
1390  CONTINUE
      IWHY=1
C
C   COMPLETE TRIAL SOLUTION DATA SET PRINTOUT.
C
      IF (OPTION.EQ.2) GO TO 1540
      IF (IPRINT.NE.1) GO TO 1540
      WRITE (9,1940)
      REWIND 5
      DO 1530 IX=1,DATASET
      IF (IWHY.EQ.0) GO TO 1410
      READ (5) (DATA(I), I=1,12), I1, I2, I3, I4
      IF (EOF,5) 1400,1410
1400  CONTINUE
      STOP 62
1410  CONTINUE
      I5=I3+1
      IF (I5.GT.120) STOP 42
      IF (I4.GT.29) STOP 43
      WRITE (9,1710) IX
      WRITE (9,1720) (DATA(I), I=1,12)
      WRITE (9,1730) I1, I2, I3, I4
      IF (IWHY.EQ.0) GO TO 1440
      READ (5) ((FLUX(K,J), J=1,13), K=1,14)
      IF (EOF,5) 1420,1440
1420  CONTINUE
      STOP 61
1430  CONTINUE
      IF (IFLUX.EQ.1) GO TO 1440
      IF (ICURRENT.EQ.1) GO TO 1490
      IF (IFLUX2.EQ.1) GO TO 1440
      IF (ICUR2.EQ.1) GO TO 1490
      STOP 45
1440  CONTINUE
      WRITE (9,1950)
      WRITE (9,1790)
      DO 1450 IZK=1,13
      WRITE (9,1810) IZK, (FLUX(J,IZK), J=1,10)
1450  CONTINUE
      WRITE (9,1820)
      DO 1460 IZK=1,13
      WRITE (9,1810) IZK, (FLUX(J,IZK), J=11,20)
1460  CONTINUE
      WRITE (9,1830)
      DO 1470 IZK=1,13
      WRITE (9,1840) IZK, (FLUX(J,IZK), J=21,29)
1470  CONTINUE
      IF (IFLUX.EQ.1) GO TO 940

```



```

1      J=15      J=16      J=17      J=18      J=19
2      J=20      *///)
1830  FORMAT (///* I      J=21      J=22      J=23      J=24
1      J=25      J=26      J=27      J=28      J=29 *///
2)
1840  FORMAT (1X,I2,1X,9(1PE13,5))
1850  FORMAT (////////)
1860  FORMAT (///* IOPTION = *.I3,///)
1870  FORMAT (///* TITLE OF DELETED DATA SET *///)
1880  FORMAT (///* KLW = *.I3,///,* IOPTION(IP) = *.I3,///,* IOPTION(IP-1)
1= *.I3,///,* ISKIP(IP) = *.I3,///,* ISKIP(IP-1) = *.I3,///)
1890  FORMAT (///* TITLE CHANGE. DATA SET WITH OLD TITLE. *///)
1900  FORMAT (///* BECAUSE OF NEGATIVE TAPENO IPRINT SET EQUAL TO*.I3,///)
1910  FORMAT (///* OLD TRIAL SOLUTION DIRECTORY PRINTED OUT BEFORE ALTERE
1D VERSION.*///)
1920  FORMAT (///* OLD DIRECTORY ENTRY AND COMPLETE NEW REPLACEMENT.*///)
1930  FORMAT (///* NEW DATA SET.*///)
1940  FORMAT (1H0,5X,* COMPLETE TRIAL SOLUTION DATA SET PRINTOUT.*1H0)
1950  FORMAT (///* FLUX PRINTOUT.*///)
1960  FORMAT (///* CURRENT PRINTOUT.*///)
1970  FORMAT (///* THE EQUIVALENT TO A STOP 56 HAS BEEN ENCOUNTERED.*///)
1980  FORMAT (///* IN 7600 TAPE CONVERSION THE EQUIVALENT TO A STOP 60 WA
1S ENCOUNTERED*.I3,* TIMES.*///)
1990  FORMAT (///* EXIT FROM MAIN LOOP WITH ILOG =*.I4,* AND IREC =*.I4,/
1/)
2000  FORMAT (///* EXIT FROM MAIN LOOP WITH I =*.I4,* AND ISKIP(IZIP) :*,
1I4,///)
2010  FORMAT (///* EXIT FROM MAIN LOOP BECAUSE EOF FOUND IN TRIAL SOLUTIO
IN TITLE READ.*///)

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