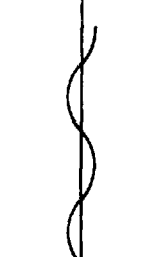
LA-4941

Linkage of Reactor Physics Codes through Standard Interfaces



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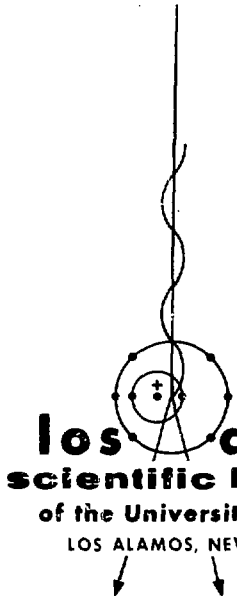

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Linkage of Reactor Physics Codes through Standard Interfaces

by

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LINKAGE OF REACTOR PHYSICS CODES THROUGH STANDARD INTERFACES

by

B. M. Carmichael and J. C. Vigil

ABSTRACT

Selected reactor physics codes have been linked by a set of interface files. Access to codes, free-format card input for creating or modifying the files, system-restart capability, and file-printing options are all available at any point in whatever calculation path the user chooses to prescribe.

I. INTRODUCTION AND SUMMARY

The linked set of codes described in this report is an outgrowth of the Los Alamos Scientific Laboratory's (LASL) participation in the work of the *de facto* Committee on Computer Code Coordination (CCCC). This Committee consisted of representatives from several laboratories selected by the AEC to study the problems of adapting reactor codes to various types of computers and the problems of interfacing reactor codes from different organizations in linked calculations. The set of prototypical codes, adopted by the Committee for exchange and interface testing, was adapted to the LASL CDC 6600 computers in a linked system under the control of a driver program. Under the driver program, the codes may be executed in any logical sequence, and the interface files may be stored at any point in a run and may be retrieved in a subsequent run. Also, any one of the interface files may be created or modified by user input at any point in a sequence of calculations.

The set of codes adopted by the CCCC, and the organizations assigned to the work of adapting the codes to the standard interfaces are:

MC[2] code[1] (cross-section processing)
Argonne National Laboratory (ANL)

ETOX code[2] and 1DX code[3] (cross-section processing and one-dimensional diffusion)
Hanford Engineering Development Laboratory (HEDL)

ANISN code[4] (one-dimensional S_n or diffusion)
Brookhaven National Laboratory (BNL)

DOT2DB code[5] (two-dimensional S_n and diffusion)
General Electric - Sunnyvale, California (GE-Sunnyvale)

DAC code[6,7] (one-, two-, or three-dimensional perturbation)
Los Alamos Scientific Laboratory (LASL)

CLUB code[8] (fuel depletion)
Oak Ridge National Laboratory (ORNL)

The standard interface files (Version I) adopted by the Committee for linking the above codes are:

ADMNSTR (administration and control file containing dimension and option control data)

GEO DIST (geometry and material distributions)

SN CONS (S_n constants)

INTQUANT (integral quantities, such as zone volumes and zone-averaged fluxes)

MIX DATA (mixture data)

MULTIGRP (multigroup cross-section data)

GRP FLXS (group fluxes and currents)

ZONEDENS (material density by zone)

The codes cited above are well known and well documented. Readers are referred to the cited references for discussions of the algorithms solved and the detailed description of the options available. This report covers primarily the modifications related to the interfacing of the codes. These modifications include the creation of a set of code-dependent interface files and a set of service modules that provide card input, file printing, and restart capabilities.

The linked system was developed to achieve a thorough verification and test of the interface files. However, the system, or components of the system, should provide capabilities useful to others. The individual codes are completely interfaced; consequently, they are readily separable from the system. Particular fixed calculation paths involving code subsets can be readily provided.

The present system of codes represents only an interim development. A new set of interface files (Version II) of greater efficiency and broader capabilities has been developed. The system is presently being adapted to these new interfaces. Other more advanced codes are also being adapted to the new interfaces and will be tested as components of the system.

II. SYSTEM-LINKAGE PROCEDURES

Linking of the codes is accomplished through the segmentation facilities available on the CDC 6600 computer.[9] The set of codes can be thought of as one large FORTRAN-IV program consisting of a main program (DRIVER) and many subroutines. The segmentation procedure provides a means of loading and executing the parts or segments of the large program as needed. SEGMENT calls are inserted into the program to direct the loading of segments, and SEGMENT specification statements are placed before the main program to specify the set of subroutines comprising each segment. Conversely, the SEGMENT specification statements and SEGMENT calls would be removed as a first step in converting the system of codes to the overlay systems available on other types of computers. These conversion procedures are discussed in detail in Appendix A.

The format of SEGMENT specification statements is

SEGMENT (SEG1, SUB1, SUB2, ...)

where SEG1 is the name of the segment, and SUB1, SUB2, ... are the names of the subroutines included in the segment. SEG1 is loaded using a statement of the form

CALL SEGMENT (4HFILE, LEVEL, 4HSEG1, LIB, MAP)

where

FILE is the name of the disk or tape file containing the binary object codes for the subroutines of the segment,

LEVEL is the level at which the segment is loaded into core (levels 0 to 63 available),

SEG1 is the name of the segment, and

LIB and MAP are flags controlling the acquisition of system library routines and printing of the loader map.

After a segment is called, control is returned to the calling routine, which may then call any of the subroutines in the called segment. Segmentation is otherwise similar to other overlay systems, except that labeled common arrays are not transmitted between segments.

The codes in the system are accessed by a series of level 1 segment calls in the DRIVER program, which resides at level 0. These calls are at the complete control of the user through card input. The codes and service modules are listed in Table I.

TABLE I

REACTOR CODE SET

Call Name	File	Code or Module
ETX	ETX	ETOX code for processing cross sections.
ODX	ODX	1DX code -- one-dimensional diffusion code used primarily to convert ETOX cross sections into standard multigroup file.
ANI	ANI	ANISN code -- one-dimensional S_n or diffusion code.
DOT	DOT	DOT2DB code -- two-dimensional S_n or diffusion code.
CLB	CLB	CLUB code -- burnup code, which may use fluxes from 1DX, ANISN, or DOT2DB.
DAC	DAC	One-, two-, or three-dimensional perturbation code, which may use total fluxes and currents or S_n angular fluxes from 1DX, ANISN, or DOT2DB.
INP	SER	Service module for processing card input.
PRN	SER	Service module for printing interface files.
FL0	SER	Service module for retrieving files from tape for restart.
FL1	SER	Service module for storing files on tape for restart.

Communication between codes and modules is accomplished by means of binary interface data files. The set of standard files in the system is given in Table II.

Input data other than those contained in the standard files are required by each code. Such data

TABLE II

VERSION I STANDARD FILES

File Name	General Contents
ADMNSTR	Administration file containing control flags and dimension parameters.
SN CONS	S_n constants file.
INTQUANT	Integral quantities including derived constants, zone-averaged fluxes, and zone volumes.
GEO DIST	Geometry and material distributions.
MIX DATA	Mixture data.
GRP FLXS	Regular fluxes, currents, and angular fluxes.
ADJ FLXS	Adjoint fluxes, currents, and angular fluxes.
MULTIGRP	Reference multigroup cross sections.
PERTMTGP	Perturbed multigroup cross sections.
ZONEDENS	Zone atomic densities.

are incorporated in special files called code-dependent files. These files are listed in Table III.

TABLE III

CODE-DEPENDENT FILES

File Name	Contents
ETX INPT	ETOX input
ODX INPT	1DX input
ANI INPT	ANISN input
DOT INPT	DOT2DB input
CLB INPT	CLUB input
DAC INPT	DAC input

Initially, the operation of the system may start with the assignment of three magnetic tapes. The binary code files ETX, ODX, ANI, DOT, CLB, DAC, and SER plus the DRIVER file are stacked onto one tape (CODEB). The code files are copied onto individual disk files using control cards such as

```
COPYBF(CODEB, ETX)
REWIND(ETX) .
```

The second tape (tape 49) contains standard and code-dependent data files that were generated in previous runs. The third tape (tape 50) is used for storing data files at the end of the run.

At the beginning of execution of the main program, or DRIVER, the execution path is read from cards. The path must be so arranged that the input data files to a code are configured properly for execution of the code in the path. These input files may be created from cards using INP, may be retrieved from tape 49 using FLO, or may be output by the execution of another code. In the two latter cases, where files already exist, INP may be called to alter the existing files selectively. The print module PRN is usually called to print files that were created or extensively altered by execution of INP and to obtain prints of code output files.

A simple example of a path is

```
INP ANI PRN .
```

INP is used to create the input files ADMNSTR, SN CONS, GEO DIST, MIX DATA, MULTIGRP, and ANI INPUT, which define the problem to be solved by the ANISN code. PRN provides a detailed print of all the files, including the GRP FLXS file generated by ANISN.

In executing this path, the three level 1 segment calls

```
CALL SEGMENT (3HSER, 1, 4HINPS, LIB, MAP)
CALL SEGMENT (3HANI, 1, 4HANIS, LIB, MAP)
CALL SEGMENT (3HSER, 1, 4HPRNS, LIB, MAP)
```

are performed in sequence by DRIVER. An S is appended to the segment names because the segmentation system requires the file name (ANI) and segment name (ANIS) to be different.

The CLUB code is a special case because it involves a closed-loop calculation. CLUB calls one of the flux codes periodically while performing fuel-cycle calculations. The user selects the desired flux code by card input to the CLB INPT file. All the codes called by DRIVER are loaded at level 1. Consequently, a flux code called from CLUB is loaded at a higher level. Because the flux codes are individually segmented, variable level parameters are required. The MAIN subroutine of the flux code is loaded at level I and higher level segments are referenced with respect to I. The variable I is transmitted between segments by blank common.

Many different calculation paths are conceivable. A few examples are listed below:

(1) INP ETX ODX INP DOT PRN FL1

(2) FLO INP DOT INP DOT PRN

(3) FLO INP ANI INP ANI DAC

(4) INP PRN CLB .

In path (1), ETX and ODX provide a multigroup cross-section file for use in a DOT2DB problem. In

path (2), a two-dimensional diffusion calculation is performed in the first DOT call. The diffusion fluxes provide a good flux guess for a two-dimensional S_n calculation performed under the second DOT call. INP is called between the two DOT calls to alter the ADMNSTR file from the diffusion option to the S_n option. Because of the overlay facilities in the input processor, only the input for changing the one flag is required. In path (3), regular and adjoint ANISN calculations are performed to obtain fluxes for use in DAC perturbation calculations. Path (4) provides a CLUB burnup calculation. As mentioned before, ODX, ANI, or DOT may be used to provide the fluxes for the burnup calculations. Any path can be interrupted with an FL1 call to save the files created to the given point. The path can then be resumed in a later run by using FL0 to retrieve the files.

Some routine procedures do not require the flexibility provided. For such procedures, the user could be provided with a deck that already contains the input cards for the desired path. Alternatively, a DATA specification card containing a desired fixed path could replace the path input statement in DRIVER. The procedures required for converting a code or subset of codes into a free-standing fixed-calculation facility are similarly straightforward.

Any free-standing interfaced code can be added to the system by converting it to the segmentation form without changing the existing system. However, it would ultimately be desirable to add any code-dependent input required by the new code to the service modules.

An interfaced version of the MC^2 cross-section processing code is available for use with the system; however, it has not been converted for direct access by a path call. Because of the computation times involved in the MC^2 calculations, users would normally prefer to operate it as a free-standing code. The output MULTIGRP file from MC^2, however, is written on a tape that can be accessed by the system.

III. SERVICE MODULES

There are three service modules in the code system that provide various file handling services, including creation of files from card input, printing of files, and storage and retrieval of files. These functions are discussed below.

A. Input Processor (INP)

All card input for the system except for input to MC^2 and the print processor is processed by INP. The detailed definition and description of the card input are given in Appendix B. The input is organized in terms of the data files listed in Tables II and III. A set of flags is read first by INP to control the handling of input for each file. The options available are:

(1) Read entire file from cards.

(2) Read existing file using no card input. This option normally applies only to the ADMNSTR file, which contains parameters required in the reading of other files.

(3) Read existing file and overlay with card input to create a new file. This option is most frequently used to alter the options requested from calculational modules or to correct erroneous data. In the multigroup cross-section file, data for selected isotopes on the existing file may be altered or replaced and additional isotopes may be added.

(4) Skip file. This option is used when an existing file requires no changes, or when the given file is not required for the selected calculation path.

When Option (3) is requested for a given file, the first record read from cards for that file contains a set of record read control flags. These flags enable the user to overlay or skip over each record as desired. Further, in the reading of an individual record from cards, words in the record may be omitted in the reading by using the skip-words option. An order on the input card of the type Sn is punched to indicate skip n words in overlaying the record.

All card input is processed through subroutine RGEN, which is a free-format card-input processor written completely in standard FORTRAN.[10] This subroutine is described in a separate report.[11] Numeric entries are delimited by blanks, and numerics are interpreted as integers if they contain no decimal point or exponent. Otherwise, numerics are taken to be floating-point numbers. Hollerith data are delimited by asterisks. The maximum size of a Hollerith word is six characters; however, a Hollerith string containing more than six characters is allowed, as in

INPbbbPRN .

In this example, INPbbb is loaded as the first word, and PRN is loaded left-adjusted as a second word. A record must be terminated by T. A slash (/) may be used to signify an end to the data to be stored from a given card. Comments may be inserted after T or / on a card or otherwise may be set off by dollar signs ($). Card images are printed as they are read.

In addition to the skip option cited above, repeat, nested repeat, and interpolate options are also available. The repeat option is of the form

Rn(a,b,c,...) ,

where n is an integer signifying that n copies of the array contained in the parentheses are to be stored. The a,b,c,... arguments of the repeat operation may be numerics, nested repeats, and/or interpolation operations. The interpolation operation is of the form

In(a) ,

which directs that n interpolates, between the last word read prior to the I operation and a, be calculated and stored. The R and I specifications must contain no imbedded blanks, and commas must be used to separate items in an argument list. Several error diagnostics and associated printed comments are provided.

B. Print Processor (PRN)

This processor provides the option to print files or selected records of files at any point in the path. As in INP, a set of flags that govern the printing of files is read first. The three options available are:

(1) Skip file.

(2) Print entire file.

(3) Print selected records in file.

If Option (3) is used, additional flags are read to identify which records are to be printed in the given file.

Most of the data output by the codes is contained in the 16 interface-data files. Consequently, it is planned that eventually individual codes will print only information that indicates the progress of calculations such as iteration monitor lines.

C. Storage and Retrieval of Files (FL0 and FL1)

Both storage and retrieval of files are processed by subroutine FILER. An FL0 call in the path directs FILER to read the files that are stacked on tape 49 and to store them on disk as individual files. An FL1 call requests FILER to perform the inverse operation of copying the files from disk to tape 50.

A common array NFILES is used for storing the logical unit number of the files. NFILES is initialized to zero by DRIVER, and the associated logical unit numbers are stored in NFILES as files are created. NFILES is also written as the first record on tape 50 when an FL1 call is made. When files are read under FL0, a zero in NFILES signals to FILER that the associated file does not exist and is to be omitted in the transfer operation. The NFILES record on tape is also read into the NFILES array under FL0 to restore the configuration of logical units associated with the disk files. Methods used to assign logical unit numbers and buffers to the interface files are discussed in Appendix C.

D. Segmentation Structure of Service Modules

The segmentation structure of the service modules is given in Table IV. As indicated in Table I,

TABLE IV

SERVICE MODULE SEGMENT STRUCTURE

Call Name	Segment Name	Routines Included in Segment
	DRIVE1(SEGZERO)	DRIVER, BUFOPEN, STOW, REED, RITE
INP	INPS	CDINP, SNIFF, RGEN, IFDGIT, ITGR, FLOT, SETFMT
PRN	PRNS	FPRINT, RGEN, IFDGIT, ITGR, FLOT, SETFMT, SNIFF, WOT, WOTS, WOTI
FL0,FL1	FILR	FILER

these segments, except for DRIVE1, are stored in file SER. DRIVE1 is the main segment of the system, which is loaded at level 0. This segment is prescribed in a special specification statement

SEGZERO(DRIVE1,DRIVER,BUFOPEN,STOW,REED,RITE) .

The service modules each consist of a single level 1 segment. These segments are loaded by DRIVER. Subroutines in the service modules are described in Table V.

TABLE V

SERVICE MODULE SUBROUTINES

Routine	Description
DRIVER	Main program of system. Calls codes and service modules as directed by path prescribed by user input.
BUFOPEN	Written in COMPASS assembly language.[12] Called by DRIVER and SNIFF routines to assign buffers to files.
STOW	Small routine for transferring array from one location in core to another. Called by CDINP and FPRINT.
REED	Reads an array from a file. May be replaced to accommodate local environment where other than FORTRAN I/O is required. Called by CDINP, FPRINT, and FILER.
RITE	Writes an array on a file. May also be replaced as required. Called by CDINP, FPRINT, and FILER.
SNIFF	Assigns a file number corresponding to a given file name and assigns buffers. Calls BUFOPEN and is called by CDINP, FILER, and FPRINT. For machines other than CDC 6600, SNIFF should be altered or replaced to suit local file environment.
CDINP	Main subroutine of card input module INP. Called by DRIVER and calls REED, RITE, STOW, SNIFF, and RGEN.
RGEN	Reads a free-format array from cards. Called by DRIVER, CDINP, and FPRINT and calls IFDGIT, ITGR, FLOT, and SETFMT.
IFDGIT	Identifies integer characters. Called by RGEN.
ITGR	Decodes a string of Hollerith characters to form a signed integer constant. Called by RGEN.
FLOT	Decodes a string of Hollerith characters to form a signed floating-point constant. Called by RGEN.
SETFMT	Converts a positive integer less than 100 into two consecutive Hollerith characters. Called by RGEN.
FPRINT	Main subroutine of print module PRN. Called by DRIVER and calls REED, RITE, STOW, SNIFF, RGEN, WOT, WOT8, and WOTI.
WOT	Prints one-, two-, or three-dimensional floating-point arrays. Called by FPRINT.
WOT8	Prints up to eight one-dimensional arrays. Called by FPRINT.
WOTI	Prints one-, two-, or three-dimensional integer arrays. Called by FPRINT.
FILER	Stores and retrieves files from tape in response to FL0 and FL1 path calls. Called by DRIVER and calls SNIFF, REED, RITE, and BUFOPEN.

IV. CODE DESCRIPTIONS

The seven reactor physics codes in the system are described in this section. Organization of the codes under the linked system is stressed, and the code capabilities are summarized.

A. ETOX Code

The ETOX (ENDF/B TO 1DX) code processes the Evaluated Nuclear Data File[13] (ENDF/B) to produce multigroup constants in the Bondarenko format[14] that can be used as input to the 1DX code. Both Version-I and -II ENDF/B data can be processed, but the data must be in standard binary (Mode 1) form. Details of the computational methods used in ETOX are given in Ref. 2.

ETOX is currently restricted to a maximum of 99 energy groups, 250 resonances, and single-level Breit-Wigner representation of resolved resonances. The dimension of the common array A in the DRIVER module must be set at 35,000 to provide sufficient storage for the code. The output must be processed by the 1DX code to produce a standard MULTIGRP file.

Output from ETOX includes infinite-dilution group cross sections, inelastic-transfer matrices (P_0 with downscatter only), and resonance-shielding factors by group for specified values of temperature and σ_0 (total cross section per atom). The principal advantage of this form of output is that calculations can be made for fast reactors of various compositions and temperatures using the same set of group constants. This is done by interpolating on the resonance-shielding factors.

A segment in the code is available for creating or updating a cross-section library. The new library is written on tape 46. If an old library is to be updated, it must be assigned to tape 47. Also, the ENDF/B data file must be assigned to tape 48.

Input specifications for the ETOX code are given in Appendix B (ETX INPT data file). Input parameters must be within the ranges specified in the ETX INPT file description; otherwise, a comment is printed and the run is terminated.

The segmentation structure of the ETOX code is shown in Table VI. ETXS, the level 1 segment, is loaded by DRIVER. All level 2 segments are loaded by subroutine MAIN, level 3 segments FIL2 and FIL3 are loaded by subroutine ENDFB, and level 3 segments OVLAY21 and OVLAY22 are loaded by subroutine RESON.

TABLE VI

SEGMENTATION STRUCTURE OF ETOX CODE

Segment Level	Segment Name	Subroutines Included in Segment
1	ETXS	MAIN, ERRF, ERROR, FFLUX TERP1, ZERO, RETREV, CHI, AVER, AVSEC, SNIFF
2	WLIBR	WLIB, W
2	INPTR	INPT
2	OVLAY10	ENDFB, FILE1, LOCISO, HEADR
2	OVLAY20	RESON, AVSECR, AJK, NA23, QK, QUICKW, RELIB
2	FFAC	FFACNR
2	OVLAY30	INELAS, FILE5, INTERP, INTOR?
2	OVLAY40	OUTPDX
2	PUPXS	PUPX, UPDATE, PRINT, INPUT, OUTPUT, NTRAN
3	FIL2	FILE2
3	FIL3	FILE3, SETUP1, TSUM, MISS, REMT, VER2, CAPSUM, WCP, TERP2
3	OVLAY21	RRES, SR, SETUFG, ROMB
3	OVLAY22	URES, SETUPJ

A simplified flow diagram for the ETOX code is shown in Fig. 1 (system library routines are not shown), and a brief description of each subroutine is given in Table VII. Two formerly free-standing codes, WLIB and PUPX, are incorporated as segments in the ETOX code. WLIB computes a table of psi and chi functions for the complex probability integral and is called at the beginning of a calculation before cross-section processing begins. PUPX creates or updates a library of cross sections and is called after all of the isotopes in the problem have been processed.

ETOX contains a number of programmed error stops; the reason for some of the error stops is stated explicitly in the output. However, many of the stops are identified only by the comment ERROR STOP N, where N may have any of the values given in Table VIII. The subroutine in which this type of error stop occurs and the condition causing the stop are given in Table VIII.

TABLE VII

DESCRIPTION OF SUBROUTINES IN ETOX CODE

Subroutine	Description
MAIN	Controls the overall flow of the ETOX calculation and reads the first part of the ETX INPT data file. Also loads all level 2 segments. Called by DRIVER and calls subroutines BUFOPEN, WLIB, ZERO, SNIFF, INPT, ENDFB, RESON, FFACNR, INELAS, OUTPDX, CHI, and PUPX. BUFOPEN is part of the DRIVER module.
SNIFF	Assigns a file number corresponding to a given file name and assigns a particular buffer to the file. Calls BUFOPEN (see DRIVER module) and is called by MAIN, FILE2, FILE3, RETREV, WCP, TSUM, RELIB, URES, INELAS, and OUTPDX.
WLIB	Controls calculation of psi and chi functions (W table) for the complex probability integral. Called by MAIN and calls W.
W	Computes W table. Called by WLIB.
ZERO	Zeros out arrays in common. Called by MAIN, FILE3, TSUM, CAPSUM, RESON, SR, URES, and OUTPDX.
INPT	Reads remainder of ETX INPT data file and edits all the input data. Called by MAIN.
ENDFB	Controls reading of ENDF/B library tape. Also loads level 3 segments FILE2 and FILE3. Called by MAIN and calls HEADR, LOCISO, FILE1, FILE2, and FILE3.
HEADR	Reads ENDF/B tape ID record. Called by ENDFB and calls ERROR.
LOCISO	Locates isotope on ENDF/B library tape. Called by ENDFB and calls ERROR.
FILE1	Reads File 1 data (general information) from ENDF/B tape. Called by ENDFB and calls ERROR.
FILE2	Reads File 2 data (resonance parameters) from ENDF/B tape. Called by ENDFB and calls ERROR and SNIFF.
FILE3	Reads File 3 data (smooth cross sections) from ENDF/B tape. Called by ENDFB and calls REMT, SNIFF, ERROR, SETUP1, TERP2, ZERO, and TSUM.
REMT	Locates a particular cross-section type on the ENDF/B tape. Called by FILE3 and calls CAPSUM, MISS, ERROR, VER2, and WCP.
CAPSUM	Calculates the total capture cross section at fine-group points by summing all capture components. Called by REMT and calls TERP2 and ZERO.
TERP2	Interpolates a series of points according to ENDF/B specifications. Called by FILE3 and CAPSUM and calls ERROR and TERP1.

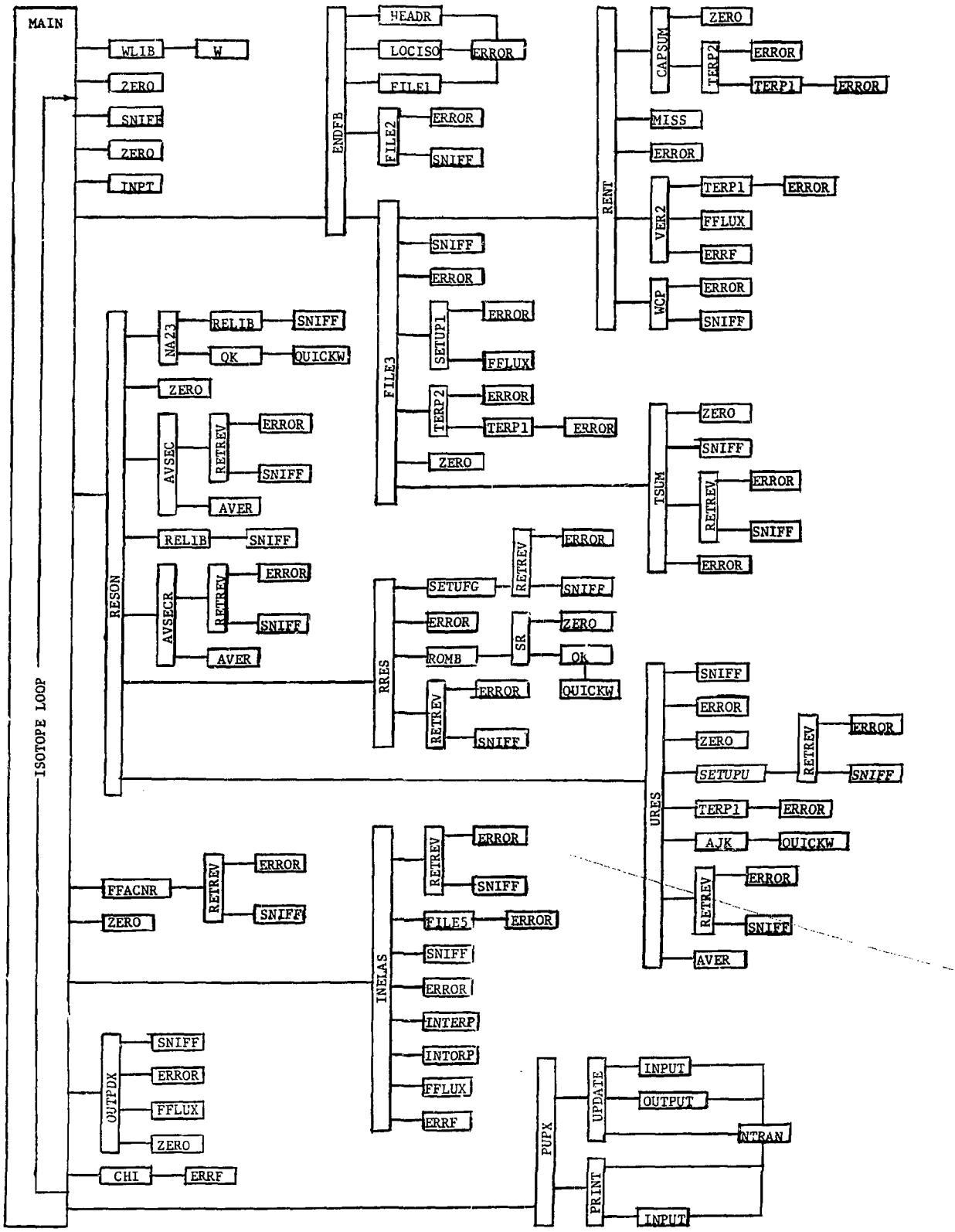

Fig. 1. Simplified flow diagram for ETOX code.

TABLE VII (cont.)

Subroutine	Description
TERP1	Interpolates one point according to ENDF/B specifications. Called by TERP2, VER2, and URES and calls ERROR.
MISS	Prints out any missing cross-section types in File 3 of ENDF/B library tape. Called by REMT.
VER2	Computes inelastic-scattering cross sections from File 3 data. Called by REMT and calls TERP1, FFLUX, and ERRF.
FFLUX	Computes fission flux spectrum. Called by SETUP1, VER2, INELAS, and OUTPDX.
ERRF	Calculates the error function. Called by CHI, VER2, and INELAS.
WCP	Writes capture cross sections on scratch file. Called by REMT and calls SNIFF and ERROR.
SETUP1	Sets up the fine-group energy mesh. Called by FILE3 and calls ERROR and FFLUX.
TSUM	Sums cross sections over fine groups. Called by FILE3 and calls ZERO, SNIFF, RETREV, and ERROR.
RETREV	Reads File 3 smooth cross sections previously written on a scratch file by FILE3. Called by TSUM, AVSEC, AVSECR, SETUFG, RRES, SETUPU, URES, FFACNR, and INELAS and calls SNIFF and ERROR.
RESON	Controls resonance region calculations. Also loads level 3 segments OVLAY21 and OVLAY22. Called by MAIN and calls NA23, ZERO, AVSEC, RELIB, AVSECR, RRES, and URES.
NA23	Calculates resonance cross sections for ^{23}Na only. Called from RESON and calls RELIB and QK.
RELIB	Reads W table previously computed by subroutine W. Called by NA23 and RESON and calls SNIFF.
QK	Calls QUICKW and is called by NA23 and SR.
QUICKW	Generates psi and chi line shape functions from W table. Called by QK and AJK.
AVSEC	Controls calculation of infinite-dilution cross sections in the resolved resonance region. Called by RESON and calls AVER and RETREV.
AVER	Calculates infinite-dilution cross sections from fine-group data. Called by AVSEC, AVSECR, and URES.
AVSECR	Controls calculation of infinite-dilution cross sections in the non-resonance region. Called by RESON and calls RETREV and AVER.
RRES	Performs and controls resolved resonance calculations. Called by RESON and calls SETUFG, ERROR, ROMB, and RETREV.
SETUFG	Sets up energy mesh for the ultrafine groups in the resolved region, determines which resonances contribute to a given ultrafine group, and determines the average "floor" cross sections for each ultrafine group. Called by RRES and calls RETREV.
ROMB	Calculates resolved-resonance integrals over each ultrafine group using the Romberg method (order=7). Called by RRES and calls SR.
SR	Generates integrands used in the ROMB calculations. Called by ROMB and calls ZERO and QK.
URES	Performs and controls unresolved-resonance calculations. Called by RESON and calls SNIFF, ERROR, ZERO, SETUPU, TERP1, AJK, RETREV, and AVER.
SETUPU	Sets up energy mesh for the unresolved groups. Called by URES and calls RETREV.
AJK	Calculates J and K integrals. Called by URES and calls QUICKW.
FFACNR	Calculates self-shielding factors for resonance regions not described by resonance parameters. Called by MAIN.
INELAS	Performs and controls inelastic-scattering calculations [including (n,2n)] using File 5 data (partial energy distributions) on the ENDF/B tape. Called by MAIN and calls RETREV, FILE5, SNIFF, ERROR, INTERP, INTORP, FFLUX, and ERRF.
FILE5	Reads and labels the File 5 inelastic (n,n) or (n,2n) partial energy distributions from the ENDF/B library. Called by INELAS and calls ERROR.
INTERP	Interpolates the inelastic (n,n) or (n,2n) cross sections. Called by INELAS.
INTORP	Interpolates the inelastic (n,n) or (n,2n) probabilities. Called by INELAS.
OUTPDX	Prints and writes (on disk file TAPE1) infinite-dilution group cross sections and self-shielding factors. Called by MAIN and calls SNIFF, ERROR, FFLUX, and ZERO.
ERROR	Prints error message when calculation is beyond limitations of the code. Called by HEADR, LOCISO, FILE1, FILE2, FILE3, SETUP1, TERP1, TERP2, RETREV, TSUM, REMT, WCP, RRES, URES, INELAS, FILE5, and OUTPDX.
CHI	Computes group fission spectrum. Called by MAIN and calls ERRF.
PUPX	Control subroutine for creating, updating, or printing a library of ETOX cross sections. Reads last record of ETX INPT data file. Called by MAIN and calls BUFOPEN, UPDATE, and PRINT. BUFOPEN is part of the DRIVER program.

TABLE VII (cont.)

Subroutine	Description	Subroutine	Description
UPDATE	Creates or updates a library of ETOX cross sections. Called by PUPX and calls INPUT, OUTPUT, and NTRAN.	OUTPUT	Writes cross-section data on the output library tape. Called by UPDATE and calls NTRAN.
PRINT	Prints cross-section data from the output library. Called by PUPX and calls NTRAN and INPUT.	NTRAN	Either skips over a specified number of files or writes an end-of-file on the ETOX library tape. Called by UPDATE, INPUT, OUTPUT, and PRINT.
INPUT	Reads cross-section data from the input library tape. Called by UPDATE and PRINT and calls NTRAN.		

TABLE VIII

SUMMARY OF "ERROR STOP N" OCCURRENCES IN ETOX CODE

N	Routine	Condition Causing Error Stop
1	URES	KS.GT.6. Dimension of a subscripted variable exceeded.
2	HEADR	(MF+MT).NE.0. File number and interaction type should be zero in ENDF/B header record.
3	LOCISO	MAT.EQ.-1. End of data on ENDF/B tape.
4		MAT.GT.MATS. Could not find the specified material on the ENDF/B tape. This error stop occurs if the materials are not processed in the order in which they reside on the ENDF/B tape because the tape is not rewound after each material is processed.
5	FILE1	MAT.NE.MATN. Not positioned to correct material on ENDF/B tape.
6		MF.NE.1. Not positioned to correct file on ENDF/B tape.
7		MT.NE.451. Not positioned to correct interaction type on ENDF/B tape.
8		MAT.EQ.0. Material number read from ENDF/B tape should not be equal to zero at this point.
9		LNU.EQ.0.OR.LNU.GE.3. Type representation for $\bar{\nu}(E)$ from ENDF/B should be equal to either one or two.
10		MT.NE.452. See Error Stop 7.
11		NC.GT.10. Number of terms used in polynomial representation (LNU=1) of $\bar{\nu}(E)$ exceeds the dimension of a subscripted variable.
12		N18.GT.250. Number of points at which $\bar{\nu}(E)$ is given on the ENDF/B tape (LNU=2) exceeds the dimension of a subscripted variable.
13	FILE2	MAT.NE.MATN. See Error Stop 5.
14		MF.NE.2. See Error Stop 6.
15		MT.NE.151. See Error Stop 7.
16	FILE2	NER.NE.1.AND.NER.NE.2. This ENDF/B parameter indicates the number of energy regions in the resonance range.
18		LRU.NE.1.AND.LRU.NE.2. This ENDF/B parameter indicates whether there are resolved (LRU=1) or unresolved (LRU=2) resonances in the energy region in question.
19		LRF.NE.1. This ENDF/B parameter indicates the form in which the resolved resonance data are given. Only single-level Breit-Wigner data (LRF=1) can be handled by the current version of ETOX.
20		NLS1.GT.5. Limitation on the number of ℓ states allowed in the resolved resonance region.
21		INDEX.GT.250. Total number of resolved resonances exceeds the dimension of several subscripted variables.
23		LFW.NE.0.OR.LFW.NE.1. ENDF/B parameter indicating whether average fission widths for the unresolved region are given (LFW=1) or not (LFW=0).
24		INDEU.GT.250. Total number of unresolved resonances exceeds the dimension of several subscripted variables.
25		LFW.NE.1. LFW (see Error Stop 23) should be equal to one at this point in the code.
26		NLS1.GT.3. Restriction on the number of ℓ states in the unresolved region.
27		NJS1.GT.3. Restriction on the number of j states in the unresolved region.
28		NEU1.GT.100. Restriction on the number of energy points at which energy-dependent widths are tabulated for the unresolved region.

TABLE VIII (cont.)

N	Routine	Condition Causing Error Stop
30	FILE2	INDEU.GT.250. Same as Error Stop 24 but in a different loop of the routine.
31		IDXGFU.GT.250. Dimension of several subscripted variables exceeded in the unresolved region.
32	REMT	MF.NE.3. See Error Stop 6.
33	REMT	MTX.GT.108. See Error Stop 7.
35	TERP2	X(NA).GT.X(NA+1). X should be in increasing order in the ENDF/B interpolation table.
36		XP(M-1).GT.XP(M). Values of X at which Y is to be interpolated should be in increasing order.
37		K.GT.N1. Interpolation table in ENDF/B is incorrect.
38	TERP1	II.LE.0. Interpolation code in ENDF/B is out of range.
39		XP.LE.0. Zero or negative value of X cannot be interpolated by logs.
40		XA.EQ.XB. Cannot interpolate on a discontinuity (X1=X2).
41	SETUP1	NFGT.GT.2699. Total number of fine groups exceeds the dimension of several subscripted variables. Increase DELMAX and/or decrease ANFMPD.
42		K.GT.600. Number of fine groups in the energy region defined by a fission spectrum exceeds the dimension of several subscripted variables. Increase DELMAX and/or EMN1EF and/or decrease ANFMPD.
43		MFFL.EQ.MFFU. Test on the lowest and highest group numbers for resonance shielding calculations.
45	SETUPU	NURG.GT.99. Number of groups in the unresolved region exceeds the dimension of a subscripted variable. Increase DELUMX.
48	RRES	EH(1).GE.EG(NG+1). Upper energy bound for the resolved region should be less than the highest input group boundary. Increase EG(NG+1).
50	FILE5	NK.GT.25. Number of partial distributions given in File 5 of ENDF/B exceeds the dimension of several subscripted variables.
51		INDEX.GT.2000. Total number of tabulated data points in ENDF/B for all partial distributions exceeds the dimension of several subscripted variables.
52		NR1.GT.10. Number of energy regions having different interpolation schemes in File 5 exceeds the dimension of several subscripted variables.
53		INDEX.GT.2000. Same as Error Stop 51 but in a different section of the routine.
54		NR1.GT.10. Same as Error Stop 52 but in a different section of the routine.
55		INDEX.GT.2000. See Error Stop 53.
56		NR1.GT.10. See Error Stop 54.
998	RETREV	JD.LT.0. Argument returned by subroutine SNIFF indicating that a scratch file could not be located.
999	FILE2 TSUM WCP FILE3 URES INELAS OUTPDX	JD.LT.0. See Error Stop 998.

B. 1DX Code

1DX is a one-dimensional (slab, cylinder, or sphere), multigroup, diffusion-theory code designed primarily to compute resonance-shielded and collapsed-group cross sections. The code can also be used to compute k_{eff}, compute alpha, or perform criticality searches on material concentrations, region dimensions, and buckling for either regular or adjoint cases. Alpha or k_{eff} can be used as a parametric eigenvalue in a search calculation. Variable dimensioning is used in 1DX. Reference 3 gives a description of the mathematical models used.

Resonance-shielded cross sections are calculated from cross-section data generated by the ETOX code. These data are in the Bonderenko format which include infinite-dilution group cross sections, inelastic-scattering matrices, and group resonance-shielding factors for specified values of temperature and σ_0. Interpolation schemes are used to compute shielding factors and effective cross sections applicable to the specific compositions and temperatures in the reactor. After the flux calculation, 1DX computes collapsed cross sections averaged over the spectrum in any specified zone. Collapsed cross-section output is in standard MULTIGRP format.

If cross-section data are to be read from an ETOX library, 1DX expects the library to be present on tape 46. A library created or updated by ETOX is written on the same logical unit. At user option, cross-section input to 1DX can be read instead from the standard MULTIGRP data file.

Standard data files that can be read by the 1DX code are ADMNSTR, GEO DIST, GRP FLXS (either regular or adjoint), MIX DATA, and MULTIGRP (either reference or perturbed). Input data not contained in the standard data files or in the ETOX library are read from the code-dependent data file, ODX INPT. Card input for creation of the ODX INPT file is described in Appendix B. Of the files mentioned above, ODX INPT, ADMNSTR, GEO DIST, and MIX DATA are always required. If the flux guess is to be read from GRP FLXS and the cross sections are to be read from MULTIGRP, these two data files must also be available.

Standard data files that can be created by 1DX are INTQUANT, GRP FLXS (either regular or adjoint), ZONEDENS, and MULTIGRP (either reference or perturbed). These files are always created except MULTIGRP, which is created only if a group collapse is specified.

1DX does not treat upscatter and cannot read a MULTIGRP file in which the number of downscatter terms is not constant for every group and isotope in the file.

The segmentation structure for the 1DX code, which can be loaded by either the DRIVER or CLUB code, is shown in Table IX. Segment ODXS is loaded at level I+1 by either the DRIVER module (I=0) or by the CLUB code (I=2). All level I+2 segments are loaded by subroutine MAIN. Level I+3 segment MULTI is loaded by subroutines INP, RECS, and CRUNCH. Level I+3 segment DATFS is loaded by subroutines INP and FINPR.

TABLE IX

SEGMENTATION STRUCTURE OF 1DX CODE

Segment Level[a]	Segment Name	Subroutines Included in Segment
I+1	ODXS	MAIN, ERRO2, CLEAR, RCSTUP, SNIFF, MIXDAT, NTRAN
I+2	INPR	FXINP, ADMNST, INP
I+2	RCXS	RCINP1, RCPUP, RCPRT1, RCCHK
I+2	RCCAL	RCCAL1, RCCAL2
I+2	FLXCAL	RCCSS, RECS, INIT, FISCAL, MONPR, OUTER, INNER1, INNER, CNNP, FINPR, NBAL
I+2	XSCOL	GRAM, CRUNCH, INTQUA, ZONEDE
I+3	MULTI	MULTIG
I+3	DATFS	GRPFLX, GEODIS

[a] I=0 if 1DX is loaded by DRIVER, and I=2 if loaded by CLUB.

A simplified flow diagram for the 1DX code is shown in Fig. 2, and a brief description of each subroutine in the code is given in Table X. The causes of a few error stops are explicitly identified in the output. Several other error stops are identified only by the subroutine and statement number where the error occurred. Conditions leading to the latter error stops are given in Table XI.

TABLE X

DESCRIPTION OF SUBROUTINES IN 1DX CODE

Subroutine	Description
MAIN	Controls overall flow of 1DX calculation and loads segments INPR, RCXS, RCCAL, FLXCAL, and XSCOL. Called by DRIVER and CLUB and calls subroutines BUFOPEN, INP, RCINP1, RCSTUP, RCCAL1, RCCAL2, RCCSS, RECS, INIT, FISCAL, MONPR, OUTER, CNNP, FINPR, GRAM, and CRUNCH. BUFOPEN is part of the DRIVER module.
INP	Controls reading, writing, and printing of all input data except cross sections. Also loads segments MULTI and DATFS. Called by MAIN and calls ADMNST, ERRO2, GRPFLX, GEODIS, MULTIG, MIXDAT, and FXINP. In the call to subroutine MULTIG at this point, only the velocities and fission spectrum are read from the MULTIGRP file.
ADMNST	Reads the ADMNSTR standard file. Called by INP and calls SNIFF.
SNIFF	Assigns a buffer to a specified logical unit. Called by ADMNST, GRPFLX, GEODIS, INTQUA, ZONEDE, MIXDAT, and MULTIG and calls BUFOPEN. BUFOPEN is in the DRIVER module.

TABLE X (cont.)

Subroutine	Description
NTRAN	Writes an end-of-file on a specified logical unit or reads through a specified number of files on a specified logical unit. Called by RCPUP.
ERRO2	Writes an error message identifying the routine and statement number where the error occurred. Called by INIT, CNNP, INP, and MULTIG.
GRPFLX	Reads and writes the GRP FLXS standard file. Called by INP and FINPR and calls SNIFF.
GEODIS	Reads the GEO DIST standard file. Called by INP and calls SNIFF.
MULTIG	Reads and writes the MULTIGRP standard file. Called by INP, RECS, and CRUNCH and calls SNIFF and ERRO2.
MIXDAT	Reads the MIX DATA standard file. Called by INP and calls SNIFF.
FXINP	Assigns a flat flux guess. Called by INP.
RCINP1	Calls RCPUP and is called by MAIN.
RCPUP	Reads cross-section data in the Bondarenko format from an ETOX library tape. Called by RCINP1 and calls RCPRT1, RCCHK, and NTRAN.
RCPRT1	Prints cross-section data in the Bondarenko format. Called by RCPUP.
RCCHK	Checks cross-section data in the Bondarenko format for consistency. Called by RCPUP.
RCSTUP	Calculates a table of σ_0-dependent resonance-shielding factors (appropriate to the temperature of the mixture) for each isotope in the mixture. This is done by interpolating the temperature-dependent shielding factors for each σ_0. Called by MAIN.
RCCAL1	Calculates the appropriate σ_0 for each isotope in the mix. Since σ_0 cannot be calculated until the appropriate shielding factors are known (and vice versa), iteration is required between RCCAL1 and RCCAL2. RCCAL1 is called by MAIN.
RCCAL2	Calculates resonance-shielding factors for each isotope appropriate to the value of σ_0 computed in RCCAL1. This is done by interpolating on the table of σ_0-dependent values computed in RCSTUP. RCCAL2 is called by MAIN.
RCCSS	Calculates resonance-shielded cross sections by applying the appropriate shielding factors to the infinite-dilution cross sections. Called by MAIN.
RECS	Checks cross sections from standard file MULTIGRP, performs adjoint reversal on the cross sections, and writes the cross sections on a scratch file. Also loads segment MULTI. Called by MAIN and calls MULTIG.
INIT	Performs adjoint reversals on the velocities and fission spectrum, mixes the cross sections, modifies the mesh intervals, and computes areas and volumes. Also calculates the effective fission spectrum and the fission rate. Called by MAIN and calls ERRO2 and CLEAR.
CLEAR	Sets a specified number of words in a specified array to a specified value. Called by INIT, CNNP, and GRAM.
FISCAL	Calculates fission sums and lambda and normalizes the flux and fission rate. Called by MAIN.
MONPR	Prints the monitor line (time, iteration counts, eigenvalue slope, eigenvalue, and lambda). Called by MAIN and FINPR.
OUTER	Performs an outer iteration and overrelaxes the fission source. Called by MAIN and calls INNER1 and INNER.
INNER1	Calculates coefficients for the flux equation. Called by OUTER.
INNER	Calculates the flux for a specified group (inner iteration). Called by OUTER.
CNNP	Performs convergence tests and calculates new parameters for search calculations. Called by MAIN and calls CLEAR and ERRO2.
FINPR	Computes zone fluxes and total flux; prints area, volume, total flux, power, and fission source for each mesh interval; prints flux by group and space point; and controls calculation of the balance table. Also loads segment DATFS. Called by MAIN and calls MONPR, NBAL, and GRPFLX.
NBAL	Computes and prints the neutron balance tables. Called by FINPR.
GRAM	Calculates and prints material inventories. Called by MAIN and calls CLEAR and ZONEDE.
ZONEDE	Writes the ZONEDENS standard file. Called by GRAM and calls SNIFF.
CRUNCH	Calculates and prints collapsed cross sections and fission spectrum. Also loads segment MULTI. Called by MAIN and calls INTQUA and MULTIG.
INTQUA	Writes the INTQUANT standard file. Called by CRUNCH and calls SNIFF.

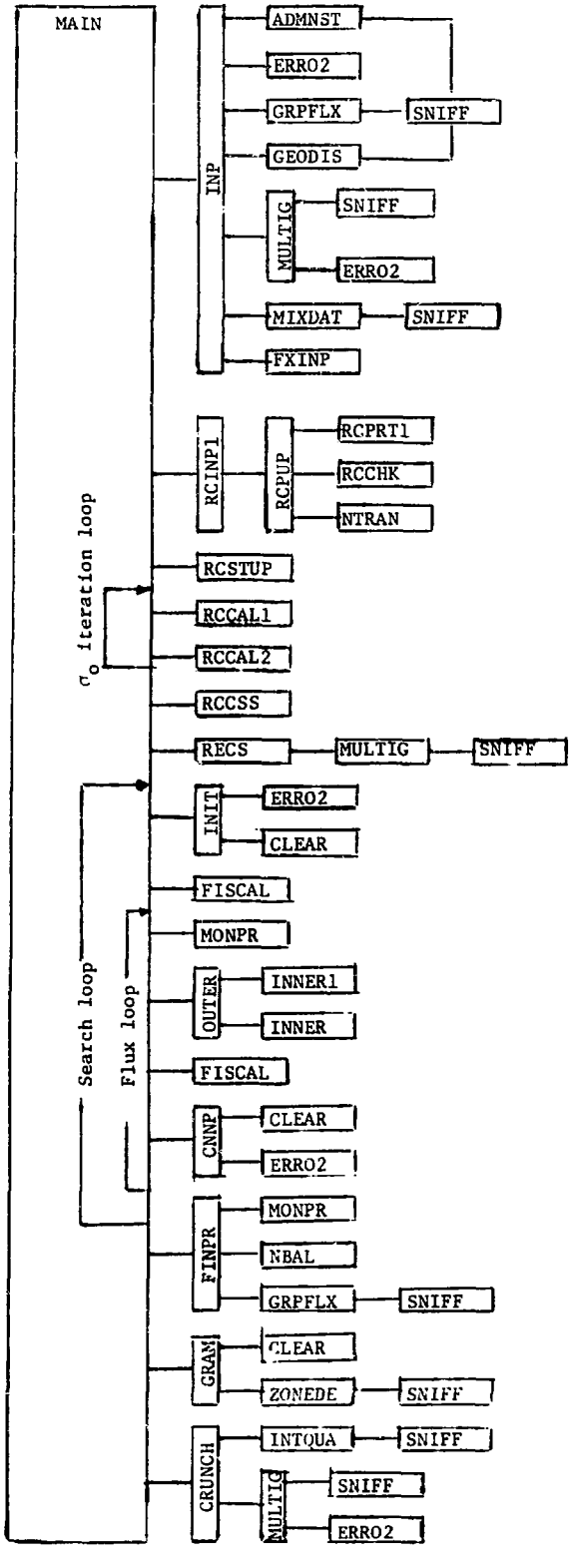

Fig. 2. Simplified flow diagram for 1DX code.

TABLE XI

ERROR STOPS IN 1DX CODE

Routine	Statement Number	Condition Causing Error Stop
MULTIG	51	Incorrect number of energy groups in the input MULTIGRP file.
MULTIG	53	1DX cannot read Bondarenko data from the MULTIGRP file.
MULTIG	82	1DX cannot read a MULTIGRP file that contains upscatter.
MULTIG	84	Incorrect number of downscatter terms in the MULTIGRP file.
CNNP	130	Zero fission source.
INIT	140	Error in the I0 or I1 tables, i.e., I0(M)>MT or I1(M)>MT for some 1≤M≤M01.
INP	250	Input parameter S03 cannot equal zero if IS02≠0 (see ADMNSTR file description).
INIT	520	R1(I+1) - R1(I)≤0 where the array R1 contains the current mesh boundaries.

C. ANISN Code

The ANISN code[4] is a one-dimensional (slab, cylinder, or sphere) transport theory (S_n) code with general anisotropic scattering. A diffusion solution can also be executed for specified groups. This code can perform a fixed source, k_{eff}, or alpha calculation. It can also perform searches on concentration, zone width, outer radius, or buckling. Either a regular or adjoint model can be used. Alpha or k_{eff} can be used as a parametric eigenvalue in search calculations.

ANISN can also compute activities by interval and zone for any material in the system and can perform a group collapse of the cross sections. The collapsed cross sections can be punched in a format suitable for use in creating a standard MULTIGRP file with the INP module.

Variable dimensioning is used in ANISN. If all of the data cannot be accommodated in fast memory, selected arrays are stored on disk files.

Cross-section input to ANISN is obtained exclusively from the standard MULTIGRP (either reference or perturbed) file. Other standard files required are ADMNSTR, SN CONS, GEO DIST, and MIX DATA. At user option, the GRP FLXS (either regular or adjoint) file is read to obtain a flux guess for the problem.

Input data not available in the standard files are read from the ANI INPT file. Card input for the creation of the ANI INPT file is described in Appendix B. Standard files created are INTQUANT, ZONEDENS, and GRP FLXS (either regular or adjoint).

ANISN can be loaded by either the DRIVER module or by the CLUB code and is segmented as shown in Table XII. The ANIS segment is loaded at level I+1 where I=0 if loaded by DRIVER and I=2 if loaded by CLUB. All the level I+2 segments are loaded by subroutine MAIN. A simplified flow diagram for the ANISN code is shown in Fig. 3, and a brief description of each subroutine in the code is given in Table XIII. Causes of error stops are explicitly identified in the output.

D. DOT2DB Code

The DOT2DB code[5] is a combination of the 2DB code[15] and the DOT code.[16] It can solve either the transport theory (S_n) or the diffusion theory multigroup equations in two space dimensions. If diffusion theory is specified, selected groups can be treated by S_n. Solutions can be obtained in slab (X-Y) and cylindrical (R-Z or R-θ) geometries. An additional option, triangular geometry, is available if diffusion theory is specified for all groups. Anisotropic scattering of any order is allowed in the S_n option. In the diffusion theory option, anisotropic scattering is treated in the transport approximation. That is, the P_1 scattering matrix, when provided, is used to calculate the transport cross section.

Either direct or adjoint fluxes can be computed for fixed volume-distributed source, k_{eff}, alpha, concentration search, delta search, or fixed boundary source problems. Alpha or k_{eff} can be used as a parametric eigenvalue in search calculations. In addition, activities for any material in the system can be computed by interval and zone.

Cross-section input to DOT2DB is obtained exclusively from the MULTIGRP file. Although the calculational portion of the code can treat anisotropic scattering, subroutine S860, which reads the MULTIGRP file, cannot do so at present. Other standard data files required are ADMNSTR, SN CONS, GEO DIST, MIX DATA, and GRP FLXS (either regular or adjoint). The flux guess is always read from GRP FLXS, and SN CONS is always read because of the

TABLE XII

SEGMENTATION STRUCTURE OF ANISN CODE

Segment Level[a]	Segment Name	Subroutines Included in Segment
I+1	ANIS	MAIN, WOT, TIME, SNIFF
I+2	OVLAY1	PLSNT, TP, ADJNT, S805, S804, S814, WOT8
I+2	OVLAY2	GUTS, HEART, S807, S810, S821, DT, S824, S833, S851
I+2	OVLAY3	FINPR1, FINPR, PUNSH, DTFPUN, FLTFX, BT, SUMARY, WRITE, FEWG, WATE

[a] I=0 if ANISN is loaded by DRIVER, I=2 if loaded by CLUB.

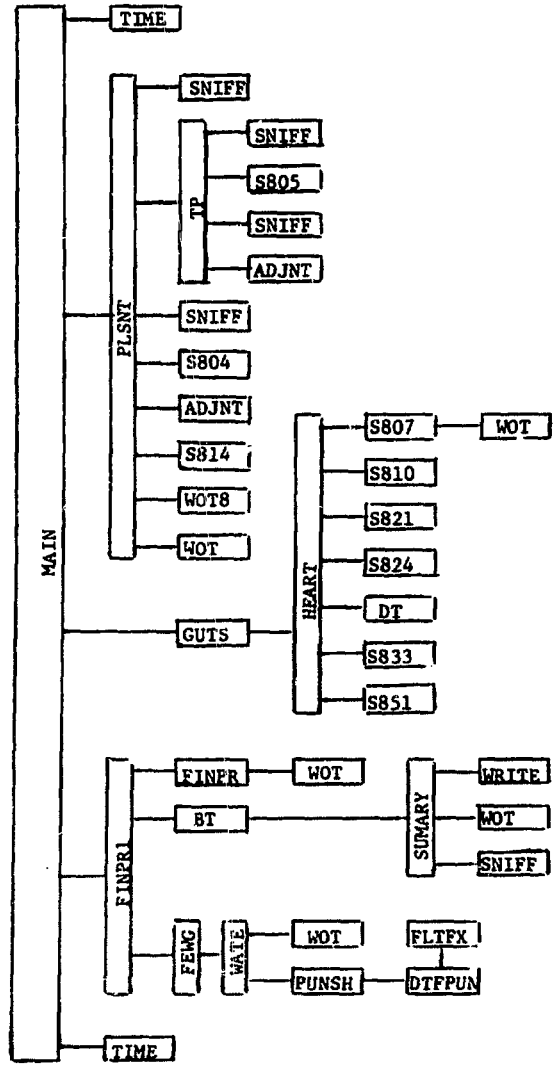

Fig. 3. Simplified flow diagram for ANISN code.

TABLE XIII

DESCRIPTION OF SUBROUTINES IN ANISN CODE

Subroutine	Description
MAIN	Controls overall flow of ANISN calculation and loads segments OVLAY1, OVLAY2, and OVLAY3. Called by DRIVER and CLUB and calls BUFOPEN, TIME, PLSNT, GUTS, and FINPR1. BUFOPEN is included in the DRIVER module.
WOT	Prints one-, two-, or three-dimensional arrays. Called by PLSNT, S807, FINPR, SUMARY, and WATE.
TIME	Obtains and prints elapsed CP time for the job. Called by MAIN.
SNIFF	Assigns a file number corresponding to a given file name and assigns a particular I/O buffer to the file. Called by PLSNT, TP, and SUMARY and calls BUFOPEN (see DRIVER module).
PLSNT	Controls the reading of all the input data and computes pointers for variable dimension arrays. Called by MAIN and calls SNIFF, TP, S804, ADJNT, S814, WOT8, and WOT.
TP	Reads cross sections, source, and flux or fission guess and copies the data to scratch files if it does not all fit in core. Called by PLSNT and calls SNIFF, S805, and ADJNT.
ADJNT	Performs group reversal of specified arrays. Called by PLSNT and TP.
S805	Rearranges cross-section matrices for adjoint calculations. Called by TP.
S804	Checks S_n constants and computes P_ℓ constants. Called by PLSNT.
S814	Computes areas and volumes, performs source normalization, and computes total fixed source by group. Called by PLSNT.
WOT8	Prints up to eight one-dimensional arrays. Called by PLSNT.
GUTS	Called by MAIN and calls HEART.
HEART	Controls the outer iteration loop. Called by GUTS and calls S807, S810, S821, S824, DT, S833, and S851.
S807	Mixes cross sections. Called by HEART and calls WOT.
S810	Computes geometry-dependent arrays. Called by HEART.
WATE	Performs group collapse of cross sections. Called by FEWG and calls WOT and PUNSH.
PUNSH	Sets up each card to be punched by DTFPUN. Called by WATE and calls DTFPUN.
DTFPUN	Punches collapsed cross sections in DTF format. Called by PUNSH and calls FLTFX.
FLTFX	Converts a floating point number to an integer. Called by DTFPUN.
S821	Computes and normalizes fission source Also normalizes fluxes and currents. Called by HEART.
DT	Performs diffusion theory inner iteration. Called by HEART.
S824	Computes total source (exclusive of self-scatter) for each interval. Called by HEART.
S833	Performs transport theory (S_n) inner iteration. Called by HEART.
S851	Performs outer iteration convergence tests and computes new parameters for search calculations. Called by HEART.
FINPR1	Prints final monitor line and sets up pointers for activity and collapsing calculations. Called by MAIN and call FINPR, BT, and FEWG.
FINPR	Computes and prints activities and prints scalar flux and sources. Calle by FINPR1 and calls WOT.
BT	Determines storage needed for balance tables. Called by FINPR1 and calls SUMARY.
SUMARY	Computes and prints summary tables, prints angular fluxes, and writes INTQUANT, GRP FLXS, and ZONEDENS data files. Called by BT and calls WRITE, WOT, and SNIFF.
WRITE	Writes one-dimensional arrays on a scratch file. Called by SUMARY.
FEWG	Performs preliminary calculations for cross-section collapsing. Called by FINPR1 and calls WATE.

possibility of mixed diffusion-S_n calculations. Input data not available in the standard files are read from the DOT INPT file. Card input for creating this file with the INP module is described in Appendix B. Standard files created by DOT2DB are INTQUANT, ZONEDENS, and GRP FLXS (either regular or adjoint).

The DOT2DB code can be loaded by either the DRIVER module or the CLUB code and is segmented as shown in Table XIV. The DOTS segment is loaded at level I+1, where I=0 if loaded by DRIVER and I=2 if loaded by CLUB. All of the level I+2 segments are loaded by subroutine MAIN. Level I+3 segments DOTTY2 and DOTTY3 are loaded by subroutine INP, and the remaining level I+3 segments are loaded by subroutine OUTER.

TABLE XIV

SEGMENTATION STRUCTURE FOR DOT2DB CODE

Segment Level[a]	Segment Name	Subroutines Included in Segment
I+1	DOTS	MAIN, SNIFF, BUFCL, BUFOP, CLEAR CLOCK, ERRO2, WOT
I+2	DOTTY1	INP
I+2	DOTTY4	S8830, OUTER, INIT, WOT8, FISCAL, S8847, CNNP
I+2	DOTTY5	S8850, SUMRY, ACTVTY
I+3	DOTTY2	S860
I+3	DOTTY3	S862, S863, RSTD, PCON, MAPR
I+3	DOT4A	INNER, GRIND
I+3	DOT4B	DTC, IFLUXN, DTP, DTJ, DTI

[a] I=0 if DOT2DB loaded by DRIVER, I=2 if loaded by CLUB.

Variable dimensioning is used in DOT2DB, and the code has been processed with the DYNBUF code[17] to simulate dynamic buffer allocation on the CDC 6600. A simplified flow diagram is shown in Fig. 4. Subroutines BUFOP and BUFCL, which provide dynamic buffer allocation and are called by many of the DOT2DB subroutines, are not shown. A brief description of each subroutine is given in Table XV.

Most error stops in DOT2DB are identified only by the message "ERROR(H,I) DETECTED," where H is a four-character Hollerith word and I is an integer. Conditions resulting in this type of error message are summarized in Table XVI. Causes of all other error stops are explicitly identified in the output.

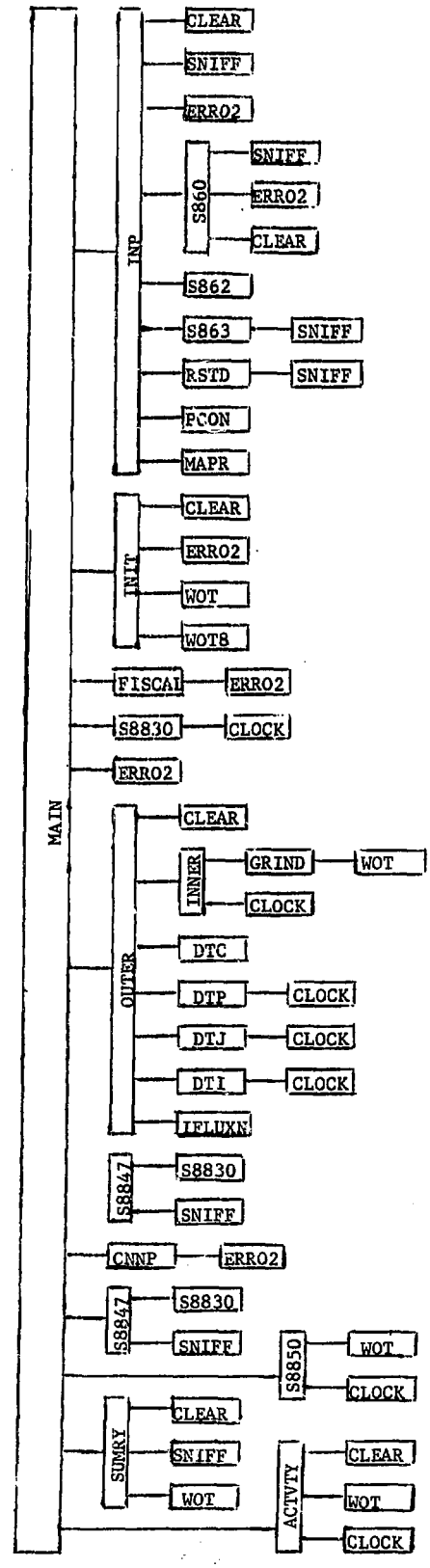

Fig. 4. Simplified flow diagram for DOT2DB code.

TABLE XV

DESCRIPTION OF SUBROUTINES IN DOT2DB CODE

Subroutine	Description
MAIN	Controls the flow of the DOT2DB calculation and loads segments DOTTY1, DOTTY4, and DOTTY5. Called by DRIVER and CLUB and calls BUFOP, INP, INIT, FISCAL, S8830, ERRO2, OUTER, S8847, CNNP, BUFCL, S8850, SUMRY, and ACTVTY.
BUFOP	Assigns a buffer to a specified logical unit. Calls BUFOPEN (see DRIVER routines) and is called by MAIN, INP, SNIFF, INIT, FISCAL, OUTER, S8847, S8850, SUMRY, ACTVTY, S860, S862, S863, RSTD, MAPR, S8830, WOT8, INNER, GRIND, DTC, DTP, ERRO2, WOT, DTJ, and DTI.
BUFCL	Rewinds a specified logical unit and releases the buffer assigned to the unit. Called by MAIN, SNIFF, INP, S860, S862, S863, RSTD, OUTER, INIT, FISCAL, S8847, S8850, SUMRY, and ACTVTY.
ERRO2	Prints error messages. Calls BUFOP and is called by MAIN, INP, S860, INIT, FISCAL, and CNNP.
INP	Coordinates reading of the input data, loads segments DOTTY2 and DOTTY3, calculates pointers for array variables, and reads ADMNSTR file and control parameters from DOT INPT file. Called by MAIN and calls CLEAR, SNIFF, BUFOP, BUFCL, ERRO2, S860, S862, S863, RSTD, PCON, and MAPR.
CLEAR	Sets a specified numer of elements in a given array to a specified value. Called by INP, S860, OUTER, INIT, SUMRY, and ACTVTY.
SNIFF	Assigns a file number corresponding to a specified file name. Called by INP S860, S863, RSTD, S8847, and SUMRY and calls BUFOP and BUFCL.
S860	Reads cross sections from the MULTIGRP file, checks cross-section balance, and rearranges the cross sections for the adjoint case. Called by INP and calls SNIFF, ERRO2, BUFCL, BUFOP, and CLEAR.
S862	Reads the distributed fixed source from the DOT INPT file. Called by INP and calls BUFCL and BUFOP.
S863	Reads the fixed boundary source from the DOT INPT file. Called by INP and calls SNIFF, BUFOP, and BUFCL.
RSTD	Reads SN CONS, GEO DIST, and GRP FLXS files and the remainder of the DOT INPT file. Called by INP and calls SNIFF, BUFOP, and BUFCL.
PCON	Calculates P_ℓ constants. Called by INP.
MAPR	Prints zone and material maps. Called by INP and calls BUFOP.
INIT	Computes S_n constants, mixes cross sections, performs adjoint reversals on fission fractions and velocities, modifies meshes for delta calculations, normalizes distributed and boundary sources, and calculates the fission source by interval. Called by MAIN and calls CLEAR, ERRO2, BUFOP, WOT, BUFCL, and WOT8.
WOT	Prints one-, two-, and three-dimensional arrays. Calls BUFOP and is called by INIT, S8850, SUMRY, ACTVTY, and GRIND.
WOT8	Prints up to eight one-dimensional arrays. Called by INIT and calls BUFOP.
FISCAL	Calculates the total fission source and normalizes the fluxes and fission sources. Called by MAIN and calls BUFOP, BUFCL, and ERRO2.
S8830	Prints the iteration monitor line. Called by MAIN and S8847 and calls CLOCK and BUFOP.
CLOCK	Obtains the current CPU time in seconds. Called by S8850, S8830, INNER, DTP, DTJ, DTI, and ACTVTY.
OUTER	Coordinates the outer iteration loop and loads segments DOT4A and DOT4B. Called by MAIN and calls CLEAR, BUFOP, BUFCL, INNER, DTC, DTP, DTJ, DTI, and IFLUXN.
INNER	Coordinates the S_n inner iteration loop. Called by OUTER and calls GRIND, BUFCL, CLOCK, and BUFOP.
GRIND	Solves the S_n equations for a group. Called by INNER and calls BUFOP and WOT.
DTC	Calculates coefficients for the diffusion theory flux equations. Called by OUTER and calls BUFOP.
DTP	Performs the diffusion theory inner iteration calculation on horizontal mesh lines for problems with periodic boundary conditions. Called by OUTER and calls CLOCK and BUFOP.
DTJ	Performs the diffusion theory inner iteration calculation on vertical mesh lines. Called by OUTER and calls CLOCK and BUFOP.
DTI	Performs the diffusion theory inner iteration calculation on horizontal mesh lines for nonperiodic boundary conditions. Called by OUTER and calls CLOCK and BUFOP.
IFLUXN	Calculates leakages, reaction rates, and neutron balance and normalizes fluxes after diffusion theory inner iteration. Called by OUTER.

TABLE XV (cont.)

Subroutine	Description
S8847	Sums the reaction rates and leakages and prints the final monitor line and balance tables. Also writes first record of INTQUANT file. Called by MAIN and calls BUFOP, S8830, SNIFF, and BUFCL.
CNNP	Performs outer iteration convergence tests on fission and scatter source ratios and adjusts search parameters. Called by MAIN and calls ERR02.
S8850	Prints the final boundaries, total flux, fission source density, and flux moments. Called by MAIN and calls BUFOP, WOT, BUFCL, and CLOCK.
SUMRY	Calculates and prints the summary table by group and zone, writes the remainder of the INTQUANT file, and writes the GRP FLXS and ZONEDENS files. Called by MAIN and calls BUFCL, CLEAR, BUFOP, SNIFF, and WOT.
ACTVTY	Calculates and prints activities by interval and zone. Called by MAIN and calls BUFOP, BUFCL, CLEAR, WOT, and CLOCK.

TABLE XVI

SUMMARY OF "ERROR(H,I) DETECTED" MESSAGES

H	I	Condition Causing Error Stop
DOT2	106	Program logic error encountered in MAIN.
*B01	0	IB01 = 2 or IB02 = 2 and IB01 ≠ IB02. If either the left- or right-boundary condition is periodic, the other must also be periodic.
*B03	0	IB03 = 2 or IB04 = 2 and IB03 ≠ IB04. If either the top- or bottom-boundary condition is periodic, the other must also be periodic.
*A04	n	Order n of S_n quadrature is not even.
*S03	IS02	IS02 ≠ 0 and S03 = 0.0 where IS02 is the parametric eigenvalue type and S03 is the parametric eigenvalue.
IBSS	IBSS	Insufficient core storage available for boundary source that uses IBSS words. Increase dimension of common array A in DRIVER.
SIZE	LAST	Insufficient core storage available for variable dimension arrays. Amount of storage required is LAST words. Increase size of common array A in DRIVER.
S860	161	MTP≤0 where MTP is the number of isotopes in the MULTIGRP file.
S860	160	Insufficient storage for reading MULTIGRP file. Increase size of common array A in DRIVER.
*MU	m	$\mu = 0$ for angle m.
*ETA	m	$\eta = 0$ for angle m.
-ETA	m	$\eta < 0$ for angle number $m > MM/2$.
+ETA	m	$\eta > 0$ for angle number $m \leq MM/2$.
-MU	m	No μ found that mates with $-\mu_m$.
*WT	0	$\left\lvert \sum_{m=1}^{MM} W_m \right\rvert + \left\lvert \sum_{m=1}^{MM} W_m \mu_m \right\rvert + \left\lvert \sum_{m=1}^{MM} W_m \eta_m \right\rvert \neq 1.0$
*MT	MT	Mixture number or component in mixing table exceeds MT where MT is the total number of materials.
TMAX	0	$\theta_{max} > 1.0$ (θ-mesh is measured in revolutions, i.e., in units of 2π).
*R	I	R(I+1)-R(I) < 0.0. Radial mesh is not in ascending order.
*Z	J	Z(J+1)-Z(J) < 0.0. Axial mesh is not in ascending order.
*EV	I	Calculated eigenvalue for outer iteration I differs from input estimate by more than 1/I.
*FS	IEVT	Calculated fission source is zero. Not allowed except for fixed-source problems.

E. CLUB Code

The CLUB code is a time-dependent fuel-depletion and fission-product-buildup program based on the CITATION code.[8] CLUB uses zone-averaged fluxes to compute time-dependent changes in atom densities on a subzone and zone scale. Fuel management is not available.

Zone-averaged fluxes are obtained from the INTQUANT interface file. At user option, this file can be provided by (1) the user, (2) infinite-medium calculations in CLUB, or (3) any one of the flux codes. For Option (1), the user creates the INTQUANT file from card input to the INP module. This file is then used for every burnup step. For Option (2), CLUB performs an infinite-medium flux calculation and writes the INTQUANT file at the beginning of each burnup step. For Option (3), CLUB loads the specified flux code (1DX, ANISN, or DOT2DB) at the beginning of each time step. CLUB provides the flux code with current compositions through the MIX DATA file, and the flux code provides CLUB with zone-averaged fluxes through the INTQUANT file. In concentration search problems, the flux code also provides CLUB with a new ZONEDENS file.

CLUB uses variable dimensioning and has been processed with the DYNBUF code[17] to provide dynamic buffer allocation on the CDC 6600.

Interface files always required by CLUB are ZONEDENS, MULTIGRP, INTQUANT, and CLB INPT. Card input for creating CLB INPT with the INP module is described in Appendix B. It is recommended that the isotopes on the MULTIGRP file be ordered such that the fission products follow the fissile isotopes. If a flux code is used, CLUB also requires the ADMNSTR, MIX DATA, and GEO DIST files.

The ZONEDENS file is always created after each depletion step. If a flux code is used, CLUB also creates the MIX DATA file after each burnup step. The INTQUANT and GRP FLXS (both regular and adjoint) files are created by CLUB if an infinite-medium flux calculation is specified.

The segmentation structure for the CLUB code is shown in Table XVII. Level 1 segment CLBS is loaded by the DRIVER module; level 2 segments DEPINP, FLXCON, and DEPLET are loaded by subroutine CLUB; and level 3 segment PTSPEC is loaded by subroutine NFLX if an infinite-medium flux calculation is specified. However, if a finite-medium flux calculation is specified, NFLX loads (at level 3) the ODXS, ANIS, or DOTS segment of the 1DX, ANISN, or DOT2DB code, respectively. Level 3 segments BURNDTA and BURNUP are loaded by subroutine BURN.

TABLE XVII

SEGMENTATION STRUCTURE FOR CLUB CODE

Segment Level	Segment Name	Subroutines Included in Segment
1	CLBS	CLUB, ITTIME, ICLOCK, GRIT, XION, BUFCL, BUFOP
2	DEPINP	INPT
2	FLXCON	NFLX
2	DEPLET	BURN
3	PTSPEC	SPEC, SPTC, SPTQ, SPTP
3	BURNDTA	BRNA, BRNB, BRNC, BRND, BRNH, BRNI, BRNJ
3	BURNUP	BRNP, BRNQ, BRNR, MIXDAT, NUCX

A simplified flow diagram for the CLUB code is shown in Fig. 5. Not shown are subroutines BUFOP and BUFCL, which are used in connection with dynamic buffer allocation and are called by many of the CLUB subroutines. A brief description of each subroutine is given in Table XVIII.

Many of the error stops in CLUB are explained adequately in printed messages. However, one of the error messages is in the form

***DATA ERROR STOP NUMBER N

where N is an integer. The possible values of N, the routine in which the message is printed, and the conditions leading to the error message are summarized in Table XIX.

TABLE XVIII

DESCRIPTION OF SUBROUTINES IN CLUB CODE

Subroutine	Description
CLUB	Controls the overall flow of the CLUB calculation and loads segments DEPINP, FLXCON, and DEPLET. Called by DRIVER module and calls subroutines INPT, NFLX, ICLOCK, BUFOP, BURN, and ITTIME.
INPT	Reads title and neutronics selection from the CLB INPT file. Called by CLUB and calls BUFOP, ICLOCK, and ITTIME.
BUFOP	Assigns an available buffer to a specified logical unit. Calls BUFOPEN (see DRIVER module) and is called by CLUB, INPT, NFLX, XION, SPEC, GRIT, SPTC, SPTQ, SPTP, BURN, BRNA, BRNB, BRNC, BRND, BRNH, BRNI, BRNJ, BRNP, BRNQ, NUCX, BRNR, and MIXDAT.
BUFCL	Rewinds a specified logical unit and releases the buffer assigned to the unit. Called by NFLX, SPEC, GRIT, SPTC, SPTQ, BURN, BRNA, BRNB, BRNJ, BRNP, BRNQ, BRNR, and MIXDAT.
ICLOCK	Obtains current CPU time in units of 0.01 sec. Called by CLUB, INPT, NFLX, and BURN.
ITTIME	Obtains current real time in units of 0.01 sec. Called by CLUB, INPT, NFLX, and BURN.
NFLX	Loads the appropriate segment (PTSPEC, ODXS, ANIS, or DOTS) for the flux calculation at each depletion step. Called by CLUB and calls ITTIME, ICLOCK, SPEC, BUFOP, GRIT, BUFCL, and MAIN. Depending on the flux module selected, MAIN is the main subroutine of the 1DX, ANISN, or DOT2DB module.
SPEC	Reads infinite-medium data from the CLB INPT file and computes pointers for the infinite-medium flux calculation. Called by NFLX and calls XION, BUFOP, BUFCL, GRIT, SPTC, and SPTQ.
XION	Assigns a logical unit number given the file name. Calls BUFOP and is called by SPEC, SPTC, SPTQ, BURN, BRNA, BRNB, BRNC, BRND, BRNH, BRNI, BRNJ, BRNP, and BRNR.
GRIT	Performs block-data transfers to or from a specified logical unit. Calls BUFCL and BUFOP and is called by NFLX, SPEC, SPTC, SPTQ, BURN, BRNQ, and BRNR.
SPTC	Reads ZONEDENS and MULTIGRP files and computes constants for the infinite-medium flux calculation. Called by SPEC and calls XION, GRIT, BUFCL, and BUFOP.
SPTQ	Performs the infinite-medium flux calculation. Writes INTQUANT and GRP FLXS (both regular and adjoint) files. Called by SPEC and calls XION, BUFCL, BUFOP, SPTP, and GRIT.
SPTP	Performs perturbation calculations using infinite-medium fluxes. Called by SPTQ and calls BUFOP.
BURN	Controls flow of burnup calculation for the depletion step and loads segments BURNDTA and BURNUP. Called by CLUB and calls ICLOCK, ITTIME, XION, BUFCL, GRIT, BRNA, BUFOP, BRNP, BRNQ, and BRNR.
BRNA	Controls reading of input data from CLB INPT file and computes pointers for burnup calculation. Called by BURN and calls XION, BUFCL, BUFOP, BRNC, BRND, BRNB, BRNH, BRNI, and BRNJ.
BRNC	Reads depletion history and editing options from CLB INPT file. Called by BRNA and calls XION and BUFOP.
BRND	Reads zone-classification data from CLB INPT file. Called by BRNA and calls BUFOP and XION.
BRNB	Reads cross sections from MULTIGRP file. Called by BRNA and calls XION, BUFCL, and BUFOP.
BRNH	Reads yield data for fission products from CLB INPT file. Called by BRNA and calls XION and BUFOP.
BRNI	Reads nuclide-chain specifications from CLB INPT file. Called by BRNA and calls BUFOP and XION.
BRNJ	Reads nuclide densities by subzone from CLB INPT file. If subzone densities are specified, writes the ZONEDENS file. If subzone densities are to be set equal to the zone densities, reads the ZONEDENS file. Called by BRNA and calls XION, BUFCL, and BUFOP.
BRNP	Performs initialization for each depletion step and reads INTQUANT and ZONEDENS files. Called by BURN and calls XION, BUFCL, and BUFOP.
BRNQ	Performs the depletion calculation for the time step. Called by BURN and calls BUFOP, GRIT, NUCX, and BUFCL.
NUCX	Solves the chain equations. Called by BRNQ and calls BUFOP.
BRNR	Performs after-depletion-step calculations and edits and writes ZONEDENS file. If a flux code is used, reads ADMNSTR file. Called by BURN and calls BUFCL, BUFOP, GRIT, XION, and MIXDAT.
MIXDAT	Writes new MIX DATA file after each depletion step. Reads old MIX DATA file to obtain mix numbers and mix commands and GEO DIST to obtain material numbers by zone.

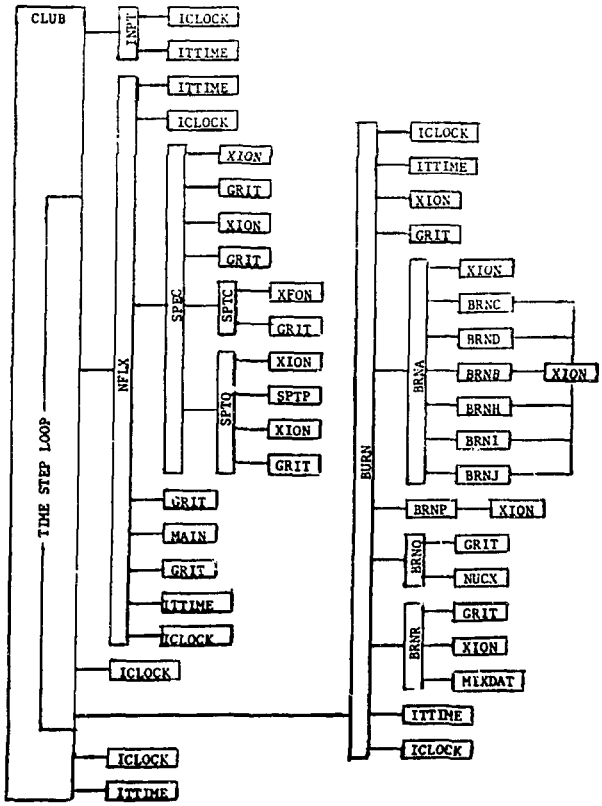

Fig. 5. Simplified flow diagram for CLUB code.

F. DAC Code

The DAC code is a perturbation theory program for use with one-, two-, and three-dimensional geometries. Geometries treated are slab (X, X-Y, and X-Y-Z), cylinder (R, R-Z, R-θ, and R-θ-Z), sphere (R), and hexagon (H and H-Z). At user option, DAC can use either angular fluxes from S_n calculations or scalar fluxes and currents from either diffusion or S_n calculations.

Reactivity worths of perturbations in microscopic cross sections and/or atom densities are computed by mesh interval and reaction type (fission, scattering, and total cross-section components). The prompt-neutron generation time and effective delayed-neutron fractions are also computed for the reference (unperturbed) system. The theory and numerical methods are the same as those used in the one-dimensional DAC1 code.[6] Only isotropic scattering is treated. The code is variably dimensioned.

TABLE XIX
SUMMARY OF "***DATA ERROR STOP NUMBER N" OCCURRENCES IN CLUB CODE

N	Routine	Condition Causing Error Stop
702	SPEC	INFD(1).EQ.0 where INFD(1) is the number of energy groups for the infinite-medium flux calculation.
703	SPEC	Insufficient core storage available for infinite-medium flux calculation. Increase dimension of common array A in DRIVER.
705	SPTC	No fission source in first group in infinite-medium calculation. Check fission fractions (average for set) in MULTIGRP file.
706	SPTC	Total fission source is zero in infinite-medium flux calculation. See error stop 705.
710	SPTQ	No convergence in infinite-medium flux calculation, i.e., fluxes growing without bound.
802	BRNA	Insufficient core storage for burnup arrays. Increase dimension of common array A in DRIVER.
811	BRNC	DD(1).LE.0.0 where DD(1) is reference core power level for first cycle.
820	BRND	NL(N).LT.NF(N) for zone set N in zone-classification data.
821	BRND	All zones were not specified in zone-classification data.
844	BRNH	A fission product specified in the fission-yield data is not in the MULTIGRP file.
854	BRNI	A nuclide in a nuclide chain is not in the MULTIGRP file.
855	BRNI	Incorrect transition type (NTYPE=0) in a nuclide chain.
857	BRNI	A fissile nuclide specified in the fission-yield data is not in the MULTIGRP file.
858	BRNI	Logic error in setting up the chain array in subroutine BRNI.
861	BRNJ	A nuclide specified in the subzone concentration data is not in the MULTIGRP file.
862	BRNJ	Logic error in setting up subzone concentrations in subroutine BRNJ.
863	BRNJ	Logic error in setting up zone concentrations in subroutine BRNJ.
871	BRNP	Could not perform end-of-cycle recovery for overshot conditions because start-of-step nuclide concentrations were not saved. See input parameter ND(7) in CLB INPT file.

Interface-data files required by DAC are ADMNSTR, GEO DIST, GRP FLXS (both regular and adjoint), INTQUANT, MIX DATA, reference MULTIGRP, and DAC INPT. If worths of perturbations in microscopic cross sections are to be calculated, the perturbed MULTIGRP (PERTMTGP) file is required. If angular fluxes are to be used, the SN CONS file is also required. Card input for creation of the DAC INPT file is described in Appendix B. In the current system, there are no interface files created by DAC.

The segmentation structure of DAC consists of a single segment DACS as shown in Table XX. DACS is loaded at level 1 by the DRIVER module.

A simplified flow diagram is shown in Fig. 6, and a brief description of each subroutine is given in Table XXI. All error messages printed by DAC are self-explanatory.

TABLE XX

SEGMENTATION STRUCTURE OF DAC CODE

Segment Level	Segment Name	Subroutines Included in Segment
1	DACS	MAIN, SNIFF, TRSINT, PRINCS, DNSPEC, SCATCS, DNSORT, RMAVGF, MIXCX, SCRATO, PERT

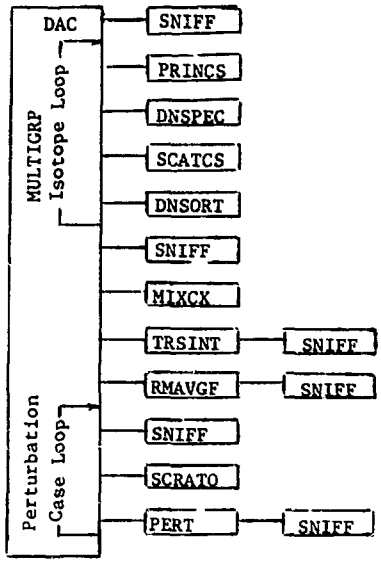

Fig. 6. Simplified flow diagram for DAC code.

TABLE XXI

DESCRIPTION OF SUBROUTINES IN DAC CODE

Subroutine	Description
MAIN	Controls overall flow of DAC calculation, reads all input data except fluxes, and computes pointers for variable-dimension arrays. Called by DRIVER and calls BUFOPEN (see DRIVER subroutines), SNIFF, PRINCS, DNSPEC, SCATCS, DNSORT, MIXCX, TRSINT, RMAVGF, SCRATO, and PERT.
SNIFF	Assigns a file number corresponding to a specified file name and assigns a buffer to the file. Calls BUFOPEN (see DRIVER subroutines) and is called by MAIN, TRSINT, RMAVGF, and PERT.
PRINCS	Stores principal cross sections from the MULTIGRP file into the cross-section matrix. Called by MAIN.
DNSPEC	Stores delayed-neutron spectrum data from MULTIGRP into the proper array. Called by MAIN.
SCATCS	Stores the scattering cross sections from MULTIGRP into the cross-section matrix. Called by MAIN.
DNSORT	Sorts delayed-neutron spectrum and abundances. Called by MAIN.
MIXCX	Mixes and prints cross sections for the reference configuration. Called by MAIN.
TRSINT	Reads the GRP FLXS (both regular and adjoint) file and computes the transport weighting integrals. Called by MAIN and calls SNIFF.
RMAVGF	Computes volume elements corresponding to the final spatial mesh. In delta and outer radius search problems, the final mesh is computed from the eigenvalue and initial mesh and mesh modifiers. Called by MAIN and calls SNIFF.
SCRATO	Reads and writes a scratch file. Called by MAIN.
PERT	Computes the prompt-neutron generation time, effective delayed-neutron fractions, and perturbation reactivities. Called by MAIN and calls SNIFF.

G. MC^2 Code

The interfaced version of the MC^2 code[1] processes both Version-I and -II ENDF/B data to produce a standard multigroup file. The code has not been converted for direct access by a path call in DRIVER. Instead, it is operated as a free-standing code whose output can be accessed by the other codes in the system. This mode of operation is used because of the computation time required in generating a MULTIGRP file containing a number of materials.

MC^2 treats the resonance region in a detailed manner, provides for linear anisotropy (P_1) in the elastic-scattering matrix, and accounts for heterogeneity effects through a two-region cell model. Cross sections for the thermal group are supplied by the user.

MC^2 is limited to single-level Breit-Wigner representation of resolved resonances, a broad-group lethargy mesh that is a multiple of a basic lethargy width $\Delta u = 1/120$, and downscattering. MC^2 does not have the capability to update or add to an existing MULTIGRP file; therefore, all isotopes needed on MULTIGRP must be calculated in the same run. This problem can be circumvented outside of MC^2 by writing a separate code to merge two MULTIGRP files into one file.

Although the code uses variable dimensioning, a container array of 40,000 words has been found necessary for some problems. For this size array, the code requires a total of 82,000 words of fast memory, including 9,500 words of buffer space.

The input ENDF/B binary tape must be arranged by files (alternate arrangement). MC^2 expects the first two files (general information and resonance parameters) on logical unit tape 1, and the next four files (smooth cross sections, secondary angular distributions, secondary energy distributions, and secondary energy-angle distributions) on tape 9. The output MULTIGRP file is written on tape 20. Card input to the code is described in Appendix B. In contrast to the INP module, card input is not in free format.

MC^2 was originally programmed for the IBM 360 and required much effort to make it operational on the CDC 6600. Most of the problems were the result of basic differences in the two computers (e.g., small word size on the IBM 360 requiring the use of double precision), use of nonstandard FORTRAN (e.g., subscripted subscripts), and differences in file usage (e.g., I/O buffer assignment).

Difficulties in converting MC^2 to the CDC 6600 resulted in the development of the CONVERT code[18] and the DYNBUF code.[17] CONVERT looks for and flags or changes some of the FORTRAN differences in an IBM program in converting it for use on the CDC. DYNBUF makes changes to an IBM FORTRAN program to provide dynamic buffer allocation on the CDC 6600.

Table XXII shows the MC^2 overlay structure and the subroutines in each overlay. The subroutines BUFOP, BUFCL, and BUFOPEN are used in connection with dynamic buffer allocation on the CDC 6600. For a description of the other subroutines, computational algorithms, etc., the reader is referred to Ref. 1.

An improved version of MC^2 is being developed at ANL.[19] The new version, called MC^2-2, will output multigroup cross sections in the Version-II standard interface-file format and will provide, at user option, rapid generation of cross sections by relaxing the rigor of the computational algorithms. By using standard FORTRAN to the fullest extent possible, conversion of the code to computers other than the IBM 360 should be simplified. When MC^2-2 becomes available, it will be incorporated into the system of linked reactor physics codes at LASL.

TABLE XXII

OVERLAY STRUCTURE OF INTERFACED MC^2 CODE

Overlay Level	Subroutines Included in Overlay
(0,0)	DRIVER, TIMEIT, SKIPFI, SNIFF, BUFCL, BUFOP, BUFOPEN, POINTR, FREE, PUTM, PUTPNT, WIPOUT, DUMP, GETPNT, SAVPRG, GETN, PRGSET, STATUS, IGET, PRTI1, PRTI2, PRTR1, PRTR2, PRTA1, PRTA2, IPTERR, ILAST, ILASTB, ALLOC2, LOCF, FREE1, REDEFM, REDEF, TLEFT, ABSTOP, ABEND
(1,0)	CSI001, INPT, READ1
(2,0)	CSC001, FDPRTU, QUICKW
(2,1)	TWO1, UNRES, QFJ
(2,2)	TWO2, RESRS
(3,0)	CSC002
(3,1)	CNTRL1, FDPTR1, FIGERO, SIGAVC, EF, ROMBI, INSCAT, FDINST, SOURCE
(3,2)	THREE2, CNTRL2, ALRAGO, PONE
(4,0)	CSC003
(4,1)	FOUR1, AVER
(4,2)	FOURTWO, AVER1, DTASET, FDATWT, FRVEL, RESON, INSCA, QUEZE, ELAST
(4,3)	FOUR3, BGPONE
(4,4)	FOUR4, MULTGRP, PRNTAB, PRNTI4, PRNTA, RWSCT

APPENDIX A

CONVERSION OF SYSTEM TO OTHER COMPUTERS

For computers that define the overlay structure by control cards or job control language, it is suggested that a dummy subroutine called SEGMENT be added to nullify the segment calls. In situations where other calls, such as CALL LINK, are required, it is suggested that a subroutine SEGMENT be set up to perform the required call. Such a subroutine could be as simple as the following:

```
SUBROUTINE SEGMENT (FILE, L, SEG, LIB, MAP)
CALL LINK (SEG)
RETURN
```

For systems with built-in dynamic buffering, subroutines BUFOPEN, BUFCL, and BUFOP should be replaced by dummy subroutines. In other situations, local adaptations of the SNIFF subroutine may be required.

In general, it is not desirable to compile the whole system of codes in a single compilation run. The binary object codes for each of the files listed in Table I (Sec. II) are normally created or updated in separate compilation runs and are stacked on a magnetic tape. In executing a particular problem, the binary files are transferred to separate disk files from the tape. The small DRIVER program is usually recompiled at execution time to adjust the size of the common container block A to the particular problem dimensions. Sample control card decks for performing these operations on the CDC 6600 will be supplied with the source programs.

APPENDIX B

DESCRIPTION OF CARD INPUT

The card input description follows procedures used by the CCCC in defining files. The description is punched on comment cards, which provide a convenient method for updating and correcting the description. The first two columns of a card contain characters CF, CL, CR, etc., which identify the type of information contained on the card. These conventions are defined as

- CF Denotes name of a file or block of input data.
- CE Description of file or block. CF and CE normally appear together enclosed by asterisk cards.
- CR Record name.
- CL List defining array to be input.
- CD Description or definition of input parameters.
- CN Explanatory notes.
- CS Description of file structure.
- CC Condition controlling reading of record.
- C Used for spacing and delimiting records.
- CEOF End of file or block of data.

The first block of input, the CONTROL block, is always read by DRIVER at the beginning of a run. The remaining input is controlled by the path defined by the user. Whenever an INP call is used in the path, the CARD INPUT FILE CONTROLS are read first. These controls determine which of the 16 data files are to be created or modified by card input during the given INP execution. The block entitled FILE AND RECORD PRINT CONTROLS is read whenever a PRN call occurs in the path. Additional information on card reading and file printing is given in Secs. III.A and III.B.

The last file in the card input description contains the input description for the free-standing interfaced MC^2 code. This input description was provided by ANL for the MC^2 code.

Card input for a number of sample problems is discussed in Appendix D.

```
C*****************************************************************
C                                                                 -
CF          CONTROL                                               -
CE          DRIVER CONTROL INPUT                                  -
C                                                                 -
C*****************************************************************


C-----------------------------------------------------------------
CR    NUMBER OF PATH ELEMENTS                                     -
C                                                                 -
CL    NPATH                                                       -
C                                                                 -
CD    NPATH              NUMBER OF PATH ELEMENTS                  -
C                                                                 -
C-----------------------------------------------------------------


C-----------------------------------------------------------------
CR    PATH                                                        -
C                                                                 -
CL    (PATH(I),I=1,NPATH)                                         -
C                                                                 -
CD    PATH(I)            THREE-CHARACTER HOLLERITH NAME FOR THE ITH -
CD                       MODULE,CODE BLOCK, OR ELEMENT IN THE PATH. -
CD                       AVAILABLE MODULES ARE                    -
CD                       FLO  READS STANDARD AND CODE-DEPENDENT FILES -
CD                            FROM TAPE AND STORES EACH FILE AS A -
CD                            SEPARATE DISK FILE.                -
CD                       FLI  STORES FILE ON AN OUTPUT TAPE.      -
CD                       INP  INPUT PROCESSOR.  CREATES OR MODIFIES ANY -
CD                            OF THE STANDARD OR CODE-DEPENDENT FILES -
CD                            FROM CARD INPUT.                   -
CD                       PRN  AT USER OPTION, PRINTS ANY OF THE FILES -
CD                            OR SELECTED RECORDS FROM ANY OF THE FILES.-
CD                       ETX  ETOX CODE.  CONSTRUCTS MULTIGROUP CROSS- -
CD                            SECTION DATA IN BONDARENKO FORM USING DATA-
CD                            FROM ENDF/B FILE.                  -
CD                       ODX  ONEDX CODE.  A ONE-DIMENSIONAL DIFFUSION -
CD                            CODE.  CONVERTS ETOX OUTPUT INTO A MULTI- -
CD                            GROUP CROSS-SECTION SET.           -
CD                       ANI  ANISN CODE.  A ONE-DIMENSIONAL SN CODE. -
CD                       DOT  DOT2D6 CODE.  A TWO-DIMENSIONAL FLUX -
CD                            CODE PROVIDING EITHER THE DIFFUSION OR -
CD                            SN OPTIONS.                        -
CD                       DAC  PERTURBATION CODE.  CALCULATES PERTUR- -
CD                            BATION REACTIVITIES USING FLUXES FROM -
CD                            ANY OF THE ABOVE FLUX CODES.       -
CD                       CLB  PERFORMS BURNUP CALCULATIONS USING ANY -
CD                            OF THE ABOVE FLUX CODES            -
C-----------------------------------------------------------------
CEOF
```

```
C*****************************************************************
C                                                                 -
CF    CARD INPUT FILE CONTROLS                                    -
C                                                                 -
C*****************************************************************


C-----------------------------------------------------------------
CR    FILE CONTROL                                                -
C                                                                 -
CL    IREAD(I),I=1,16                                             -
C                                                                 -
CD    IREAD             =1, READ FILE FROM CARDS                  -
CD                      =2, READ FILE FROM TAPE                   -
CD                      =3, READ FILE FROM BOTH CARDS AND TAPE    -
CD                      =4, SKIP FILE                             -
CD                                                                -
CD    I                 =1, ADMNSTR FILE                          -
CD                      =2, SN CONS FILE                          -
CD                      =3, INTQUANT FILE                         -
CD                      =4, GEO DIST FILE                         -
CD                      =5, MIX DATA                              -
CD                      =6, GRP FLUX FILE, REGULAR (GRP FLXS)     -
CD                      =7, GRP FLUX FILE, ADJOINT (ADJ FLXS)     -
CD                      =8, MULTIGRP FILE,REFERENCE (MULTIGRP)    -
CD                      =9, MULTIGRP FILE, PERTURBED (PERTMTGP)   -
CD                      =10, ZONEDENS FILE                        -
CD                      =11, ETX INPT FILE                        -
CD                      =12, ODX INPT FILE                        -
CD                      =13, ANI INPT FILE                        -
CD                      =14, DOT INPT FILE                        -
CD                      =15, CLB INPT FILE                        -
CD                      =16, DAC INPT FILE                        -
C-----------------------------------------------------------------
CEOF



C*****************************************************************
C                                                                 -
CF    ADMNSTR FILE                                                -
CE    ADMINISTRATION AND CONTROL DATA                             -
C                                                                 -
C*****************************************************************


C-----------------------------------------------------------------
CR    ADMINISTRATION AND CONTROL DATA                             -
C                                                                 -
CL    (ID(I),I=1,8),      IA01, IA11, IA02, IA03, IA04,  IGE,  IZM,  -
CL       IM,   JM,   KM,  IBK, IEVT,   EV,  EVM,  EPS,TEMP1,TEMP2,  -
CL    TEMP3,TEMP4,TEMP5, I801, I802, I803, I804, I805, I806,  M07,  -
CL     IFAT,  S01,   MT,  M01,  MCR,  MSF,   IZ,   JZ,   KZ, IS02,  -
CL      S03,  IGM,  M06, I005, IG07,  G05,  G06, ALAL, ALAM,  POD,  -
CL     EPSA, XFAC                                                 -
C                                                                 -
CD    ID                IDENTIFICATION AND TITLE, 8A6             -
CD    IA01              DIMENSION 1, 2, OR 3                      -
CD    IA11              TYPE,  0=DIFFUSION THEORY,  1=TRANSPORT THEORY -
CD    IA02              THEORY,  0=REGULAR,  1=ADJOINT            -
CD    IA03              SCATTERING,  0=ISOTROPIC,  N=ORDER OF     -
CD                          ANISOTROPIC                           -
CD    IA04              ORDER OF SN APPROXIMATION                 -
CD    IGE               GEOMETRY,  0=FUNDAMENTAL MODE             -
CD                                   1=1-D SLAB (X)               -
CD                                   2=1-D CYL (R)                -
CD                                   3=1-D SPHERE (R)             -
CD                                   6=2-D SLAB (X,Y)             -
CD                                   7=2-D CYL (R,Z)              -
```

```
CD                                  8=2-D CYL(R,THETA)                    -
CD                                  9=2-D HEX(H)                          -
CD                                 11=3-D SLAB(X,Y,Z)                     -
CD                                 12=3-D CYL(R,THETA,Z)                  -
CD                                 13=3-D HEX(H,Z)                        -
CD     IZM              NUMBER OF ZONES                                   -
CD     IM               NUMBER OF FIRST DIMENSION INTERVALS               -
CD     JM               NUMBER OF SECOND DIMENSION INTERVALS              -
CD     KM               NUMBER OF THIRD DIMENSION INTERVALS               -
CD     IBK              NUMBER OF BUCKLING SETS                           -
CD                      =0, NONE                                          -
CD                      =+1, ZONE DEPENDENT ONLY                          -
CD                      =-1, INDEPENDENT OF ZONE AND GROUP                -
CD                      =+IGM, ZONE AND GROUP DEPENDENT                   -
CD                      =-IGM, GROUP DEPENDENT ONLY                       -
CD     IEVT             EIGENVALUE TYPE.  0= SOURCE CALCULATION           -
CD                                        1= K-EFFECTIVE CALCULATION      -
CD                                        2= ALPHA CALCULATION            -
CD                                        3= CONCENTRATION CALCULATION    -
CD                                        4= ZONE WIDTH CALCULATION       -
CD                                        5= BUCKLING SEARCH              -
CD                                        6= OUTER RADIUS SEARCH          -
CD     EV               INITIAL EIGENVALUE GUESS                          -
CD     EVM              EIGENVALUE MODIFIER                               -
CD     EPS              CONVERGENCE CRITERION                             -
CD     TEMP1, TEMP5     UNDEFINED                                         -
CD     IB01             LEFT BOUNDARY CONDITION                           -
CD                           -1= FLUX VANISHES AT BOUNDARY                -
CD                            0= VACUUM                                   -
CD                            1= REFLECTIVE                               -
CD                            2= PERIODIC                                 -
CD                            3= WHITE                                    -
CD                            4= GRAY                                     -
CD     IB02             RIGHT BOUNDARY CONDITION.  SAME OPTIONS AS IB01-
CD     IB03             TOP BOUNDARY CONDITION.  SAME OPTIONS AS IB01   -
CD     IB04             BOTTOM BOUNDARY CONDITION. SAME OPTIONS AS IB01-
CD     IB05             FRONT BOUNDARY CONDITION.  SAME OPTIONS AS IB01-
CD     IB06             BACK BOUNDARY CONDITION.  SAME OPTIONS AS IB01  -
CD     M07              FLUX INPUT OPTIONS.                               -
CD                           -1= NO FLUX GUESS                            -
CD                            0= A VALUE FOR EACH GROUP, X(G), WHICH      -
CD                               REPRESENTS THAT GROUP IN EVERY INTER-    -
CD                               VAL, I.E., FLUX(G,I,J,K)=X(G).           -
CD                            1= A VALUE FOR EACH INTERVAL, IN BLOCKS     -
CD                               BY GROUP, EACH BLOCK IM*JM*KM LONG,      -
CD                               I.E., FLUX(G,I,J,K)=X(G,I,J,K).          -
CD                            2= A VALUE FOR EACH GROUP, X(G), FOL-       -
CD                               LOWED BY A BLOCK OF VALUES, ONE FOR      -
CD                               EACH INTERVAL, Y(I,J,K), I.E.,           -
CD                               FLUX(G,I,J,I)=X(G)*Y(I,J,K).             -
CD                            3= A VALUE FOR EACH GROUP, X(G), A VALUE    -
CD                               FOR EACH 1ST DIM. INTERVAL, Y(I), A      -
CD                               VALUE FOR EACH 2ND DIM. INTERVAL, Z(J)-
CD                               AND A VALUE FOR EACH 3RD DIM. INTERVAL,
CD                               W(K), I.E., FLUX(G,I,J,K)=               -
CD                               X(G)*Y(I)*Z(J)*W(K).                     -
CD                            4= ENTER COMPLETE RESTART FOR CONTINUA-     -
CD                               TION OF PROBLEM FROM STANDARD FILES.     -
CD                            5= EXTRACT FLUXES FROM THE STANDARD FILE.-
CD     IFXT             USE NEGATIVE SOURCE CHECK - 0=NO, 1=YES           -
CD     S01              SOURCE NORMALIZATION FACTOR                       -
CD     MT               TOTAL NUMBER OF MATERIALS INCLUDING MIXTURES      -
CD     M01              NUMBER OF MATERIAL SPECIFICATIONS                 -
CD     MCR              NUMBER OF ISOTOPES FOR WHICH CROSS SECTIONS       -
CD                      ARE INPUT FROM CARDS.                             -
CD     MSF              SAME AS MCR, BUT INPUT FROM STANDARD FILE         -
CD     IZ               NUMBER OF FIRST DIMENSION ZONE MODIFIERS          -
CD     JZ               NUMBER OF SECOND DIMENSION ZONE MODIFIERS         -
CD     KZ               NUMBER OF THIRD DIMENSION ZONE MODIFIERS          -
```

```
CD     IS02              PARAMETRIC EIGENVALUE TYPE FOR SEARCH CALCS    -
CD                             0= NONE                                  -
CD                             1= K-EFFECTIVE FOR OFF-CRITICAL SYSTEM   -
CD                                WHERE S03= K-EFF                      -
CD                             2= ALPHA FOR OFF-CRITICAL SYSTEM         -
CD                                WHERE S03=ALPHA                       -
CD     S03               PARAMETRIC EIGENVALUE                          -
CD     IGM               NUMBER OF ENERGY GROUPS                        -
CD     M06               SOURCE INPUT OPTIONS                           -
CD                           0= A VALUE FOR EACH GROUP, X(G), WHICH      -
CD                              WILL BE USED IN ALL INTERVALS, I.E.,     -
CD                              Q(G,I,J,K)= X(G)                         -
CD                           1= A VALUE FOR EACH INTERVAL, IN BLOCKS     -
CD                              BY GROUP, EACH BLOCK IM*JM*KM* LONG,     -
CD                              I.E., Q(G,I,J,K)= X(G,I,J,K)             -
CD                           2= A VALUE FOR EACH GROUP, X(G), FOLLOWED   -
CD                              BY A BLOCK OF VALUES, ONE FOR EACH       -
CD                              INTERVAL, Y(I,J,K), I.E.,                -
CD                              Q(G,I,J,K), X(G)*Y(I,J,K)                -
CD                           3= A VALUE FOR EACH GROUP, X(G), A VALUE    -
CD                              FOR EACH 1ST DIM. INTERVAL, Y(I), A      -
CD                              VALUE FOR EACH 2ND DIM. INTERVAL, Z(J),  -
CD                              AND A VALUE FOR EACH 3RD DIM. INTERVAL,  -
CD                              W(K), I.E., Q(G,I,J,K)=                  -
CD                                          X(G)*Y(I)*Z(J)*W(K)          -
CD                           4= RIGHT (NORMAL TO 1ST DIM.) BOUNDARY      -
CD                              SOURCE                                   -
CD                           5= TOP (NORMAL TO 2ND DIM.) BOUNDARY        -
CD                              SOURCE                                   -
CD                           6= FRONT (NORMAL TO 3RD DIM.) BOUNDARY      -
CD                              SOURCE                                   -
CD     IB05              MAXIMUM NUMBER OF OUTER ITERATIONS             -
CD     IG07              MAXIMUM NUMBER OF INNER ITERATIONS PER GROUP   -
CD     G05               USE NEUTRON BALANCE TEST - 0=NO, G05=LIMIT     -
CD                       FOR TEST                                       -
CD     G06               USE INNER POINTWISE FLUX TEST - 0=NO, G06=     -
CD                       LIMIT FOR TEST                                 -
CD     ALAL              LOWER LIMIT ON LAMBDA                          -
CD     ALAH              UPPER LIMIT ON LAMBDA                          -
CD     POD               NEW PARAMETER MODIFIER (OR PARAMETER OSCILLATION
CD                       DAMPER)                                        -
CD     EPSA              CONVERGENCE PRECISION USED IN CRITICALITY      -
CD                       SEARCHES                                       -
CD     XPAC              EXTRAPOLATION FACTOR                           -
C----------------------------------------------------------------------
CEOF
```

```
C**********************************************************************
C                                                                      -
CF     SN CONS FILE                                                    -
CE     SN CONSTANTS                                                    -
C                                                                      -
C**********************************************************************
```

```
C----------------------------------------------------------------------
CR     RECORD CONTROL    READ IF IREAD(2).EQ.3                         -
C                                                                      -
CL     IRD(J), J=1,3                                                   -
C                                                                      -
CD     IRD(J)            READ RECORD J FROM CARDS - 1= YES, 0=NO       -
C                                                                      -
C----------------------------------------------------------------------
```

```
C-----------------------------------------------------------------------
CR     MU DIRECTIONS      READ IF IRD(1).EQ.1                           -
C                                                                       -
CL     M7(M), M=1,MM                                                    -
C                                                                       -
CD     M7                 MU DIRECTIONS                                 -
CD     MM                 NUMBER OF DIRECTIONS                          -
C                                                                       -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
C                                                                       -
CR     ETA DIRECTIONS     READ IF IRD(2).EQ.1                           -
C                                                                       -
CL     M5(M), M=1,MM                                                    -
C                                                                       -
CD     M5                 ETA DIRECTIONS                                -
C                                                                       -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR     WEIGHTS            READ IF IRD(3).EQ.1                           -
C                                                                       -
CL     WO(M), M=1,MM                                                    -
C                                                                       -
CD     WO                 WEIGHTS                                       -
C                                                                       -
C-----------------------------------------------------------------------
CEOF


C***********************************************************************
C                                                                       -
CF     INTQUANT FILE                                                    -
CE     INTEGRAL QUANTITIES                                              -
C                                                                       -
C***********************************************************************

C-----------------------------------------------------------------------
CR     RECORD CONTROL     READ IF IREAD(3).EQ.3                         -
C                                                                       -
CL     IRD(J), J=1,3                                                    -
C                                                                       -
CD     IRD(J)             READ RECORD(J) FROM CARDS - 1=YES, 0=NO       -
C                                                                       -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR     DERIVED CONSTANTS, READ IF IRD(1).EQ.1                           -
C                                                                       -
CL     EK,EV,EVS,ICON,EVC,FLO,NOI,TSO,TLO,TLE,TBLO,TBAB                 -
C                                                                       -
CD     EK                 EFFECTIVE MULTIPLICATION FACTOR               -
CD     EV                 SEARCH EIGENVALUE                             -
CD     EVS                EIGENVALUE SLOPE                              -
CD     ICON               CONVERGENCE CRITERION SATISFIED - 0=YES, 1=NO  -
CD     EVC                EIGENVALUE CONVERGENCE REACHED (ON FISSION     -
CD                                SOURCE)                               -
CD     FLO                FLUX CONVERGENCE REACHED                      -
CD     NOI                NUMBER OF OUTER ITERATIONS                    -
CD     TSO                TOTAL NEUTRON SOURCE (INTEGRATED PHI*NU       -
CD                                SIGMA FISSION)                        -
CD     TLO                TOTAL NEUTRON LOSSES                          -
CD     TLE                TOTAL LEAKAGE                                 -
CD     TBLO               TOTAL BUCKLING LOSS                           -
CD     TBAB               TOTAL INTERNAL BLACK ABSORPTION               -
C                                                                       -
C-----------------------------------------------------------------------
```

```
C-----------------------------------------------------------------------
CR    ZONE AVERAGED FLUXES, READ IF IRD(2).EQ.1                        -
C                                                                      -
CL    ((ZF(L,I),L=1,IZM),I=1,IGM)                                      -
C                                                                      -
CD    ZF                  AVERAGED FLUX BY GROUP AND ZONE              -
C                                                                      -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR    ZONE VOLUMES,       READ IF IRD(3).EQ.1                          -
C                                                                      -
CL    VOL(I),I=1,IZM                                                   -
C                                                                      -
CD    VOL                 VOLUME OF ZONE                               -
C                                                                      -
C-----------------------------------------------------------------------
CEOF
```

```
C**********************************************************************
C                                                                      -
CF    GEO DIST FILE                                                    -
CE    GEOMETRY AND MATERIAL DISTRIBUTIONS                              -
C                                                                      -
C**********************************************************************

C-----------------------------------------------------------------------
CR    RECORD CONTROL      READ IF IREAD(4).EQ.3                        -
C                                                                      -
CL    IRD(J),J=1,4                                                     -
C                                                                      -
CD    IRD(J)              READ RECORD J FROM CARDS - 1=YES, 0=NO       -
C                                                                      -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR    BOUNDARIES          READ IF IRD(1).EQ.1                          -
C                                                                      -
CL    XO(I), I=1,IM1                                                   -
CL    YO(J), J=1,JM1      READ IF IA01.GE.2                            -
CL    ZO(K), K=1,KM1      READ IF IA01.EQ.3                            -
C                                                                      -
CD    XO                  FIRST DIMENSION BOUNDARIES                   -
CD    YO                  SECOND DIMENSION BOUNDARIES                  -
CD    ZO                  THIRD DIMENSION BOUNDARIES                   -
CD    IM1                 NUMBER OF FIRST DIMENSION BOUNDARIES         -
CD    JM1                 NUMBER OF SECOND DIMENSION BOUNDARIES        -
CD    KM1                 NUMBER OF THIRD DIMENSION BOUNDARIES         -
C                                                                      -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR    MATERIAL NUMBERS    READ IF IRD(2).EQ.1                          -
C                                                                      -
CL    M2(I),I=1,IZM                                                    -
C                                                                      -
CD    M2                  MATERIAL NUMBERS BY ZONE                     -
C                                                                      -
C-----------------------------------------------------------------------
```

```
C-------------------------------------------------------------------
CR    ZONE NUMBERS        READ IF IRD(3).EQ.1                      -
C                                                                  -
CL    ((MO(I,J,K),I=1,IM),J=1,JM),K=1,KM)                          -
C                                                                  -
CD    MO                  ZONE NUMBERS BY INTERVAL                 -
C                                                                  -
C-------------------------------------------------------------------


C-------------------------------------------------------------------
CR    BUCKLING            READ IF IRD(4).EQ.1.AND.IBK.NE.0         -
C                                                                  -
CL    ((IBK(K,I),K=1,IRG),I=1,IBK1)                                -
C                                                                  -
CD    BK                  BUCKLING BY ZONE AND GROUP               -
CD    IBK1                ABSOLUTE VALUE OF IBK                    -
CD    IRG                 =1, IF IBK.LT.0                          -
CD                        =IZM, IF IBK.GT.0                        -
C                                                                  -
C-------------------------------------------------------------------
CEOF


C*******************************************************************
C                                                                  -
CF    MIX DATA FILE                                                -
CE    MIXTURE DATA AND ISOTOPE NUMBERS                             -
C                                                                  -
C*******************************************************************


C-------------------------------------------------------------------
CR    RECORD CONTROL      READ IF IREAD(5).EQ.3                    -
C                                                                  -
CL    IRD(J),J=1,4                                                 -
C                                                                  -
CD    IRD(J)              READ RECORD J FROM CARDS - 1=YES,0=NO     -
C                                                                  -
C-------------------------------------------------------------------


C-------------------------------------------------------------------
CR    MIX NUMBERS         READ IF IRD(1).EQ.1                      -
C                                                                  -
CL    IO(I),I=1,MOI                                                -
C                                                                  -
CD    IO                  NUMBERS LABELING THE CROSS-SECTION MIXTURES -
C                                                                  -
C-------------------------------------------------------------------


C-------------------------------------------------------------------
CR    MIX COMMAND         READ IF IRD(2).EQ.1                      -
C                                                                  -
CL    II(I),I=1,MOI                                                -
C                                                                  -
CD    II                  NUMBERS INDICATING WHICH ISOTOPES MAKE UP EACH -
CD                        MIXTURE                                  -
C                                                                  -
C-------------------------------------------------------------------


C-------------------------------------------------------------------
CR    MIX DENSITIES       READ IF IRD(3).EQ.1                      -
C                                                                  -
CL    AI2(I),I=1,MOI                                               -
C                                                                  -
CD    AI2                 ATOMIC DENSITIES                         -
C                                                                  -
C-------------------------------------------------------------------
```

```
C-------------------------------------------------------------------
CR     ISOTOPE NUMBERS    READ IF IRD(4).EQ.1                       -
C                                                                   -
CL     ISOID(I),I=1,ML                                              -
C                                                                   -
CD     ISOID              NUCLIDE NUMBERS ON MULTIGROUP FILE OR     -
CD                        NUCLIDE SEQUENCE NUMBERS ON ETOX LIBRARY  -
CD     ML                 ML=MCR+MSF                                -
C                                                                   -
C-------------------------------------------------------------------
CEOF


C*******************************************************************
C                                                                   -
CF          GRP FLXS FILE                                           -
CE          REGULAR TOTAL FLUXES, CURRENTS, AND ANGULAR FLUXES      -
C                                                                   -
C*******************************************************************


C-------------------------------------------------------------------
CR     RECORD CONTROL     READ IF IREAD(6).EQ.3                     -
C                                                                   -
CL     IRD(J),J=1,3                                                 -
C                                                                   -
CD     IRD(J)             READ RECORD J - 1=YES, 0=NO               -
C                                                                   -
C-------------------------------------------------------------------

C-------------------------------------------------------------------
CR     FLUX GUESS                                                   -
C                                                                   -
CL     X(L),L=1,IGM       READ IF M07.EQ.0 OR M07.EQ.2 OR M07.EQ.3  -
CL     (((Y(I,J,K),I=1,IM),J=1,JM),K=1,KM)      READ IF M07.EQ.2   -
CL     Y(I),I=1,IM        READ IF M07.EQ.3                          -
CL     Z(J),J=1,JM        READ IF M07.EQ.3 AND IA01.GE.2            -
CL     W(K),K=1,KM        READ IF M07.EQ.3 AND IA01.EQ.3            -
C                                                                   -
C-------------------------------------------------------------------

C-------------------------------------------------------------------
CR     TOTAL FLUX         READ IF IRD(1).EQ.1.AND.M07.EQ.5          -
C                                                                   -
CL     ((PHI((I,L),I=1,IM),L=1,IGM)          READ IF IA01.EQ.1     -
C                                                                   -
C      DO N L=1,IGM                                                 -
C      DO N K=1,KM                                                  -
CL   N READ(N) ((PHI((I,J),I=1,IM),J=1,JM)       READ IF IA01.GE.2 -
C                                                                   -
CD     PHI                TOTAL FLUX BY GROUP AND INTERVAL          -
C                                                                   -
C-------------------------------------------------------------------


C-------------------------------------------------------------------
CR     CURRENT            READ IF IRD(2).EQ.1.AND.((IA11.EQ.0.OR.((IA11.EQ.-
CR                        1.AND.IA03.EQ.1)).AND.M07.EQ.5            -
C                                                                   -
CL     ((X((I,L),I=1,IM),L=1,IGM)        READ IF IA01.EQ.1         -
C                                                                   -
C      DO N M=1,IA01                                                -
C      DO N L=1,IGM                                                 -
C      DO N K=1,KM                                                  -
CL   N READ(N) ((X((I,J),I=1,IM),J=1,JM)       READ IF IA01.GE.2    -
C                                                                   -
CD     X                  VECTOR CURRENT BY COMPONENT, GROUP, AND   -
CD                        INTERVAL                                  -
C                                                                   -
C-------------------------------------------------------------------
```

```
C-----------------------------------------------------------------------
CR    ANGULAR FLUX       READ IF IRD(3).EQ.1 AND IA11.EQ.1.AND.M07.EQ.5 -
C                                                                       -
C     DO N L=1,IGM                                                      -
C     DO N K=1,KM                                                       -
C     DO N J=1,JM                                                       -
CL  N READ(N) ((AF(M,I),M=1,MM),I=1,IM)                                 -
C                                                                       -
CD    AF                 ANGULAR FLUX AT MESH CENTERS BY GROUP, INTERVAL,
CD                       AND DIRECTION                                  -
C                                                                       -
C-----------------------------------------------------------------------
CEOF
```

```
C***********************************************************************
C                                                                       -
CF    ADJ FLXS FILE                                                     -
CE    ADJOINT TOTAL FLUXES, CURRENTS, AND ANGULAR FLUXES                -
C                                                                       -
C***********************************************************************

C-----------------------------------------------------------------------
CR    RECORD CONTROL     READ IF IREAD(7).EQ.3                          -
C                                                                       -
CL    IRD(J),J=1,3                                                      -
C                                                                       -
CD    IRD(J)             READ RECORD J - 1=YES, 0=NO                    -
C                                                                       -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
C                                                                       -
CC    ADJOINT GRP FLUX FILE OTHERWISE HAS THE SAME STRUCTURE AS THE     -
CC    REGULAR GRP FLUX FILE.                                            -
C                                                                       -
C-----------------------------------------------------------------------
CEOF
```

```
C***********************************************************************
C                                                                       -
CF    MULTIGRP FILE                                                     -
CE    MULTIGROUP CROSS-SECTION FILE                                     -
C                                                                       -
C***********************************************************************

C-----------------------------------------------------------------------
CS    FILE STRUCTURE                                                    -
CS                                                                      -
CS        FILE NAME                                                     -
CS        RECORD CONTROL                                                -
CS        DIMENSIONS                                                    -
CS        ISOTOPE NUMBERS                                               -
CS        FISSION ISOTOPES                                              -
CS        ANISOTROPIC ISOTOPES                                          -
CS        ISOTOPE NAMES                                                 -
CS        GROUP STRUCTURE                                               -
CS        DELAYED NEUTRON DECAY FACTORS                                 -
CS        DELAYED SPECTRUM                                              -
```

```
CS    *********(REPEAT FOR NIR ISOTOPES)
CS    *        ISOTOPE HEADING
CS    *        ISOTOPE FISSION SPECTRUM
CS    *        DELAYED NEUTRON ABUNDANCES
CS    *    *****(REPEAT NTAB TIMES FOR ANISOTROPIC ISOTOPES)
CS    *    *        PRINCIPAL CROSS-SECTIONS
CS    *    *        INELASTIC CROSS-SECTIONS
CS    *    *        ELASTIC CROSS-SECTIONS
CS    *    ********N-2N CROSS-SECTIONS
CS    *        FACTORS LN(SIGMAPO)/LN(10) FOR BONDARENKO XS
CS    *        BONDARENKO TEMPERATURES
CS    *        BONDARENKO SELF-SHIELDING FACTORS
CS    ********BONDARENKO CROSS-SECTIONS
C
C-----------------------------------------------------------------

C-----------------------------------------------------------------
CR    FILE NAME          ALWAYS READ
C
CL    ANAME(I),I=1,9
C
CD    ANAME              DESCRIPTION OF CROSS-SECTION SET, 9A6
C
C-----------------------------------------------------------------

C-----------------------------------------------------------------
CR    RECORD CONTROL     ALWAYS READ
C
CL    IRD(J),J=1,12
C
CD    IRD(J)             READ RECORD J - 1=YES, 0=NO
C
C-----------------------------------------------------------------

C-----------------------------------------------------------------
CR    FILE DIMENSIONS AND CONTROLS            ALWAYS READ
C
CL     NIR,  NGS, NDGS, NTAB, NINT, NTEM, IHM, IHT, IHS, INUF,
CL    IABS, ITOT, IFIS, IN2N,  ING,  INA, INP, IND, INT, ING1
C
CD    NIR                NUMBER OF ISOTOPES
CD    NGS                NUMBER OF PROMPT GROUPS
CD    NDGS               NUMBER OF DELAYED GROUPS
CD    NTAB               NUMBER OF SCATTERING TABLES GIVEN FOR
CD                           ANISOTROPIC ISOTOPES
CD    NINT               NUMBER OF SIGMAPO FACTORS AT WHICH BONDARENKO
CD                           SELF-SHIELDING FACTORS ARE GIVEN
CD    NTEM               NUMBER OF TEMPERATURES AT WHICH BONDARENKO
CD                           SELF-SHIELDING FACTORS ARE GIVEN
CD    IHM                PRINCIPAL CROSS-SECTION TABLE LENGTH
CD    IHT                POSITION OF TRANSPORT CROSS-SECTION
CD    IHS                POSITION OF IN-GROUP SCATTERING CROSS-SECTION
CD    INUF               POSITION OF NU-FISSION CROSS-SECTION
CD    IABS               POSITION OF ABSORPTION CROSS-SECTION
CD    ITOT               POSITION OF TOTAL CROSS-SECTION
CD    IFIS               POSITION OF FISSION CROSS-SECTION
CD    IN2N               POSITION OF N2N CROSS-SECTION
CD    ING                POSITION OF N-GAMMA CROSS-SECTION
CD    INA                POSITION OF N-ALPHA CROSS-SECTION
CD    INP                POSITION OF N-P CROSS-SECTION
CD    IND                POSITION OF N-D CROSS-SECTION
CD    INT                POSITION OF N-T CROSS-SECTION
CD    ING1               POSITION OF N-GAMMA TO FIRST EXCITED STATE
CD                           CROSS-SECTION
C
C-----------------------------------------------------------------
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C-----------------------------------------------------------------------
CR     ISOTOPE NUMBERS          ALWAYS READ                             -
C                                                                       -
CL     ISNUM(I),K=1,NIR                                                 -
C                                                                       -
CD     ISNUM               ORDER NUMBER OF ISOTOPE I IN COMBINED SET OF -
CD                             FILE AND CARD INPUT CROSS-SECTIONS       -
C                                                                       -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR     FISSION ISOTOPE INDICATORS          ALWAYS READ                 -
C                                                                       -
CL     IFIS(I),I=1,NIR                                                  -
C                                                                       -
CD     IFIS                FISSION ISOTOPE INDICATOR.  CARD INPUT ISOTOPE -
CD                             I IS FISSIONABLE.  1=YES, 0=NO           -
C                                                                       -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR     ANISOTROPIC ISOTOPE INDICATORS       ALWAYS READ                -
C                                                                       -
CL     IANI(I),I=1,NIR                                                  -
C                                                                       -
CD     IANI                ANISOTROPIC ISOTOPE INDICATOR               -
CD                         NTAB PRINCIPAL CROSS-SECTION TABLES GIVEN FOR -
CD                             ISOTOPE I. 1=YES, 0=NO                   -
C                                                                       -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR     ISOTOPE NAMES       READ IF IRD(1).EQ.1                         -
C                                                                       -
CL     (ISOID(ISO),ISONME(ISO),TDC(ISO),IRZM(ISO),ISO=1,NIR)            -
C                                                                       -
CD     ISOID               ISOTOPE ID NUMBER                           -
CD     ISONME              ISOTOPE NAME (A6)                           -
CD     TDC                 TEMPERATURE (DEGREES CENTIGRADE)            -
CD     IRZM                INDEX TO A REGION, ZONE, OR MATERIAL IF THIS -
CD                             HAS BEEN AVERAGED OVER A SPECTRUM AND    -
CD                             COMPOSITION FOR A PARTICULAR REACTOR REGION,
CD                             ZONE, OR MATERIAL                        -
C                                                                       -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR     GROUP STRUCTURE       READ IF IRD(2).EQ.1                       -
C                                                                       -
CL     JFTG,IDBF,(E(I),I=1,NGS1),(U(I),I=1,NGS1),RV(I),I=1,NGS),        -
CL     (EBAR(I),I=1,NGS),(SEPC(I),I=1,NGS)                              -
C                                                                       -
CD     JFTG                GROUP NUMBER OF FIRST THERMAL GROUP         -
CD     IDBF                DETAILED BALANCE FACTOR INDICATOR.  IDBF=0,  -
CD                             UP-SCATTERING ELEMENTS ARE GIVEN.  IDBF=1, -
CD                             COMPUTE UP-SCATTERING ELEMENTS FROM      -
CD                             DETAILED BALANCE                         -
CD     E(I)                UPPER ENERGY LIMIT (EV) OF GROUP I.         -
CD                             (E(NGS1) IS LOWER ENERGY BOUND OF GROUP NGS)
CD     U(I)                LOWER LETHARGY LIMIT OF GROUP I.  (U(NGS1) IS -
CD                             UPPER LETHARGY LIMIT OF GROUP NGS)       -
CD     RV(I)               AVERAGED RECIPROCAL VELOCITY FOR GROUP I     -
CD     EBAR(I)             CHARACTERISTIC ENERGY (EV) OF GROUP I USED IN -
CD                             CONJUNCTION WITH POINT-POINT MATRICES    -
CD     SEPC(I)             AVERAGED FISSION SPECTRUM FOR CROSS-SECTION SET-
CD     NGS1                NGS+1                                       -
C                                                                       -
C-----------------------------------------------------------------------
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C-----------------------------------------------------------------------
CR    DELAYED NEUTRON DECAY CONSTANTS       READ IF IRD(3).EQ.1          -
CR                                           AND NDGS.NE.0                -
C                                                                         -
CL    DNDC(N),N=1,NDGS                                                    -
C                                                                         -
CD    DNDC              DELAYED NEUTRON DECAY CONSTANTS                   -
C                                                                         -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR    DELAYED NEUTRON SPECTRUM     READ IF IRD(4).EQ.1 AND NDGS.NE.0      -
C                                                                         -
CL    ((CHIDN(N,L),N=1,NGS),L=1,NDGS)                                     -
C                                                                         -
CD    CHIDN             DELAYED NEUTRON YIELDS BY PROMPT GROUP AND        -
CD                          DELAYED GROUP                                 -
C                                                                         -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR    ISOTOPE HEADING   READ IF IRD(5).EQ.1                               -
C                                                                         -
CL    ISOID, ISONME,   TDC,  IRZM,   IZAS,   AWR, EFIS, ECAP, DCA,
CL    TEMP6,  TEMP7, TEMP8, TEMP9, TEMP10,   KBR, ICHI,  LIN, LEL,      -
CL     LN2N,   JSXL,  JSXH,  JDNL,   JDNH, NBINT, NBTEM                  -
C                                                                         -
CD    ISOID             ISOTOPE NUMBER                                    -
CD    ISONME            ISOTOPE NAME (A6)                                 -
CD    TDC               TEMPERATURE (DEGREES CENTIGRADE)                  -
CD    IRZM              INDEX TO REGION, ZONE, OR MATERIAL IF THIS DATA-
CD                          HAS BEEN AVERAGED OVER A SPECTRUM AND         -
CD                          COMPOSITION FOR A PARTICULAR REACTOR REGION,
CD                          ZONE, OR MATERIAL                             -
CD    IZAS              INTEGER Z,A, STATE NUMBER.  IZAS=10000*Z+10*A+S-
CD                          WHERE Z= ATOMIC NUMBER, A= ATOMIC WEIGHT,     -
CD                          AND S= FINAL STATE NUMBER (0= GROUND STATE)-
CD    AWR               RATIO OF ISOTOPE ATOMIC WEIGHT TO THAT OF A       -
CD                          NEUTRON                                       -
CD    EFIS              FISSION ENERGY (WATT SECONDS PER FISSION)         -
CD    ECAP              CAPTURE ENERGY (WATT SECONDS PER CAPTURE)         -
CD    DCA               DECAY CONSTANT FOR ISOTOPE (PER SECOND)           -
CD    TEMP6,TEMP10      UNDEFINED                                         -
CD    KBR               MATERIAL TYE FLAG                                 -
CD                          0=UNDEFINED                                   -
CD                          1=FISSILE                                     -
CD                          2=FERTILE                                     -
CD                          3=OTHER HEAVY MATERIAL                        -
CD                          4=STRUCTURAL                                  -
CD                          5=FISSION PRODUCT                             -
CD    ICHI              FISSION FLAG FOR ISOTOPE                          -
CD                         -1=FISSIONABLE, USE SET CHIS                   -
CD                          0=NONFISSIONABLE                              -
CD                        NGS=INCIDENT ENERGY DEPENDENT                   -
CD                          1=NOT INCIDENT ENERGY DEPENDENT               -
CD    LIN               MAXIMUM ORDER OF INELASTIC SCATTERING             -
CD                          0=ISOTROPIC                                   -
CD                          1=ONE                                         -
CD                       NTAB=NUMBER OF TABLES GIVEN                      -
CD    LEL               MAXIMUM ORDER OF ELASTIC SCATTERING               -
CD                          SAME OTIONS AS LIN                            -
CD    LN2N              MAXIMUM ORDER OF N2N SCATTERING                   -
CD                          SAME OPTIONS AS LIN                           -
CD    JSXL              LOWEST GROUP AT WHICH SECONDARY CROSS-SECTION      -
CD                          DATA GIVEN                                    -
CD    JSXH              HIGHEST GROUP AT WHICH SECONDARY CROSS-SECTION     -
CD                          DATA GIVEN                                    -
CD    JDNL              LOWEST GROUP AT WHICH DELAYED NEUTRON SPECTRA      -
CD                          ARE GIVEN                                     -
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CD     JDNH                HIGHEST GROUP AT WHICH DLAYED NEUTRON SPECTRA  -
CD                             ARE GIVEN                                  -
CD     NBINT               NUMBER OF VALUES OF SIGPO AT WHICH BONDARENKO   -
CD                             SELF-SHIELDING FACTORS ARE GIVEN           -
CD     NBTEM               NUMBER OF TEMPERATURES AT WHICH BONDARENKO      -
CD                             SELF-SHIELDING FACTORS ARE GIVEN           -
C                                                                         -
C-------------------------------------------------------------------------


C-------------------------------------------------------------------------
CR     ISOTOPE FISSION SPECTRUM   READ IF IRD(6).EQ.1 AND IFIS(I).GT.0    -
C                                                                         -
CL     ((CHI(K,J),K=1,IFIS(I)),J=1,NGS)                                   -
C                                                                         -
CD     CHI(K,J)            FISSION SPECTRUM INCIDENT IN GROUP K, BORN      -
CD                             IN GROUP J                                 -
C                                                                         -
C-------------------------------------------------------------------------


C-------------------------------------------------------------------------
CR           DELAYED NEUTRON ABUNDANCES  READ IF IRD(7).EQ.1 AND          -
CR                                       IFIS.NE.0 AND NDGS.GT.0          -
C                                                                         -
CL     DNAB(I),I=1,NDGS                                                   -
C                                                                         -
CD     DNAB                DELAYED NEUTRON ABUNDANCES                     -
C                                                                         -
C-------------------------------------------------------------------------


C-------------------------------------------------------------------------
CR     PRINCIPAL CROSS-SECTIONS       READ IF IRD(8).EQ.1                 -
C                                                                         -
CL     ((XS(I,J),I=1,IHM),J=1,NGS)                                        -
C                                                                         -
CD     XS                  PRINCIPAL CROSS-SECTIONS.  CROSS SECTIONS      -
CD                             OCCUPYING POSITIONS XS(1,J) TO XS(IHT-1,J) -
CD                             INCLUSIVELY ARE SPECIFIED BY THE POSITION  -
CD                             INDICATORS INUP, IABS, ETC., GIVEN IN THE  -
CD                             FILE DIMENSIONS AND CONTROLS RECORD.       -
CD                             POSITIONS XS(IHS,J) TO XS(IHM,J) ARE       -
CD                             OCCUPIED BY CROSS-SECTIONS FOR SCATTERING  -
CD                             FROM GROUP K TO GROUP J, WITH K=J,J-1,....  -
CD                             J-NDN,RESPECTIVELY, WHERE NDN IS THE TOTAL -
CD                             NUMBER OF ALLOWED DOWNSCATTERING TERMS.    -
CD                             IF NO UPSCATTER CROSS-SECTIONS ARE PRESENT,-
CD                             IHS= IHT+1.  UPSCATTER CROSS-SECTIONS      -
CD                             K= J,NUP,J,NUP-1,...,J+1 OCCUPY POSITIONS  -
CD                             XS(IHT+2) TO XS(IHS-1,J, RESPECTIVELY,     -
CD                             AND XS(IHT+1,J) CONTAINS THE SUM OF        -
CD                             SCATTERING CROSS-SECTIONS FROM GROUP J TO  -
CD                             GROUPS OF HIGHER ENERGY.  NUP IS THE TOTAL -
CD                             NUMBER OF ALLOWED UPSCATTER TERMS.         -
C                                                                         -
C-------------------------------------------------------------------------


C-------------------------------------------------------------------------
CR     INELASTIC SCATTERING CROSS-SECTIONS   READ IF IRD(9).EQ.1          -
C                                                                         -
CL     (XS(J,NUP,J),XS(J,NUP-1,J),...,XS(J,J),...,XS(J-NDN,J),J=1,NGS)    -
C                                                                         -
CD     XS                  INELASTIC SCATTERING CROSS-SECTIONS            -
C                                                                         -
C-------------------------------------------------------------------------
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C-------------------------------------------------------------------------
CR    ELASTIC SCATTERING CROSS-SECTIONS     READ IF IRD(10).EQ.1          -
C                                                                         -
C           LIST SAME AS FOR INELASTIC CROSS-SECTIONS                     -
C                                                                         -
C-------------------------------------------------------------------------


C-------------------------------------------------------------------------
CR    N2N SCATTERING CROSS-SECTIONS     READ IF IRD(11).EQ.1              -
C                                                                         -
C           LIST SAME AS FOR INELASTIC CROSS-SECTIONS                     -
C                                                                         -
C-------------------------------------------------------------------------


C-------------------------------------------------------------------------
CR    SIGMAPO FACTORS FOR BONDARENKO CROSS-SECTIONS                       -
CR                                READ IF IRD(12).EQ.1 AND NINT.NE.0      -
C                                                                         -
CL    X(I),I=1,NINT                                                       -
C                                                                         -
CD    X                   VALUES OF LN(SIGP0)/LN(10) FOR WHICH BONDARENKO-
CD                            CROSS-SECTIONS ARE GIVEN                    -
C                                                                         -
C-------------------------------------------------------------------------


C-------------------------------------------------------------------------
CR    BONDARENKO TEMPERATURES  READ IF IRD(12).EQ.1 AND NTEM.NE.0         -
C                                                                         -
CL    TB(I),I=1,NTEM                                                      -
C                                                                         -
CD    TB                  TEMPERATURES AT WHICH BONDARENKO CROSS-SECTIONS-
CD                            ARE GIVEN                                   -
C                                                                         -
C-------------------------------------------------------------------------


C-------------------------------------------------------------------------
CR    BONDARENKO SELF-SHIELDING FACTORS   READ IF IRD(12).EQ.1 AND        -
CR                                        NINT.NE.0 AND NTEM.NE.0         -
C                                                                         -
CL    ((FTOT(N,K,J),FCAP(N,K,J),FFIS(N,K,J),FTR(N,K,J),FEL(N,K,J),        -
CL    N=1,NINT),K=1,NTEM),J=1,NGS)                                        -
C                                                                         -
CD    FTOT                TOTAL SELF-SHIELDING FACTOR FOR GROUP J, SIGP0 -
CD                            FACTOR N, AND TEMPERATURE K                 -
CD    FCAP                CAPTURE SELF-SHIELDING FACTOR                   -
CD                        FISSION SELF-SHIELDING FACTOR                   -
CD    FTR                 TRANSPORT SELF-SHIELDING FACTOR                 -
CD    FEL                 ELASTIC SELF-SHIELDING FACTOR                   -
C                                                                         -
C-------------------------------------------------------------------------


C-------------------------------------------------------------------------
CR    BONDARENKO CROSS-SECTIONS       READ IF IRD(12).EQ.1 AND NINT.NE.0-
CR                                    AND NTEM.NE.0                       -
C                                                                         -
CL    (XSP0(J),XSIN(J),XSE(J),XSMU(J),XSXI(J),XSED(J),J=1,NGS)            -
C                                                                         -
CD    XSP0                POTENTIAL SCATTERING                            -
CD    XSIN                INELASTIC CROSS-SECTION                         -
CD    XSE                 ELASTIC CROSS-SECTION                           -
CD    XSMU                AVERAGE COSINE OF SCATTERING ANGLE              -
CD    XSXI                AVERAGE ELASTIC SCATTERING LETHARGY INCREMENT   -
CD    XSED                ELASTIC DOWNSCATTERING TO ADJACENT GROUP         -
C                                                                         -
C-------------------------------------------------------------------------
CEOF
```

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C*************************************************************************
C                                                                        -
CF     PERTMTGP FILE                                                     -
CE     PERTURBED MULTIGRP FILE                                           -
C                                                                        -
C*************************************************************************

C------------------------------------------------------------------------
C                                                                        -
C      SAME STRUCTURE AS MULTIGRP FILE.                                  -
C                                                                        -
C------------------------------------------------------------------------
CEOF

C*************************************************************************
C                                                                        -
CF      ZONEDENS FILE                                                    -
C                                                                        -
C*************************************************************************

C------------------------------------------------------------------------
CR     ATOM DENSITIES                                                    -
C                                                                        -
CL     ((ADEN(I,J),I=1,ML),J=1,IZN)                                      -
C                                                                        -
CD     ADEN              ATOM DENSITIES BY ISOTOPE AND ZONE              -
CD     ML                ML=NCR+NSF                                      -
C                                                                        -
C------------------------------------------------------------------------
CEOF

C*************************************************************************
C                                                                        -
CF           ETX INPT                                                    -
CE           ETOX CODE-DEPENDENT INPUT DATA FILE                         -
C                                                                        -
C*************************************************************************

C------------------------------------------------------------------------
CR           RECORD CONTROL                                              -
C                                                                        -
CC           READ IF IREAD(11).EQ.3                                      -
C                                                                        -
CL     (IRD(J),J=1,3)                                                    -
C                                                                        -
CD     IRD(J)         READ RECORD J FROM CARDS (1/0=YES/NO).  IF IREAD(11)-
CD                    .EQ.1, ALL THE IRD(J) ARE SET INTERNALLY TO 1.  IF -
CD                    IREAD(11) IS EQUAL TO 2 OR 4, OMIT ALL CARD INPUT  -
CD                    FOR THE ETX INPT FILE.                             -
CD     IREAD(11)      SEE CARD INPUT FILE CONTROLS                       -
C                                                                        -
C------------------------------------------------------------------------
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C-----------------------------------------------------------------------
CR          DATA COMMON TO ALL ISOTOPES TO BE PROCESSED                 -
C                                                                       -
CC          READ IF IRD(1).EQ.1                                         -
C                                                                       -
CL    NISO,IDTAP,NG,LN5                                                 -
C                                                                       -
CL    (EG(I),I=1,NG1)   READ IF NISO.GT.0                               -
C                                                                       -
CD    NISO     TOTAL NUMBER OF ISOTOPES TO BE PROCESSED.  ISOTOPES MUST -
CD             BE PROCESSED IN THE SAME RELATIVE ORDER AS THEY OCCUR    -
CD             ON THE ENDF/B TAPE.                                      -
CD    IDTAP    ENDF/B DATA TAPE I.D. NUMBER (IDTAP.GE.1.AND.IDTAP.LE.   -
CD             9999).  ENDF/B DATA TAPE MUST BE MODE 1 (STANDARD BINARY)-
CD             AND MUST BE ASSIGNED TO LOGICAL UNIT TAPE48.             -
CD    NG       NUMBER OF ENERGY GROUPS OF OUTPUT CROSS SECTIONS (NG.GE.5-
CD             .AND.NG.LE.99).  IF AN ETOX LIBRARY IS TO BE UPDATED, NG -
CD             MUST BE THE SAME AS THAT FOR ISOTOPES ALREADY IN THE     -
CD             LIBRARY.                                                 -
CD    LN5      NUMBER OF DOWNSCATTERING GROUPS (INCLUDING SELF-SCATTER) -
CD             OF OUTPUT CROSS SECTIONS (LN5.GE.1.AND.LN5.LE.NG).  IF   -
CD             AN ETOX LIBRARY IS TO BE UPDATED, LN5 MUST BE THE SAME   -
CD             AS THAT FOR ISOTOPES ALREADY IN THE LIBRARY.             -
CD    EG(I)    GROUP BOUNDARIES (EV) BEGINNING WITH LOWEST ENERGY.      -
CD             EG(1)=0 IS NOT ALLOWED.                                  -
CD    NG1      = NG+1                                                   -
C                                                                       -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR          ISOTOPE-DEPENDENT DATA                                      -
C                                                                       -
CC          READ IF NISO.GT.0.AND.IRD(2).EQ.1                           -
C                                                                       -
CC    DO 5 N=1,NISO                                                     -
C                                                                       -
CL    (DESCRI(I),I=1,12),NAMEI,MAT1I,NTEMP,NSIGO,LN6                    -
C                                                                       -
CL  5 EMAXFF,EMINFF,EMN1EF,CFF,DELMAX,DELUMX,ANFMPD,EPS,(TT(I),I=1,      -
CL    NTEMP),(SIGO(I),I=1,NSIGO)                                        -
C                                                                       -
CD    DESCRI(I)    TITLE (TWELVE 6-CHARACTER WORDS)                     -
CD    NAMEI        ISOTOPE NAME (ONE 6-CHARACTER WORD)                  -
CD    MAT1I        ENDF/B ISOTOPE I.D. NUMBER (MAT1I.GE.1.AND.MAT1I.    -
CD                 LE.9999).                                            -
CD    NTEMP        NUMBER OF TEMPERATURES AT WHICH SELF-SHIELDING       -
CD                 FACTORS ARE TO BE CALCULATED (NTEMP.EQ.1.OR.NTEMP.EQ -
CD                 .3).                                                 -
CD    NSIGO        NUMBER OF *SIGMA ZERO* VALUES AT WHICH SELF-SHIELDING-
CD                 FACTORS ARE TO BE CALCULATED (NSIGO.GE.1.AND.NSIGO.  -
CD                 LE.6).                                               -
CD    LN6          1/0=CALCULATE AND PRINT FISSION FRACTIONS/NO         -
CD    EMAXFF       MAXIMUM ENERGY (EV) FOR SELF-SHIELDING FACTOR        -
CD                 CALCULATIONS (EMAXFF.GE.0).                          -
CD    EMINFF       MINIMUM ENERGY (EV) FOR SELF-SHIELDING FACTOR        -
CD                 CALCULATIONS (EMINFF.GE.0.AND.EMINFF.LE.EMAXFF).     -
CD    EMN1EF       MINIMUM ENERGY (EV) FOR WHICH FISSION SPECTRUM IS     -
CD                 USED AS THE WEIGHTING SPECTRUM (EMN1EF.GE.2.0E+06).  -
CD    CFF          FISSION SPECTRUM CONSTANT (EV).  CFF.GE.1.0E+06.AND. -
CD                 CFF.LE.2.0E+06.                                      -
CD    DELMAX       MAXIMUM LETHARGY SIZE FOR FINE GROUPS (DELMAX.GE.    -
CD                 0.005.AND.DELMAX.LE.0.1).                            -
CD    DELUMX       MAXIMUM LETHARGY SIZE FOR UNRESOLVED GROUPS (DELUMX. -
CD                 GE.0.007.AND.DELUMX.LE.0.25).                        -
CD    ANFMPD       NUMBER OF FINE-GROUP POINTS PER ENDF/B SIGMA TOTAL   -
CD                 DATA POINTS (ANFMPD.GE.0.5.AND.ANFMPD.LE.5).         -
CD    EPS          ACCURACY PARAMETER FOR ROMBERG INTEGRATION (EPS.GE.  -
CD                 0.00001.AND.EPS.LE.0.1).                             -
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CD     TT(I)        TEMPERATURES (DEG K) FOR WHICH SELF-SHIELDING FACTORS-
CD                  ARE TO BE CALCULATED (TT(I).GE.273.AND.TT(I).LE.5000)-
CD                  VALUES MUST BE GIVEN IN INCREASING ORDER.            -
CD     SIGO(I)      *SIGMA ZERO* VALUES (BARNS) FOR WHICH SELF-SHIELDING -
CD                  FACTORS ARE TO BE CALCULATED (SIGO(I).GT.0).  VALUES -
CD                  MUST BE GIVEN IN INCREASING ORDER.                   -
C                                                                        -
C-------------------------------------------------------------------------

C-------------------------------------------------------------------------
CR           ETOX LIBRARY UPDATE DATA                                    -
C                                                                        -
CC           READ IF IRD(3).EQ.1                                         -
C                                                                        -
CL     NUP,NUP1,NUP2,NPR,NPR1,NPR2,NLAST                                 -
C                                                                        -
CD     NUP       1/0=PRODUCE AN UPDATED LIBRARY OF ETOX CROSS SECTIONS/NO -
CD                   IF NUP=1, CROSS SECTIONS FOR NISO=NUP2-NUP1+1       -
CD                   ISOTOPES MUST HAVE BEEN GENERATED IN THE CURRENT RUN.-
CD                   THE OUTPUT LIBRARY IS WRITTEN ON LOGICAL UNIT TAPE46.-
CD     NUP1      LIBRARY SEQUENCE NUMBER OF FIRST ISOTOPE TO BE UPDATED.  -
CD               NOT USED IF NUP=0.  IF NUP=1 AND NLAST=0, SET NUP1=1.    -
CD     NUP2      LIBRARY SEQUENCE NUMBER OF LAST ISOTOPE TO BE UPDATED.   -
CD               NOT USED IF NUP=0.  IF NUP=1 AND NLAST=0, SET NUP2=NISO. -
CD     NPR       1/0=PRINT CROSS SECTIONS/NO.  PRINT IS ALWAYS FROM       -
CD                   LIBRARY ON LOGICAL UNIT TAPE46.                     -
CD     NPR1      LIBRARY SEQUENCE NUMBER OF FIRST ISOTOPE TO BE PRINTED.  -
CD               NOT USED IF NPR=0.                                       -
CD     NPR2      LIBRARY SEQUENCE NUMBER OF LAST ISOTOPE TO BE PRINTED.   -
CD               NOT USED IF NPR=0.                                       -
CD     NLAST     TOTAL NUMBER OF ISOTOPES ON THE INPUT LIBRARY.  IF NLAST -
CD               .GT.0.AND.NUP.EQ.1, INPUT LIBRARY MUST BE ASSIGNED TO    -
CD               LOGICAL UNIT TAPE47.  IF NUP.EQ.0.AND.NPR.EQ.1, INPUT    -
CD               LIBRARY MUST BE ASSIGNED TO LOGICAL UNIT TAPE46.         -
C                                                                        -
C-------------------------------------------------------------------------
CEOF
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C************************************************************************
C                                                                       -
CF           ODX INPT                                                   -
CE           IDX CODE-DEPENDENT INPUT DATA FILE                         -
C                                                                       -
C************************************************************************

C-------------------------------------------------------------------------
CR           RECORD CONTROL                                             -
C                                                                       -
CC           READ IF IREAD(12).EQ.3                                     -
C                                                                       -
CL     (IRD(J),J=1,7)                                                   -
C                                                                       -
CD     IRD(J)         READ RECORD J FROM CARDS (1/0=YES/NO).  IF IREAD(12)-
CD                    .EQ.1, ALL THE IRD(J) ARE SET INTERNALLY TO 1.  IF -
CD                    IREAD(12) IS EQUAL TO 2 OR 4, OMIT ALL CARD INPUT  -
CD                    FOR THE ODX INPT FILE.                             -
CD     IREAD(12)      SEE CARD INPUT FILE CONTROLS                       -
C                                                                       -
C-------------------------------------------------------------------------
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C-----------------------------------------------------------------------
CR          TITLE AND CONTROL PARAMETERS                               -
C                                                                      -
CC          READ IF IRD(1).EQ.1                                        -
C                                                                      -
CL    (ID(I),I=1,11),MAXT,NXCM,NPRT,NRCF,NIFF,MM01,NCR,NTR,            -
CL    NFGM,IPUN,MULT1,MULT2                                            -
C                                                                      -
CD    ID(I)    TITLE (ELEVEN 6-CHARACTER WORDS)                        -
CD    MAXT     MAXIMUM RUNNING TIME (MIN) FOR JOB (NOT USED IF ZERO)   -
CD    NXCM     NUMBER OF DOWNSCATTER GROUPS IN CROSS SECTIONS          -
CD    NPRT     0/1/2=DELETE PRINTING OF XSEC DATA AND FLUXES(MINI PRINT)-
CD                   /DELETE PRINTING OF INPUT XSECS IN BONDARENKO     -
CD                   FORMAT(MIDI PRINT)/FULL PRINT(MAXI PRINT)         -
CD    NRCF     NUMBER OF MIXES USED IN GENERATING RESONANCE SHIELDED   -
CD             XSECS.  IF NRCF.GT.0, XSEC INPUT MUST BE IN THE         -
CD             BONDARENKO FORMAT FROM AN ETOX LIBRARY TAPE ON LOGICAL  -
CD             UNIT TAPE46.  THE NRCF MIXTURES MUST BE SPECIFIED FIRST -
CD             IN THE I0 TABLE (SEE MM01 BELOW).  IF NRCF=0, XSECS ARE -
CD             READ FROM MULTIGRP.  I0 TABLE IS SPECIFIED IN MIX DATA  -
CD             FILE.                                                   -
CD    NIFF     NUMBER OF SPECTRUM ITERATIONS IN THE CALCULATION OF     -
CD             ELASTIC DOWNSCATTERING.  RECOMMENDED VALUE NIFF=0.      -
CD             NOT USED IF NRCF=0 AND SET TO ZERO INTERNALLY IF IA02=1  -
CD             (ADJOINT CALCULATION).                                  -
CD    MM01     LENGTH OF I0 TABLE FOR THE FIRST NRCF MIXTURES I.E.     -
CD             NUMBER OF MIXTURE SPECIFICATIONS FOR GENERATING RESONANCE-
CD             SHIELDED CROSS SECTIONS (MM01.LE.M01).  SET MM01=0 IF   -
CD             NRCF=0.  M01 IS SPECIFIED IN THE ADMNSTR FILE.          -
CD    NCR      NUMBER OF COLLAPSED GROUPS.  IF NCR.GT.IGM, NO GROUP    -
CD             COLLAPSING CALCULATION IS DONE.  MULTIGRP FILE IS       -
CD             WRITTEN ONLY IF NCR.LE.IGM.  IGM IS SPECIFIED IN ADMNSTR -
CD             FILE.                                                   -
CD    NTR      TYPE WEIGHTING FOR COLLAPSED SIGMA TRANSPORT (0/1=      -
CD             NORMALIZED/RECIPROCAL)                                  -
CD    NFGM     NUMBER OF COLLAPSED MATERIALS (NOT USED IF NCR.GT.IGM)  -
CD    IPUN     0/1=PRINT COLLAPSED XSEC DATA/NO                        -
CD    MULT1    0/1=MULTIGRP/PERTMTGP TO BE READ (USED ONLY IF NRCF=0).  -
CD    MULT2    0/1=MULTIGRP/PERTMTGP TO BE WRITTEN (USED ONLY IF       -
CD             NCR.LE.IGM).                                            -
C                                                                      -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR          BUCKLING MODIFIERS                                         -
C                                                                      -
CC          READ IF (IEVT.EQ.5.OR.(IBK.EQ.-1.AND.BK.NE.0.0)).AND.IRD(2)-
CC          .EQ.1                                                      -
C                                                                      -
CL    (GAM(I),I=1,IZM)                                                 -
C                                                                      -
CD    GAM(I)  BUCKLING MODIFIERS BY ZONE                               -
CD    BK      BUCKLING (SINGLE VALUE) FROM GEO DIST FILE               -
CD    IEVT, IZM, AND IBK ARE SPECIFIED IN ADMNSTR FILE.                -
C                                                                      -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          FISSION FRACTIONS AND VELOCITIES                           -
C                                                                      -
CC          READ IF NRCF.GT.0.AND.IRD(3).EQ.1                          -
C                                                                      -
CL    (K7(I),I=1,IGM),(V7(I),I=1,IGM)                                  -
C                                                                      -
CD    K7(I)    FISSION FRACTION BY GROUP                               -
CD    V7(I)    VELOCITY BY GROUP                                       -
CD    IGM      NUMBER OF ENERGY GROUPS (SPECIFIED IN ADMNSTR FILE)     -
C                                                                      -
C-----------------------------------------------------------------------
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C-----------------------------------------------------------------------
CR          ZONE MODIFIERS                                             -
C                                                                      -
CC          READ IF IEVT.EQ.4.AND.IRD(4).EQ.1                          -
C                                                                      -
CL    (R3(I),I=1,IZM)                                                  -
C                                                                      -
CD    R3(I)    ZONE MODIFIER FOR ZONE I.  IF R3(I)=0. WIDTH OF ZONE I  -
CD             IS HELD CONSTANT.                                       -
C                                                                      -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          DATA FOR XSEC GROUP COLLAPSING                             -
C                                                                      -
CC          READ IF NCR.LE.IGM.AND.IRD(5).EQ.1                         -
C                                                                      -
CL    (NPN(I),I=1,NCR),(NFP(I),I=1,NFGM),(NZN(I),I=1,NFGM)             -
C                                                                      -
CD    NPN(I)   NUMBER OF ORIGINAL GROUPS IN ITH COLLAPSED GROUP        -
CD    NFP(I)   REFERENCE I.D. NUMBER OF ITH MATERIAL TO BE COLLAPSED   -
CD    NZN(I)   ZONE NUMBER OF FLUXES TO BE USED FOR COLLAPSING ITH     -
CD             MATERIAL                                                -
C                                                                      -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR          DATA FOR RESONANCE SHIELDING CALCULATIONS                  -
C                                                                      -
CC          READ IF NRCF.GT.0.AND.IRD(6).EQ.1                          -
C                                                                      -
CL    (NZ(I),I=1,NRCF),(HETC(I),I=1,NRCF),(J1(I),I=1,MM01),            -
CL    (ATEM(I),I=1,MM01),(MF(I),I=1,MM01),(U7(I),I=1,IGM)              -
C                                                                      -
CD    NZ(I)     ZONE NUMBER OF FLUXES TO BE USED IN ELASTIC DOWNSCATTER -
CD              ITERATIONS FOR ITH MIX                                 -
CD    HETC(I)   HETEROGENEITY CONSTANT (CM) FOR ITH MIX                -
CD    J1(I)     MIX COMMANDS SIMILAR TO I1 TABLE                       -
CD    ATEM(I)   TEMPERATURE (DEG K) OF NUCLIDES IN J1 TABLE            -
CD    MF(I)     0/1=FUEL/MODERATOR DESIGNATION FOR NUCLIDES IN J1 TABLE -
CD    U7(I)     LETHARGY WIDTH BY GROUP                                -
CD    MIXTURES IN THIS RECORD REFER TO THE NRCF MIXES USED IN          -
CD    GENERATING RESONANCE SHIELDED XSECS.  SEE BNWL-954 FOR EXAMPLE   -
CD    ON HOW TO SET UP J1 TABLE.                                       -
C                                                                      -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR          EXTRA DATA NEEDED FOR WRITING MULTIGRP FILE AFTER          -
CR          GROUP COLLAPSING                                           -
C                                                                      -
CC          READ IF NCR.LE.IGM.AND.IRD(7).EQ.1                         -
C                                                                      -
CL    NFAM,(ISONME(I),AWR(I),DCA(I),EFIS(I),ECAP(I),TDC(I),IZAS(I),    -
CL    KBR(I),ICHI(I),I=1,NFGM)                                         -
C                                                                      -
CL    (DNDC(N),N=1,NFAM)       READ IF NFAM.GT.0                     -
C                                                                      -
CC    DO 5 I=1,NFGM                                                    -
C                                                                      -
CL    ((CHI(I,J,K),J=1,ICHI(I)),K=1,NCR)   READ IF ICHI(I).GT.0        -
C                                                                      -
CL  5 ((DNCHI(I,J,N),J=1,NCR),N=1,NFAM)   READ IF ICHI(I).NE.0.AND.
CL                                        NFAM.GT.0                    -
C                                                                      -
CD    NFAM      NUMBER OF DELAYED NEUTRON FAMILIES                     -
CD    ISONME(I) 6-CHARACTER NAME FOR COLLAPSED ISOTOPE I               -
CD    AWR(I)    RATIO OF COLLAPSED ISOTOPE ATOMIC WEIGHT TO THAT OF    -
CD              NEUTRON                                                -
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CD     DCA(I)    DECAY CONSTANT (1/SEC) FOR COLLAPSED ISOTOPE I          -
CD     EFIS(I)   FISSION ENERGY (W-SEC/FISS) FOR COLLAPSED ISOTOPE I     -
CD     ECAP(I)   CAPTURE ENERGY (W-SEC/CAP) FOR COLLAPSED ISOTOPE I      -
CD     TDC(I)    TEMPERATURE (DEG C) FOR COLLAPSED ISOTOPE I             -
CD     IZAS(I)   1000*Z+10*A+S WHERE Z=ATOMIC NO. A=ATOMIC WT. AND S=    -
CD               FINAL STATE NO (0=GD STATE) FOR COLLAPSED ISOTOPE I     -
CD     KBR(I)    MATERIAL TYPE FLAG FOR COLLAPSED ISOTOPE I              -
CD               0/1/2/3/4/5=UNDEFINED/FISSILE/FERTILE/OTHER HEAVY       -
CD                          MATERIAL/STRUCTURAL/FISSION PRODUCT          -
CD     ICHI(I)   FISSION FLAG FOR COLLAPSED ISOTOPE I                    -
CD                  -1=FISSIONABLE-USE CHI FOR SET                       -
CD                   0=NONFISSIONABLE                                    -
CD                   1=FISSIONABLE-CHI NOT INCIDENT ENERGY DEPENDENT     -
CD                 NCR=FISSIONABLE-CHI IS INCIDENT ENERGY DEPENDENT      -
CD     DNDC(N)   DECAY CONSTANT (1/SEC) FOR DELAYED NEUTRON PRECURSORS   -
CD               IN FAMILY N.                                            -
CD     CHI(I,J,K)   FISSION SPECTRUM FOR ISOTOPE I.  GIVEN AS THE        -
CD                  FRACTION OF FISSION NEUTRONS BORN IN GROUP K WHEN    -
CD                  THE INCIDENT NEUTRON IS IN GROUP J.  IF ICHI(I)=1.   -
CD                  CHI IS NOT INCIDENT ENERGY DEPENDENT.                -
CD     DNCHI(I,J,N)   DELAYED NEUTRON SPECTRUM FOR ISOTOPE I.  GIVEN AS -
CD                    THE FRACTION OF DELAYED NEUTRONS ASSOCIATED WITH   -
CD                    FAMILY N WHICH ENTER GROUP J.  THE SUM OF          -
CD                    DNCHI(I,J,N) OVER ALL J IS THE YIELD FOR FAMILY N.-
C                                                                         -
C-------------------------------------------------------------------------
CEOF
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C*************************************************************************
C                                                                         -
CF          ANI INPT                                                      -
CE          ANISN CODE-DEPENDENT INPUT DATA FILE                          -
C                                                                         -
C*************************************************************************

C-------------------------------------------------------------------------
CR          RECORD CONTROL                                                -
C                                                                         -
CC          READ IF IREAD(13).EQ.3                                        -
C                                                                         -
CL     (IRD(J),J=1,9)                                                     -
C                                                                         -
CD     IRD(J)        READ RECORD J FROM CARDS (1/0=YES/NO).  IF IREAD(13)-
CD                   .EQ.1. ALL THE IRD(J) ARE SET INTERNALLY TO 1.  IF  -
CD                   IREAD(13) IS EQUAL TO 2 OR 4, OMIT ALL CARD INPUT   -
CD                   FOR THE ANI INPT FILE.                              -
CD     IREAD(13)     SEE CARD INPUT FILE CONTROLS.                       -
C                                                                         -
C-------------------------------------------------------------------------

C-------------------------------------------------------------------------
CR          CONTROL PARAMETERS                                            -
C                                                                         -
CC          READ IF IRD(1).EQ.1                                           -
C                                                                         -
CL     (T(I),I=1,12),ID,IHT,IHS,IHM,IDFM,IPM,IPP,ID1,ID3,ID4,IDAT2,       -
CL     IFG,IFLU,IFN,IPRT,DFM1,NYF                                         -
C                                                                         -
CD     T(I)      TITLE (TWELVE 6-CHARACTER WORDS)                        -
CD     ID        PROBLEM ID NUMBER                                       -
CD     IHT       CROSS SECTION TABLE POSITION OF SIGMA TOTAL             -
CD     IHS       CROSS SECTION TABLE POSITION OF SELF SCATTER SIGMA      -
CD     IHM       CROSS SECTION TABLE LENGTH                              -
CD     IDFM      1/0=DENSITY FACTORS USED/NO                             -
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CD     IPM      IM/1/0=ENTER SHELL SOURCE BY INTERVAL,GROUP, AND ANGLE/  -
CD                    BY GROUP AND ANGLE ONLY/NONE                      -
CD     IPP      INTERVAL NUMBER THAT CONTAINS SHELL SOURCE IF IPM=1       -
CD     ID1      1/0=PRINT ANGULAR FLUX/NO                                -
CD     ID3      N/0=COMPUTE N ACTIVITIES BY ZONE/NO ACTIVITIES           -
CD     ID4      1/0=COMPUTE N ACTIVITIES BY INTERVAL WHERE N REFERS      -
CD                   TO ID3/NO                                          -
CD     IDAT2    1/0=EXECUTE DIFFUSION SOLUTION FOR SPECIFIED GROUPS/NO   -
CD     IFG      1/0=COLLAPSE CROSS SECTIONS/NO                           -
CD     IFLU     0/1/2=STEP MODEL USED WHEN LINEAR EXTRAPOLATION YIELDS   -
CD                    NEGATIVE FLUX (MIXED MODE)/USE LINEAR MODEL ONLY/  -
CD                    USE STEP MODEL ONLY                                -
CD     IFN      1/0=USE FLUX GUESS/FISSION GUESS.  FLUX GUESS TAKEN FROM -
CD                  GRP FLXS FILE. FISSION GUESS MUST BE ENTERED FROM    -
CD                  CARDS.                                               -
CD     IPRT     0/1=PRINT CROSS SECTIONS/NO                              -
CD     DFM1     TRANSVERSE DIMENSION FOR VOID STREAMING CORRECTION       -
CD     RYF      NORMALLY 0.5.  EPS/RYF IS USED AS CONVERGENCE CRITERION  -
CD              ON SCATTERING (TOTAL AND UP)                             -
C                                                                        -
C-------------------------------------------------------------------------

C-------------------------------------------------------------------------
CR           FIXED SOURCE                                                -
C                                                                        -
CC           READ IF IEVT.EQ.0.AND.IRD(2).EQ.1                           -
C                                                                        -
CL     ((QD(I,J),I=1,IM),J=1,IGM)   READ IF M06.EQ.11                    -
C                                                                        -
CL     (((QS(M,I,J),M=1,MM),I=1,IPM),J=1,IGM)   READ IF IPM.GT.0         -
C                                                                        -
CD     QD(I,J)       DISTRIBUTED SOURCE FOR INTERVAL I AND GROUP J       -
CD     QS(M,I,J)     SHELL SOURCE FOR DIRECTION M, INTERVAL I, AND       -
CD                   GROUP J                                            -
CD     QD AND QS CANNOT BOTH BE PRESENT IN THE SAME PROBLEM.             -
CD     MM       NUMBER OF ANGULAR DIRECTIONS.                           -
CD     IEVT, IM, IGM, AND M06 ARE SPECIFIED IN THE ADMNSTR FILE.         -
C                                                                        -
C-------------------------------------------------------------------------

C-------------------------------------------------------------------------
CR           FISSION GUESS                                               -
C                                                                        -
CC           READ IF IFN.EQ.0.AND.IRD(3).EQ.1                            -
C                                                                        -
CL     (FD(I),I=1,IM)                                                    -
C                                                                        -
CD     FD(I)   FISSION DENSITY BY INTERVAL                               -
C                                                                        -
C-------------------------------------------------------------------------

C-------------------------------------------------------------------------
CR           RADIUS MODIFIERS                                            -
C                                                                        -
CC           READ IF IEVT.EQ.4.AND.IRD(4).EQ.1                           -
C                                                                        -
CL     (RM(I),I=1,IZM)                                                   -
C                                                                        -
CD     RM(I)   RADIUS MODIFIERS BY ZONE                                  -
CD     IEVT AND IZM ARE SPECIFIED IN THE ADMNSTR FILE.                   -
C                                                                        -
C-------------------------------------------------------------------------

C-------------------------------------------------------------------------
CR           DENSITY FACTORS                                             -
C                                                                        -
CC           READ IF IDFM.EQ.1.AND.IRD(5).EQ.1                           -
C                                                                        -
CL     (DF(I),I=1,IM)                                                    -
C                                                                        -
CD     DF(I)   DENSITY FACTORS BY INTERVAL                               -
CD     IM      SPECIFIED IN THE ADMNSTR FILE.                            -
C                                                                        -
C-------------------------------------------------------------------------
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C-----------------------------------------------------------------------
CR          ACTIVITY DATA                                              -
C                                                                      -
CC          READ IF ID3.GT.0.AND.IRD(6).EQ.1                           -
C                                                                      -
CL    (J3(I),I=1,ID3),(J4(I),I=1,ID3)                                  -
C                                                                      -
CD    J3(I)    MATERIAL NUMBERS FOR ACTIVITIES                         -
CD    J4(I)    CROSS SECTION TABLE POSITION FOR ACTIVITIES             -
C                                                                      -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          DIFFUSION MARKERS                                          -
C                                                                      -
CC          READ IF IDAT2.EQ.1.AND.IRD(7).EQ.1                         -
C                                                                      -
CL    (IGT(I),I=1,IGM)                                                 -
C                                                                      -
CD    IGT(I)      0/1=USE TRANSPORT/DIFFUSION THEORY IN GROUP I        -
CD    IGM       SPECIFIED IN ADMNSTR FILE.                             -
C                                                                      -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          ALBEDO                                                     -
C                                                                      -
CC          READ IF (IB01.EQ.3.OR.IB02.EQ.3).AND.IRD(8).EQ.1           -
C                                                                      -
CL    (ART(I),I=1,IGM),(ALFT(I),I=1,IGM)  READ IF IB01.EQ.3.AND.       -
CL                                                 IB02.EQ.3           -
CL    (ART(I),I=1,IGM)   READ IF IB02.EQ.3.AND.IB01.NE.3               -
CL    (ALFT(I),I=1,IGM)   READ IF IB01.EQ.3.AND.IB02.NE.3              -
C                                                                      -
CD    ART(I)   ALBEDO BY GROUP FOR RIGHT BOUNDARY                      -
CD    ALFT(I)  ALBEDO BY GROUP FOR LEFT BOUNDARY                       -
CD    IB01, IB02, AND IGM SPECIFIED IN ADMNSTR FILE.                   -
C                                                                      -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          GROUP COLLAPSING PARAMETERS                                -
C                                                                      -
CC          READ IF IFG.EQ.1.AND.IRD(9).EQ.1                           -
C                                                                      -
CL    ICON,IHTF,IHSF,IHMF,IPUN,(FGG(I),I=1,IGM)                        -
C                                                                      -
CD    ICON     1/2=COLLAPSE MICRO CROSS SECTIONS/MACRO (MINUS IMPLIES   -
CD                 CELL WEIGHTING)                                     -
CD    IHTF     POSITION OF SIGMA TOTAL IN COLLAPSED CROSS SECTIONS     -
CD    IHSF     POSITION OF SELF-SCATTER SIGMA IN COLLAPSED CROSS        -
CD             SECTIONS (MINUS IMPLIES UPSCATTER REMOVAL)              -
CD    IHMF     TABLE LENGTH OF COLLAPSED CROSS SECTIONS                -
CD    IPUN     1/0=PUNCH COLLAPSED CROSS SECTIONS/NO                   -
CD    FGG(I)   FEW-GROUP NUMBER FOR EACH MULTIGROUP                    -
CD    IGM      SPECIFIED IN ADMNSTR FILE.                              -
C                                                                      -
C-----------------------------------------------------------------------
CEOF
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C*****************************************************************************
C                                                                             -
CF          DOT INPT                                                          -
CE          DOT2DB CODE-DEPENDENT INPUT DATA FILE                             -
C                                                                             -
C*****************************************************************************


C-----------------------------------------------------------------------------
CR          RECORD CONTROL                                                    -
C                                                                             -
CC          READ IF IREAD(14).EQ.3                                            -
C                                                                             -
CL    (IRD(J),J=1,6)                                                          -
C                                                                             -
CD    IRD(J)        READ RECORD J FROM CARDS (1/0=YES/NO).  IF IREAD(14)-
CD                  .EQ.1, ALL THE IRD(J) ARE SET INTERNALLY TO 1.  IF  -
CD                  IREAD(14) IS EQUAL TO 2 OR 4, OMIT ALL CARD INPUT   -
CD                  FOR THE DOT INPT FILE.                              -
CD    IREAD(14)     SEE CARD INPUT FILE CONTROLS                        -
C                                                                             -
C-----------------------------------------------------------------------------


C-----------------------------------------------------------------------------
CR          CONTROL PARAMETERS                                                -
C                                                                             -
CC          READ IF IRD(1).EQ.1                                               -
C                                                                             -
CL    (ID(I),I=1,12),A01,FXT,IHT,IHS,ITL,M05,S04,IAFT,M04,M06,IB01,     -
CL    IB02,IB03,IB04                                                          -
C                                                                             -
CD    ID                  TITLE (TWELVE 6-CHARACTER WORDS)                  -
CD    A01                 PROBLEM I.D. NUMBER                               -
CD    FXT                 FLUX CALCULATION MODE                             -
CD                                0=LINEAR EQUATIONS ONLY                   -
CD                                1=LINEAR MODE, RECOMPUTE NEG. FLUX        -
CD                                2=STEP FUNCTION EQUATIONS ONLY            -
CD    IHT                 CROSS SECTION TABLE POSITION OF SIGMA TOTAL       -
CD    IHS                 CROSS SECTION TABLE POSITION OF SELF SCATTER      -
CD    ITL                 CROSS SECTION TABLE LENGTH                        -
CD    M05                 NUMBER OF REGIONWISE ACTIVITIES                   -
CD    IS04                INITIAL INNER ITERATION MAXIMUM PER GROUP         -
CD    IAFT                FLUX MOMENT AND ANGULAR FLUX OUTPUT TRIGGER       -
CD                                1=NO PRINT                                -
CD                                2=PRINT                                   -
CD    M04                 NUMBER OF POINTWISE ACTIVITIES (M04.LE.M05)       -
CD    M06       DISTRIBUTED FIXED SOURCE INPUT OPTIONS                      -
CD                  -1=NO DISTRIBUTED FIXED SOURCE INPUT                    -
CD                   0=READ ONE BLOCK CONTAINING IGM WORDS                  -
CD                   1=READ IGM BLOCKS EACH CONTAINING IM*JM WORDS.         -
CD                   2=READ TWO BLOCKS WITH THE FIRST CONTAINING IGM        -
CD                     WORDS AND THE SECOND IM*JM WORDS.                    -
CD                   3=READ THREE BLOCKS CONTAINING IGM, IM, AND JM WORDS-
CD                   4=READ TWO BLOCKS FOR EACH GROUP.  THE FIRST BLOCK  -
CD                     CONTAINS IM WORDS AND THE SECOND CONTAINS JM WORDS-
CD    IB01      LEFT BOUNDARY CONDITION (0/1/2=VACUUM/REFLECT/PERIODIC).  -
CD    IB02      RIGHT BOUNDARY CONDITION (0/1/2/3/4=VACUUM/REFLECT/       -
CD              PERIODIC/WHITE/INPUT BOUNDARY SOURCE)                     -
CD    IB03      TOP BOUNDARY CONDITION (SAME OPTIONS AS IB02)             -
CD    IB04      BOTTOM BOUNDARY CONDITION (0/1/2/3=VACUUM/REFLECT/        -
CD              PERIODIC/WHITE)                                           -
CD    IGM, IM, AND JM SPECIFIED IN ADMNSTR FILE.                          -
C                                                                             -
C-----------------------------------------------------------------------------
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C-----------------------------------------------------------------------
CR          DISTRIBUTED FIXED SOURCE                                   -
C                                                                      -
CC          READ IF IEVT.EQ.0.AND.M06.GE.0.AND.IRD(2).EQ.1             -
C                                                                      -
CL    (Z(G),G=1,IGM)                          READ IF M06.EQ.0         -
C                                                                      -
CD    FIXSOR(G,I,J)=Z(G)    G=1,IGM    I=1,IM    J=1,JM              -
C                                                                      -
C     DO 1 G=1,IGM                                                     -
CL  1 READ(N) ((FIXSOR(G,I,J),I=1,IM),J=1,JM)     READ IF M06.EQ.1     -
C                                                                      -
CL    (Z(G),G=1,IGM),((XY(I,J),I=1,IM),J=1,JM)     READ IF M06.EQ.2    -
C                                                                      -
CD    FIXSOR(G,I,J)=Z(G)*XY(I,J)                                       -
C                                                                      -
CL    (Z(G),G=1,IGM),(X(I),I=1,IM),(Y(J),J=1,JM)     READ IF M06.EQ.3  -
C                                                                      -
CD    FIXSOR(G,I,J)=Z(G)*X(I)*Y(J)                                     -
C                                                                      -
C     DO 1 G=1,IGM                                                     -
CL  1 READ(N) (X(G,I),I=1,IM),(Y(G,J),J=1,JM)     READ IF M06.EQ.4     -
C                                                                      -
CD    FIXSOR(G,I,J)=X(G,I)*Y(G,J)                                      -
C                                                                      -
CD    IEVT, IGM, IM, AND JM SPECIFIED IN ADMNSTR FILE.                 -
C                                                                      -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          FIXED BOUNDARY SOURCE                                      -
C                                                                      -
CC          READ IF (IB02.EQ.4.OR.IB03.EQ.4).AND.IRD(3).EQ.1           -
C                                                                      -
CL    (S(I),I=1,IBSS)                                                  -
C                                                                      -
CD                        IBSS=0                                       -
CD                        IF(IB02.EQ.4) IBSS=(I15+IA04/2)*JM*IGM       -
CD                        IF(IB03.EQ.4) IBSS=IBSS+I15*IM*IGM           -
CD                        I15=IA04*(IA04+4)/4                          -
CD    IA04, IM, JM, AND IGM SPECIFIED IN ADMNSTR FILE.                 -
CD    SEE GEAP-13537 FOR ORDER OF SPECIFICATION OF S(I).  DISTRIBUTED  -
CD    AND BOUNDARY SOURCES CANNOT BOTH BE SPECIFIED IN THE SAME PROBLEM-
C                                                                      -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          MATERIAL NUMBERS AND TABLE POSITIONS FOR ACTIVITY CALC     -
C                                                                      -
CC          READ IF M05.GT.0.AND.IRD(4).EQ.1                           -
C                                                                      -
CL    (MN(I),I=1,M05),(NPOS(I),I=1,M05)                                -
C                                                                      -
CD    MN(I)               MATERIAL NOS. FOR ACTIVITY CALCULATION       -
CD                              +N=ACTIVITY OF MATERIAL N COMPUTED IN-
CD                                 ALL INTERVALS IN WHICH N IS        -
CD                                 PRESENT.                           -
CD                              -N=ACTIVITY OF MATERIAL N COMPUTED    -
CD                                 IN ALL INTERVALS.                  -
CD                               0=ACTIVITY COMPUTED AT EVERY         -
CD                                 INTERVAL FOR MIXTURE ASSIGNED TO   -
CD                                 THAT INTERVAL.                     -
CD    NPOS(I)             CROSS SECTION TABLE POSITIONS FOR ACTIVITY  -
CD                        CALCULATION.                                 -
C                                                                      -
C-----------------------------------------------------------------------
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C-----------------------------------------------------------------------
CR          ZONE WIDTH SEARCH PARAMETERS                               -
C                                                                      -
CC          READ IF IEVT.EQ.4.AND.IRD(15).EQ.1                         -
C                                                                      -
CL    (NPAD(I),I=1,IM),(NMOD(I),I=1,IZ),(NAXL(J),J=1,JM),             -
CL    (AMOD(J),J=1,JZ)                                                 -
C                                                                      -
CD    NRAD(I)           SPECIFIES WHICH RADIAL MODIFIER IS USED IN THE -
CD                      INTERVAL.                                      -
CD    RMOD(I)           RADIAL MODIFIERS                               -
CD    NAXL(J)           SPECIFIES WHICH AXIAL MODIFIER IS USED IN THE  -
CD                      INTERVAL.                                      -
CD    AMOD(J)           AXIAL MODIFIERS                                -
CD    IEVT, IM, IZ, JM, AND JZ SPECIFIED IN ADMNSTR FILE.              -
C                                                                      -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR          DIFFUSION MARKERS                                          -
C                                                                      -
CC          READ IF IA11.EQ.0.AND.IRD(5).EQ.1                          -
C                                                                      -
CL    (NDM(I),I=1,IGM)                                                 -
C                                                                      -
CD    NDM(I)            I=USE DIFFUSION THEORY IN GROUP I              -
CD                      0=USE TRANSPORT THEORY IN GROUP I              -
CD    IA11 AND IGM SPECIFIED IN ADMNSTR FILE.                          -
C                                                                      -
C-----------------------------------------------------------------------
CEOF

C**********************************************************************
C                                                                      -
CF          CLR INPT                                                   -
CE          CLEAR CODE-DEPENDENT INPUT DATA FILE                       -
C                                                                      -
C**********************************************************************

C-----------------------------------------------------------------------
CR          RECORD CONTROL                                             -
C                                                                      -
CC          READ IF IREAD(15).EQ.3                                     -
C                                                                      -
CL    (IRD(J),J=1,7)                                                   -
C                                                                      -
CD    IRD(J)        READ RECORD J FROM CARDS (1/0=YES/NO).  IF         -
CD                  IREAD(15).EQ.1, ALL THE IRD(J) ARE SET INTERNALLY  -
CD                  TO 1.  IF IREAD(15) IS EQUAL TO 2 OR 4, OMIT ALL   -
CD                  INPUT FOR THE CLR INPT FILE.                       -
CD    IREAD(15)     SEE CARD INPUT FILE CONTROLS                       -
C                                                                      -
C-----------------------------------------------------------------------
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C-----------------------------------------------------------------------
CR          TITLE AND NEUTRONICS SELECTION                             -
C                                                                      -
CC          READ IF IRD(1).EQ.1                                        -
C                                                                      -
CL    (TITL(I),I=1,24),LIM,SEL                                         -
C                                                                      -
CD    TITL     TITLE (TWENTY FOUR 6-CHARACTER WORDS)                   -
CD    LIM      CPU TIME LIMIT (MIN) FOR THE CALCULATION                -
CD    SEL      NEUTRONICS SELECTION (3-CHARACTER HOLLERITH WORD)        -
CD              3HZAF=NO NEUTRONICS CALCULATION, USE ZONE-AVERAGED     -
CD                   FLUXES ON INTOUANT FILE                           -
CD              3HAIM=INFINITE MEDIUM CALCULATION                      -
CD             OTHERWISE DENOTES THE PARTICULAR FLUX MODULE TO BE USED  -
CD             IN THE FUEL CYCLE CALCULATION.  3HOUX, 3HANI, AND 3HDOT  -
CD             CURRENTLY AVAILABLE.                                     -
C                                                                      -
C-----------------------------------------------------------------------
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C-----------------------------------------------------------------------
CR          INFINITE MEDIUM DATA                                       -
C                                                                      -
CC          READ IF SEL.EQ.3HAIM.AND.IRD(2).EQ.1                       -
C                                                                      -
CL    (INFD(I),I=1,11),(AB(I),I=1,4)                                   -
CL    (B(I),I=1,INFD(1))            READ IF INFD(7).EQ.1               -
C                                                                      -
CD    INFD(1)       NUMBER OF ENERGY GROUPS                            -
CD    INFD(2)       LIMITING NUMBER OF ITERATIONS                      -
CD    INFD(3)       EIGENVALUE TYPE (0/1/2=KEFF/BUCKLING SEARCH/       -
CD                  (1/V) ABSORBER SEARCH)                             -
CD    INFD(4)       1/0=SOLVE ADJOINT PROBLEM EACH TIME THE SPECTRUM   -
CD                      IS CALCULATED/NO                               -
CD    INFD(5)       1/0=SOLVE ADJOINT PROBLEM AT START-OF-CYCLE/NO     -
CD    INFD(6)       1/0=SOLVE ADJOINT PROBLEM AT END-OF-CYCLE/NO       -
CD    INFD(7)       1/0=READ GROUP-DEPENDENT VALUES OF B**2/NO         -
CD    INFD(8)       NUMBER OF NUCLIDES                                 -
CD    INFD(9)       1/0=PRINT ITERATIVE DATA/NO                        -
CD    INFD(10)      1/0=PRINT MACROSCOPIC CROSS SECTIONS/NO            -
CD    INFD(11)      1/0=PRINT MACROSCOPIC SCATTERING KERNEL/NO         -
CD    AB(1)         DESIRED FLUX CONVERGENCE                           -
CD    AB(2)         DESIRED SOURCE AND FISSION RATE CONVERGENCE        -
CD    AB(3)         VALUE OF B**2 USED FOR ALL GROUPS UNLESS INFD(7)=1 -
CD    AB(4)         DESIRED KEFF FOR SEARCH PROBLEMS                   -
CD    B(I)          GROUP-DEPENDENT B**2                               -
C                                                                      -
C-----------------------------------------------------------------------
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C-----------------------------------------------------------------------
CR          DEPLETION HISTORY AND EDITING OPTIONS                      -
C                                                                      -
CC          READ IF IRD(3).EQ.1                                        -
C                                                                      -
CL    (HOLL(I),I=1,12),(ND(I),I=1,17),(DD(I),I=1,17),(IEDT(I),I=1,12)  -
C                                                                      -
CD    HOLL(I)       DEPLETION HISTORY TITLE (TWELVE 6-CHARACTER WORDS)  -
CD    ND(1)         NUMBER OF CYCLES                                   -
CD    ND(2)         MAX NUMBER OF DEPLETION TIME STEPS FOR FIRST CYCLE -
CD    ND(3)         SAME AS ND(2) BUT FOR SECOND CYCLE                 -
CD    ND(4)         SAME AS ND(3) BUT FOR ALL OTHER CYCLES             -
CD    ND(5)         NUMBER OF SUBSTEPS FOR EACH DEPLETION STEP         -
CD    ND(6)         1/0=RECALCULATE FLUX AT END OF TIME STEP AND USE   -
CD                      LINEAR-AVERAGED FLUX VALUES OVER SUBSTEP       -
CD                      INTERVALS/NO                                   -
CD    ND(7)         0/1=SAVE START-OF-STEP NUCLIDE DENSITIES FOR END-OF-
CD                      CYCLE RECOVERY/NO                              -
CD    ND(8)         0/1=RENORMALIZE FLUX AFTER EACH SUBSTEP TO ACHIEVE -
CD                      DESIRED POWER LEVEL/NO                         -
CD    ND(9)         1/0=RETURN POWER LEVEL TO ORIGINAL SPECS (SEE DD(1) -
CD                      AND DD(8)) AFTER EACH NEUTRONICS CALC/ADJUST   -
CD                      POWER LEVEL TO GIVE DESIRED AVERAGE OVER THE   -
CD                      TIME STEPS (SEE DD(5) AND DD(6))               -
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CD     ND(10)       OPTION ON LIMITING POWER DENSITY (SEE DD(4))          -
CD                      0=TERMINATE IF LIMIT EXCEEDED                     -
CD                      1=CONTINUE WITHOUT CHANGE IN PROCEDURE            -
CD                      2=ADJUST POWER LEVEL TO LIMIT THE POWER DENSITY-
CD                      3=ADJUST POWER  TO MAINTAIN THE POWER DENSITY     -
CD     ND(11)       0/1=LIMITING POWER DENSITY DD(4) APPLIES TO ZONES/    -
CD                      SUBZONES                                          -
CD     ND(12)       0/1=LIMITING AVERAGE EXPOSURE DD(9) APPLIES TO        -
CD                      ZONES/ZONE CLASSES                                -
CD     ND(13)       1/0=DO NEUTRONIC CALC FOR END-OF-CYCLE CONDITIONS/NO-
CD     ND(14)       OPTION ON END-OF-CYCLE EXTRAPOLATION                  -
CD                      -2=EXTRAPOLATE ON EXPOSURE                        -
CD                      -1=EXTRAPOLATE ON CONTROL POISON                  -
CD                       0=EXTRAPOLATE ON EXCESS REACTIVITY               -
CD                       1=DO NOT EXTRAPOLATE                             -
CD     ND(15)       OPTION FOR CALCULATION OF CONVERSION RATIO             -
CD                       0=USE CAPTURE RATE IN FERTILE MATERIAL           -
CD                       1=USE (N,GAMMA) RATE IN FERTILE MATERIAL         -
CD     ND(16)       NUMBER OF ENERGY GROUPS                               -
CD     ND(17)       NUMBER OF MATERIAL ZONES                              -
CD     DD(1)        REFERENCE CORE POWER LEVEL (WT) FOR FIRST CYCLE       -
CD     DD(2)        RATIO OF THERMAL TO FISSION ENERGY                    -
CD     DD(3)        FRACTION OF CORE INCLUDED IN THE MODEL                -
CD     DD(4)        LIMITING POWER DENSITY (W/CC).  USE OF DD(4) DEPENDS-
CD                  ON OPTIONS CHOSEN FOR ND(10) AND ND(11).              -
CD     DD(5)        DESIRED POWER LEVEL (MWT) FOR ALL CLASS 1 ZONES       -
CD     DD(6)        SAME AS DD(5) BUT FOR ALL CLASS 1 AND 2 ZONES         -
CD                  SUMMED.  FLUX LEVEL IS ADJUSTED TO MAINTAIN EITHER    -
CD                  DD(5) OR DD(6), WHICHEVER REQUIRES THE HIGHEST FLUX.-
CD     DD(7)        MAXIMUM EXPOSURE TIME (DAYS) FOR ANY CYCLE            -
CD     DD(8)        CORE POWER LEVEL (WT) FOR SECOND AND SUCCEED. CYCLES-
CD     DD(9)        LIMITING AVER HEAVY METAL EXPOSURE (MWT/METRIC TON)   -
CD                  TERMINATING CYCLE                                     -
CD     DD(10)       DESIRED END-OF-CYCLE MULTIPLICATION FACTOR            -
CD     DD(11)       DESIRED END-OF-CYCLE FRACTION NEUTRON LOSS IN         -
CD                  CONTROL ABSORBER                                      -
CD     DD(12)       DEPLETION TIME (DAYS) FOR FIRST TIME STEP OF FIRST    -
CD                  CYCLE                                                 -
CD     DD(13)       SAME AS DD(12) BUT FOR SECOND TIME STEP               -
CD     DD(14)       SAME AS DD(13) BUT FOR REMAINDER OF TIME STEPS        -
CD     DD(15)       SAME AS DD(12) BUT FOR REMAINDER OF CYCLES            -
CD     DD(16)       SAME AS DD(13) BUT FOR REMAINDER OF CYCLES            -
CD     DD(17)       SAME AS DD(14) BUT FOR REMAINDER OF CYCLES            -
CD     IEDT(1)      N/0=PRINT NUCLIDE DENSITIES BY ZONE EVERY NTH         -
CD                      TIME STEP/NO                                      -
CD     IEDT(2)      SAME AS IEDT(1) BUT BY SUBZONE                        -
CD     IEDT(3)      N/0=PRINT GROSS REACTION RATES IN INDIVIDUAL          -
CD                      NUCLIDES EVERY NTH TIME STEP/NO                   -
CD     IEDT(4)      N/0=PRINT REACTION RATES IN INDIVIDUAL NUCLIDES BY    -
CD                      ZONE EVERY NTH TIME STEP/NO                       -
CD     IEDT(5)      N/0=PRINT ZONE-AVERAGE FLUX BY GROUP EVERY NTH TIME   -
CD                      STEP/NO                                           -
CD     IEDT(6)      N/0=PRINT ZONE-AVERAGE POWER DENSITIES EVERY NTH      -
CD                      TIME STEP/NO                                      -
CD     IEDT(7)      N/0=PRINT DECAY ACTIVITY BY NUCLIDE EVERY NTH         -
CD                      TIME STEP/NO                                      -
CD     IEDT(8)      1/0=PRINT EDIT INFORMATION USEFUL IN DEBUGGING FOR    -
CD                      EACH CYCLE/NO                                     -
CD     IEDT(9)      1/0=PRINT CROSS SECTIONS EXTRACTED FROM MULTIGRP       -
CD                      FILE/NO                                           -
CD     IEDT(10)     1/0=PRINT START-OF-CYCLE ZONE NUCLIDE DENSITIES/NO    -
CD     IEDT(11)     1/0=PRINT END-OF-CYCLE NUCLIDE DENSITIES BY SUBZONE   -
CD                      /NO                                               -
CD     IEDT(12)     1/0=PRINT END-OF-CYCLE FISSILE LOADINGS/NO            -
C                                                                         -
C-------------------------------------------------------------------------
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C-----------------------------------------------------------------------
CR          ZONE CLASSIFICATION DATA                                   -
C                                                                      -
CC          READ IF IRD(4).EQ.1                                        -
C                                                                      -
CL    NZSET                                                            -
C                                                                      -
CL    (NF(N),NL(N),NSUBZ(N),NZCL(N),NDPL(N),ZA(N),ZB(N),N=1,NZSET)     -
C                                                                      -
CD    NZSET          NUMBER OF ZONE SETS.  ZONES IN EACH SET HAVE THE  -
CD                   SAME NUMBER OF SUBZONES, BELONG TO THE SAME ZONE  -
CD                   CLASS, AND ARE ALL EITHER DEPLETING OR NONDEPLETING.-
CD    NF(N)          FIRST ZONE NUMBER (OF A CONSECUTIVE SET) IN SET N -
CD    NL(N)          LAST ZONE NUMBER (OF A CONSECUTIVE SET) IN SET N  -
CD    NSUBZ(N)       NUMBER (LE.24) OF SUBZONES IN EACH ZONE OF SET N. -
CD                   IF NSUBZ(N).GT.1, SUBZONE NUCLIDE CONCENTRATIONS  -
CD                   MUST BE SPECIFIED.                                -
CD    NZCL(N)        A REFERENCE NUMBER (LE.25) IDENTIFYING THE ZONE    -
CD                   CLASS.                                            -
CD    NDPL(N)        -1/0=ZONE SET N CONTAINS NONDEPLETING/DEPLETING   -
CD                   ZONES.  CHAIN EQUATIONS ARE NOT SOLVED FOR NON-   -
CD                   DEPLETING ZONES.                                  -
CD    ZA(N)          FIRST WORD (6 CHARACTERS) OF ZONE CLASS NAME      -
CD    ZB(N)          SECOND WORD (6 CHARACTERS) OF ZONE CLASS NAME     -
C                                                                      -
C-----------------------------------------------------------------------
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C-----------------------------------------------------------------------
CR          FISSION YIELD DATA                                         -
C                                                                      -
CC          READ IF IRD(5).EQ.1                                        -
C                                                                      -
CL    JNQ,NFIPRO                                                       -
C                                                                      -
CL    (NNOF(I),I=1,JNQ)                                                -
C                                                                      -
CL    (N1(J),(YLD(I,J),I=1,JNQ),J=1,NFIPRO)                            -
C                                                                      -
CD    JNQ            TOTAL NUMBER OF NUCLIDES THAT PRODUCE FISSION PRODS -
CD    NFIPRO         TOTAL NUMBER OF FISSION-PRODUCT NUCLIDES          -
CD    NNOF(I)        REFERENCE I.D. NUMBERS OF NUCLIDES THAT PRODUCE   -
CD                   FISSION PRODUCTS                                  -
CD    N1(J)          REFERENCE I.D. NUMBER OF FISSION PRODUCT J        -
CD    YLD(I,J)       YIELD (PER FISSION) OF FISSION PRODUCT N1(J)       -
CD                   FROM FISSIONABLE NUCLIDE NNOF(I)                  -
C                                                                      -
C-----------------------------------------------------------------------
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C-----------------------------------------------------------------------
CR          NUCLIDE CHAIN SPECIFICATIONS                               -
C                                                                      -
CC          READ IF IRD(6).EQ.1                                        -
C                                                                      -
CL    NC                                                               -
C                                                                      -
CL    (LC(N),N=1,NC)                                                   -
C                                                                      -
CL    (((ID(I,N),NTYPE(I,N),I=1,I1),ID(I2,N)),N=1,NC)                  -
C                                                                      -
CD    NC             TOTAL NUMBER (GE.1.AND.LE.100) OF CHAINS TO BE    -
CD                   SPECIFIED                                         -
CD    LC(N)          LENGTH OF CHAIN N.  CHAIN LENGTH IS NORMALLY EQUAL -
CD                   TO 2*NONUC(N)-1 WHERE NONUC(N) IS THE NUMBER OF   -
CD                   NUCLIDES IN CHAIN N.                              -
CD    ID(I,N)        REFERENCE I.D. NUMBER FOR ITH NUCLIDE IN CHAIN N  -
CD    NTYPE(I,N)     TYPE OF TRANSITION FROM ITH TO (I+1)TH NUCLIDE IN -
CD                   CHAIN N.                                          -
CD                       -1=DECAY                                      -
CD                        1=TOTAL CAPTURE                              -
CD                        2=N,GAMMA                                    -
CD                        3=N,ALPHA                                    -
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CD                        4=N,2N                                              -
CD                        5=N,P                                               -
CD                        6=NONDEPLETION--RESERVED FOR ONE-NUCLIDE CHAIN      -
CD                          INDICATING THE NUCLIDE CAPTURES BACK TO           -
CD                          ITSELF.                                           -
CD                       -3=PARTS PER 100,000 FISSION TREATED AS CAPTURE       -
CD                        10=PARTS PER 1,000,000 TOTAL CAPTURE                 -
CD     I1=NONUC(N)-1                                                          -
CD     I2=I1+1                                                                -
C                                                                             -
CC     SECONDARY SOURCE ROUTES TO NUCLIDES MUST BE INDICATED FOR CORRECT-     -
CC     CALCULATIONS.  A SEPARATE CHAIN DESCRIPTION IS REQUIRED FOR            -
CC     SECONDARY ROUTES AND SECONDARY-ROUTE CHAINS ARE FLAGGED BY             -
CC     ADDING 200,000 TO ALL NUCLIDE I.D. NUMBERS IN THE CHAIN.               -
CC     FOR A NONDEPLETING ONE-NUCLIDE CHAIN, THE CHAIN CONTAINS ONLY          -
CC     THE TWO ENTRIES ID(1,N) AND NTYPE(1,N)=8 WITH LC(N)=2.                 -
C                                                                             -
C-------------------------------------------------------------------------------


C-------------------------------------------------------------------------------
CR           SUBZONE NUCLIDE CONCENTRATIONS                                   -
C                                                                             -
CC           READ IF IRD(7).EQ.1.AND.NSUBZ(N).GT.1 FOR ANY N (SEE ZONE        -
CC           CLASSIFICATION DATA).                                            -
C                                                                             -
CL     IFLG,NZSET                                                             -
C                                                                             -
C      DO 5 N=1,NZSET                                                         -
CL     READ(M) MF(N),ML(N)          READ IF IFLG.EQ.1                         -
CL     READ(M) (NUCL(I,N),I=1,NSUBZ(N))     READ IF IFLG.EQ.1                -
C      DO 5 I=1,NSUBZ(N)                                                      -
CL   5 READ(M) (IB(J,I,N),C(J,I,N),J=1,NUCL(I,N))      READ IF IFLG.EQ.1      -
C                                                                             -
CD     IFLG          1/0=PROCEED WITH REMAINDER OF INPUT/SUBZONE CONCENTR-   -
CD                       ATIONS ARE SET EQUAL TO ZONE CONCENTRATIONS IN       -
CD                       ZONEDENS FILE AND REMAINING INPUT IS NOT READ.       -
CD     NZSET         TOTAL NUMBER OF ZONE SETS.  ZONES IN EACH SET MUST       -
CD                   HAVE THE SAME NUMBER OF SUBZONES AND THE SAME SUR-       -
CD                   ZONE CONCENTRATIONS.  NOT USED IF IFLG.EQ.0              -
CD     MF(N)         FIRST ZONE NUMBER (OF A CONSECUTIVE SET) IN SET N        -
CD     ML(N)         LAST ZONE NUMBER (OF A CONSECUTIVE SET) IN SET N         -
CD     NUCL(I,N)     TOTAL NUMBER OF NUCLIDES IN ITH SUBZONE OF ZONES IN      -
CD                   SET N                                                    -
CD     NSUBZ(N)      NUMBER OF SUBZONES IN EACH ZONE OF ZONE SET N            -
CD                   (MUST AGREE WITH DATA GIVEN IN ZONE CLASSIFICATION)      -
CD     IB(J,I,N)     REFERENCE I.D. NUMBER OF JTH NUCLIDE IN SUBZONE I        -
CD                   OF ZONE SET N                                            -
CD     C(J,I,N)      ATOM DENSITY (10**24 ATOMS/CC) OF JTH NUCLIDE  IN        -
CD                   SUBZONE I OF ZONE SET N.                                 -
C                                                                             -
CC     IF SUBZONE CONCENTRATIONS ARE READ, A NEW ZONEDENS FILE IS             -
CC     WRITTEN USING ZONE-AVERAGE CONCENTRATIONS COMPUTED FROM THE            -
CC     SUBZONE CONCENTRATIONS.  THE ZONE-AVERAGE CONCENTRATION OF ANY         -
CC     NUCLIDE IS THE SUM OF THE SUBZONE CONCENTRATIONS DIVIDED BY THE        -
CC     NUMBER OF SUBZONES.                                                    -
C                                                                             -
C-------------------------------------------------------------------------------
CEOF
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C*****************************************************************************
C                                                                             -
CF          DAC INPT                                                          -
CE          DAC CODE-DEPENDENT INPUT DATA FILE                                -
C                                                                             -
C*****************************************************************************


C-----------------------------------------------------------------------------
CR          RECORD CONTROL                                                    -
C                                                                             -
CC          READ IF IREAD(16).EQ.3                                            -
C                                                                             -
CL    (IRD(J),J=1,3)                                                          -
C                                                                             -
CD    IRD(J)        READ RECORD J FROM CARDS (1/0=YES/NO).  IF IREAD(16)      -
CD                  .EQ.1, ALL THE IRD(J) ARE SET INTERNALLY TO 1.  IF        -
CD                  IREAD(16) IS EQUAL TO 2 OR 4, OMIT ALL CARD INPUT         -
CD                  FOR THE DAC INPT FILE.                                    -
CD    IREAD(16)     SEE CARD INPUT FILE CONTROLS.                             -
C                                                                             -
C-----------------------------------------------------------------------------


C-----------------------------------------------------------------------------
CR          CONTROL PARAMETERS                                                -
C                                                                             -
CC          READ IF IRD(1).EQ.1                                               -
C                                                                             -
CL    ITP,IDI,MAXLP,MAXLD,NFI,NCAS                                            -
C                                                                             -
CD    ITP      CROSS SECTION CONTROL (1/2=READ REFERENCE MULTIGRP FILE         -
CD             ONLY/READ BOTH REFERENCE AND PERTURBED MULTIGRP FILES).        -
CD    IDI      FLUX CONTROL (1/0=USE ANGULAR FLUXES/SCALAR FLUXES AND         -
CD             CURRENTS).                                                     -
CD    MAXLP    MAXIMUM NUMBER OF GROUPS TO WHICH THERE CAN BE UPSCATTER       -
CD    MAXLD    MAXIMUM NUMBER OF GROUPS TO WHICH THERE CAN BE                 -
CD             DOWNSCATTER                                                    -
CD    NFI      NUMBER OF FISSIONABLE ISOTOPES                                 -
CD    NCAS     NUMBER OF PERTURBATION CASES TO BE PROCESSED                   -
C                                                                             -
C-----------------------------------------------------------------------------


C-----------------------------------------------------------------------------
CR          MESH MODIFIERS AND MESH MODIFIER NUMBERS                          -
C                                                                             -
CC          READ IF IEVT.EQ.4.AND.IRD(2).EQ.1                                 -
C                                                                             -
CL    (XM(I),I=1,IZ),(NXM(I),I=1,IM)                                          -
C                                                                             -
CL    (YM(J),J=1,JZ),(NYM(J),J=1,JM)   READ IF IA01.GT.1                      -
C                                                                             -
CL    (ZM(K),K=1,KZ),(NZM(K),K=1,KM)   READ IF IA01.GT.2                      -
C                                                                             -
CD    XM(I)    MESH MODIFIERS FOR 1ST DIMENSION                               -
CD    NXM(I)   MESH MODIFIER NUMBERS FOR 1ST DIMENSION.  THESE NUMBERS        -
CD             SPECIFY WHICH OF THE XM(I) ARE TO BE USED IN EACH              -
CD             INTERVAL.                                                      -
CD    YM(J)    MESH MODIFIERS FOR 2ND DIMENSION                               -
CD    NYM(J)   MESH MODIFIER NUMBERS FOR 2ND DIMENSION                        -
CD    ZM(K)    MESH MODIFIERS FOR 3RD DIMENSION                               -
CD    NZM(K)   MESH MODIFIER NUMBERS FOR 3RD DIMENSION                        -
CD    IZ,JZ,KZ,IM,JM,KM,,IA01, AND IEVT DEFINED IN ADMNSTR.                  -
C                                                                             -
C-----------------------------------------------------------------------------
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C-----------------------------------------------------------------------
CR          PERTURBATION CASE DATA                                     -
C                                                                      -
CC          READ IF NCAS.GT.0.AND.IRD(3).EQ.1                          -
C                                                                      -
CC     DO 5 N=1,NCAS                                                   -
C                                                                      -
CL     ITPP,NPM,NPR                                                    -
C                                                                      -
CL     (((MPA(I,J,K),I=1,IM),J=1,JM),K=1,KM)   READ IF NPM.GT.0        -
C                                                                      -
CL     (MPZ(I),I=1,NPR),(MP(I),I=1,NPM),(MPC(I),I=1,NPM),              -
CL     (XDE(I),I=1,NPM)   READ IF NPM.GT.0                             -
C                                                                      -
CL   5 (XDEP(I),I=1,NPM)   READ IF NPM.GT.0.AND.ITPP.NE.2              -
C                                                                      -
CD     ITPP          TYPE PERTURBATION (1/2/3=DENSITY/CROSS SECTION/BOTH) -
CD                   SET ITPP.GT.1 ONLY IF ITP.EQ.2                   -
CD     NPM           NUMBER OF PERTURBATION MIXTURE SPECIFICATIONS     -
CD     NPR           NUMBER OF PERTURBATION ZONES (NPR.GT.0 IF NPM.GT.0) -
CD     MPA(I,J,K)    PERTURBATION ZONE NUMBERS BY INTERVAL             -
CD     MPZ(I)        PERTURBATION MATERIAL NUMBERS BY ZONE             -
CD     MP(I)         PERTURBATION MIX NUMBERS                          -
CD     MPC(I)        PERTURBATION MIX COMMANDS                         -
CD     XDE(I)        PERTURBATION MIX DENSITIES                        -
CD     XDEP(I)       PERTURBED MIX DENSITIES                           -
C                                                                      -
C-----------------------------------------------------------------------
CEOF
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```
C**********************************************************************
C                                                                      -
CF     FILE AND RECORD PRINT CONTROLS                                  -
C                                                                      -
C**********************************************************************
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C-----------------------------------------------------------------------
CR     FILE PRINT CONTROLS                                             -
C                                                                      -
CL     IPRIN(I),I=1,16                                                 -
C                                                                      -
CD     IPRIN              =1, SKIP FILE                               -
CD                        =2, PRINT ENTIRE FILE                       -
CD                        =3, PRINT SELECTED RECORDS IN FILE          -
C                                                                      -
CD     I                  =1, ADMNSTR FILE                            -
CD                        =2, SN CONS FILE                            -
CD                        =3, INTQUANT FILE                           -
CD                        =4, GEO DIST FILE                           -
CD                        =5, MIX DATA FILE                           -
CD                        =6, GRP FLUX FILE, REGULAR                  -
CD                        =7, GRP FLUX FILE, ADJOINT                  -
CD                        =8, MULTIGRP FILE, REFERENCE                -
CD                        =9, MULTIGRP FILE, PERTURBED                -
CD                        =10, ZONE DFNS FILE                         -
CD                        =11, ETX INPT FILE                          -
CD                        =12, ODX INPT FILE                          -
CD                        =13, ANI INPT FILE                          -
CD                        =14, DOT INPT FILE                          -
CD                        =15, CLB INPT FILE                          -
CD                        =16, DAC INPT FILE                          -
C                                                                      -
C-----------------------------------------------------------------------
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C-------------------------------------------------------------------
CR    ADMNSTR FILE RECORD PRINTING CONTROLS                        -
C                                                                  -
CC    NO RECORD CONTROLS - PRINT ENTIRE FILE IF IPRIN(1) = 2 OR = 3 -
C                                                                  -
C-------------------------------------------------------------------

C-------------------------------------------------------------------
CR    SN CONS FILE RECORD PRINTING CONTROLS                        -
C                                                                  -
CC    NO RECORD CONTROLS - PRINT ENTIRE FILE IF IPRIN(2) = 2 OR = 3 -
C                                                                  -
C-------------------------------------------------------------------

C-------------------------------------------------------------------
CR    INTGUANT FILE RECORD PRINTING CONTROLS   READ IF IPRIN(3) = 3 -
C                                                                  -
CL    IPR(I),I=1,3                                                 -
C                                                                  -
CD    IPR(I)             PRINT RECORD I, 1=YES, 0=NO               -
C                                                                  -
CD    I                  =1, DERIVED CONSTANTS                     -
CD                       =2, ZONE AVERAGED FLUXES                  -
CD                       =3, ZONE VOLUMES                          -
C                                                                  -
C-------------------------------------------------------------------

C-------------------------------------------------------------------
CR    GEO DIST FILE RECORD PRINTING CONTROLS   READ IF IPRIN(4) = 3 -
C                                                                  -
CL    IPR(I),I=1,4                                                 -
C                                                                  -
CD    IPR(I)             PRINT RECORD I, 1=YES, 0=NO               -
C                                                                  -
CD    I                  =1, BOUNDARIES                            -
CD                       =2, MATERIAL NUMBERS                      -
CD                       =3, ZONE NUMBERS                          -
CD                       =4, BUCKLING                              -
C                                                                  -
C-------------------------------------------------------------------

C-------------------------------------------------------------------
CR    MIX DATA FILE RECORD PRINTING CONTROLS    READ IF IPRIN(5) = 3 -
C                                                                  -
CL    IPR(I),I=1,4                                                 -
C                                                                  -
CD    IPR(I)             PRINT RECORD I, 1=YES, 0=NO               -
C                                                                  -
CD    I                  =1, MIX NUMBERS                           -
CD                       =2, MIX COMMAND                           -
CD                       =3, MIX DENSITIES                         -
CD                       =4, ISOTOPE NUMBERS                       -
C                                                                  -
C-------------------------------------------------------------------

C-------------------------------------------------------------------
CR    REGULAR GRP FLUX FILE RECORD PRINTING CONTROLS               -
CR        READ IF IPRIN(6) = 3                                     -
C                                                                  -
CL    IPR(I),I=1,3                                                 -
C                                                                  -
CD    IPR(I)             PRINT RECORD I, 1=YES, 0=NO               -
C                                                                  -
CD    I                  =1, TOTAL FLUX                            -
CD                       =2, CURRENTS                              -
CD                       =3, ANGULAR FLUX                          -
C                                                                  -
C-------------------------------------------------------------------
```

```
C-----------------------------------------------------------------------
CR    ADJOINT GRP FLUX FILE RECORD PRINTING CONTROLS                    -
CR        READ IF IPRIN(7) = 3                                          -
C                                                                       -
CL    IPR(I),I=1,3                                                      -
C                                                                       -
CD    IPR(I)              PRINT RECORD I, 1=YES, 0=NO                   -
C                                                                       -
CD    I                   =1, TOTAL FLUX                                -
CD                        =2, CURRENTS                                  -
CD                        =3, ANGULAR FLUX                              -
C                                                                       -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR    MULTIGRP FILE RECORD PRINTING CONTROLS   READ IF IPRIN(8) = 3     -
C                                                                       -
CL    IPR(I),I=1,13                                                     -
C                                                                       -
CD    IPR(I)              PRINT RECORD I, 1=YES, 0=NO                   -
C                                                                       -
CD    I                   =1, FILE TITLE AND PARAMETERS                 -
CD                        =2, ISOTOPE IDENTIFICATION                    -
CD                        =3, GROUP STRUCTURE                           -
CD                        =4, DELAYED NEUTRON DECAY CONSTANTS           -
CD                        =5, DELAYED NEUTRON SPECTRUM                  -
CD                        =6, DELAYED NEUTRON ABUNDANCES                -
CD                        =7, ISOTOPE PARAMETERS                        -
CD                        =8, ISOTOPE FISSION SPECTRUM                  -
CD                        =9, PRINCIPAL CROSS-SECTIONS                  -
CD                        =10, INELASTIC SCATTERING CROSS-SECTIONS      -
CD                        =11, ELASTIC SCATTERING CROSS-SECTIONS        -
CD                        =12, N2N SCATTERING CROSS-SECTIONS            -
CD                        =13, BONDARENKO                               -
C                                                                       -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR    PERTURBED MULTIGRP FILE RECORD PRINTING CONTROLS                  -
CR        READ IF IPRIN(9) = 3                                          -
C                                                                       -
CL    IPR(I),I=1,13                                                     -
C                                                                       -
CD    IPR(I)              PRINT RECORD RECORD I, 1=YES, 0=NO            -
C                                                                       -
CD    I                   =1, FILE TITLE AND PARAMETERS                 -
CD                        =2, ISOTOPE IDENTIFICATION                    -
CD                        =3, GROUP STRUCTURE                           -
CD                        =4, DELAYED NEUTRON DECAY CONSTANTS           -
CD                        =5, DELAYED NEUTRON SPECTRUM                  -
CD                        =6, DELAYED NEUTRON ABUNDANCES                -
CD                        =7, ISOTOPE PARAMETERS                        -
CD                        =8, ISOTOPE FISSION SPECTRUM                  -
CD                        =9, PRINCIPAL CROSS-SECTIONS                  -
CD                        =10, INELASTIC SCATTERING CROSS-SECTIONS      -
CD                        =11, ELASTIC SCATTERING CROSS-SECTIONS        -
CD                        =12, N2N SCATTERING CROSS-SECTIONS            -
CD                        =13, BONDARENKO DATA                          -
C                                                                       -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR    ZONE DENSITIES FILE RECORD PRINTING CONTROLS                      -
C                                                                       -
CC    NO RECORD CONTROLS.  PRINT ENTIRE FILE IF IPRIN(10) = 2 OR =3     -
C                                                                       -
C-----------------------------------------------------------------------
```

```
C-----------------------------------------------------------------------
CR    ETXIN FILE RECORD PRINTING CONTROLS - READ IF IPRIN(11) = 3      -
C                                                                      -
CL    IPR(I),I=1,3                                                     -
C                                                                      -
CD    IPR(I)            PRINT RECORD I, 1=YES, 0=NO                    -
C                                                                      -
CD    I                 =1, DATA COMMON TO ALL ISOTOPES                -
CD                      =2, ISOTOPE DEPENDENT DATA                     -
CD                      =3, LIBRARY UPDATE DATA                        -
C                                                                      -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR    OBXIN FILE RECORD PRINTING CONTROLS - READ IF IPRIN(12) = 3      -
C                                                                      -
CL    IPR(I),I=1,7                                                     -
C                                                                      -
CD    IPR(I)            PRINT RECORD I, 1=YES, 0=NO                    -
C                                                                      -
CD    I                 =1, TITLE AND CONTROL PARAMETERS               -
CD                      =2, BUCKLING MODIFIERS                         -
CD                      =3, FISSION FRACTIONS AND VELOCITIES           -
CD                      =4, ZONE MODIFIERS                             -
CD                      =5, XSEC GROUP COLLAPSING DATA                 -
CD                      =6, RESONANCE SHIELDING DATA                   -
CD                      =7, MULTIGRP FILE DATA                         -
C                                                                      -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR    ANIIN FILE RECORD PRINTING CONTROLS - READ IF IPRIN(13) = 3      -
C                                                                      -
CL    IPR(I),I=1,9                                                     -
C                                                                      -
CD    IPR(I)            PRINT RECORD I, 1=YES, 0=NO                    -
C                                                                      -
CD    I                 =1, CONTROL PARAMETERS                         -
CD                      =2, FIXED SOURCE                               -
CD                      =3, FISSION GUESS                              -
CD                      =4, RADIUS MODIFIERS                           -
CD                      =5, DENSITY FACTORS                            -
CD                      =6, ACTIVITY DATA                              -
CD                      =7, DIFFUSION MARKERS                          -
CD                      =8, ALBEDO                                     -
CD                      =9, XSEC GROUP COLLAPSE DATA                   -
C                                                                      -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR    DOTIN FILE RECORD PRINTING CONTROLS - READ IF IPRIN(14) = 3      -
C                                                                      -
CD    IPR(I)            PRINT RECORD I, 1=YES, 0=NO                    -
C                                                                      -
CD    I                 =1, CONTROL PARAMETERS                         -
CD                      =2, DISTRIBUTED FIXED SOURCE                   -
CD                      =3, FIXED BOUNDARY SOURCE                      -
CD                      =4, ACTIVITY DATA                              -
CD                      =5, ZONE WIDTH SEARCH PARAMETERS               -
CD                      =6, DIFFUSION MARKERS                          -
C                                                                      -
C-----------------------------------------------------------------------
```

```
C-------------------------------------------------------------------
CR     CLBIN FILE RECORD PRINTING CONTROLS - READ IF IPRIN(15) = 3
C
CL     IPR(I),I=1,7
C
CD     IPR(I)              PRINT RECORD I, 1=YES= 0=NO
C
CD     I                   =1, TITLE AND NEUTRONICS SELECTION
CD                         =2, INFINITE MEDIUM DATA
CD                         =3, DEPLETION HISTORY AND EDITING OPTIONS
CD                         =4, ZONE CLASSIFICATION DATA
CD                         =5, FISSION YIELD DATA
CD                         =6, NUCLIDE CHAIN SPECIFICATIONS
CD                         =7, SUBZONE NUCLIDE CONCENTRATIONS
C
C-------------------------------------------------------------------

C-------------------------------------------------------------------
CR     DACIN FILE RECORD PRINTING CONTROLS - READ IF IPRIN(16) = 3
C
CL     IPR(I),I=1,3
C
CD     IPR(I)              PRINT RECORD I, 1=YES, 0=NO
C
CD     I                   =1, CONTROL PARAMETERS
CD                         =2, MESH MODIFIERS AND MESH MODIFIER NUMBERS
CD                         =3, PERTURBATION CASE DATA
C
C-------------------------------------------------------------------
CEOF

C*******************************************************************
C
CF          CARD INPUT FOR INTERFACED MC**2 CODE
C
CN     THE LIST FOR EACH RECORD IS GIVEN IN TERMS OF THE BCD FORMAT OF
CN     THE DATA CARD.  COLUMNS 1-2 ALWAYS CONTAIN THE CARD TYPE NUMBER.
C
C*******************************************************************

C-------------------------------------------------------------------
CR          PROBLEM TITLE
C
CC          CARD TYPE 01 MUST ALWAYS BE PRESENT
C
CL     FORMAT(I2,4X,9A8)
C
CD     COLUMNS                        CONTENTS
CD     =======   ==========================================
CD     1-2       01
CD     7-78      ANY ALPHANUMERIC CHARACTERS
C
C-------------------------------------------------------------------

C-------------------------------------------------------------------
CR          POINTR CONTAINER ARRAY SPECIFICATIONS
C
CC          CARD TYPE 02 IS OPTIONAL
C
CL     FORMAT(I2,4X,3I6)
C
```

```
CD     COLUMNS                          CONTENTS
CD     =======    ==================================================
CD     1-2        02
CD     19-24      PRINT OPTION FLAG FOR CONTAINER ARRAY, TYPICALLY 0.
CD                DEFAULT=0.
CD                0=NO TRACE OR DUMPS
CD                1=DUMPS ONLY
CD                2=TRACE ONLY
CD                3=TRACE AND DUMPS
C
C-------------------------------------------------------------------

C-------------------------------------------------------------------
CR           GENERAL PROBLEM SPECIFICATIONS
C
CC           CARD TYPE 03 MUST ALWAYS BE PRESENT
C
CL     FORMAT(I2,10X,6I6,E12.5,I6)
C
CD     COLUMNS                          CONTENTS
CD     =======    ==================================================
CD     1-2        03
CD     13-18      FUNDAMENTAL MODE TYPE
CD                1=P1
CD                2=CONSISTENT B1 FOR ISOTROPIC NEUTRONICS
CD                3=CONSISTENT P1 FOR ISOTROPIC NEUTRONICS
CD                4=CONSISTENT B1 FOR ANISOTROPIC NEUTRONICS
CD                5=CONSISTENT P1 FOR ANISOTROPIC NEUTRONICS
CD     19-24      FUEL PIN GEOMETRY (1/2=SLAB/CYLINDER)
CD     25-30      LIBRARY IDENTIFICATION NUMBER OF ISOTOPE TO BE USED AS
CD                FISSION SOURCE.
CD     31-36      0/1=CALCULATE BROAD GROUP CROSS SECTIONS/NO
CD     37-42      0/1=ALL FINE GROUP PROBLEM/ULTRAFINE GROUP PROBLEM
CD     43-48      FINE GROUP WEIGHTING SPECTRUM OPTION
CD                1=1/E SPECTRUM
CD                2=CONSTANT SPECTRUM
CD                3=E SPECTRUM
CD     49-60      FINE GROUP LETHARGY WIDTH, TYPICALLY 0.25.  MUST BE
CD                ONE OF THE VALUES LISTED BELOW.  THE CORRESPONDING
CD                NUMBER N OF ULTRAFINE GROUPS PER FINE GROUP IS ALSO
CD                GIVEN FOR EACH LETHARGY WIDTH.
CD                LETHARGY WIDTH              N
CD                --------------              --
CD                8.33333E-3                   1
CD                1.66667E-3                   2
CD                2.50000E-2                   3
CD                3.33333E-2                   4
CD                4.16667E-2                   5
CD                5.00000E-2                   6
CD                8.33333E-2                  10
CD                1.00000E-1                  12
CD                1.25000E-1                  15
CD                1.66667E-1                  20
CD                2.50000E-1                  30
CD                5.00000E-1                  60
CD     61-66      CALCULATION PATH OPTION
CD                1=COMPLETE MC**2 PROBLEM
CD                2=CALCULATE RESOLVED AND UNRESOLVED RESONANCE CROSS
CD                  SECTIONS ONLY
C
C-------------------------------------------------------------------

C-------------------------------------------------------------------
CR           BROAD GROUP SPECIFICATIONS
C
CC           CARD TYPE 04 MUST ALWAYS BE PRESENT
C
CL     FORMAT(I2,10X,3(I6,E12.5))
```

```
CD     COLUMNS                          CONTENTS                          -
CD     =======   ========================================================-
CD     1-2       04                                                       -
CD     13-18     BROAD GROUP NUMBER                                       -
CD     19-30     UPPER ENERGY OF GROUP (EV)                               -
CD     31-36     BROAD GROUP NUMBER                                       -
CD     37-48     UPPER ENERGY OF GROUP (EV)                               -
CD     49-54     BROAD GROUP NUMBER                                       -
CD     55-66     UPPER ENERGY OF GROUP (EV)                               -
C                                                                         -
CC     AS MANY TYPE 04 CARDS ARE USED AS ARE NECESSARY TO SPECIFY THE     -
CC     ENERGY BOUNDARIES.  GROUP 1 IS THE GROUP OF HIGHEST ENERGY.        -
C                                                                         -
C---------------------------------------------------------------------------

C---------------------------------------------------------------------------
CR           FUEL PIN SPECIFICATIONS                                      -
C                                                                         -
CC           CARD TYPE 05 IS OPTIONAL                                     -
C                                                                         -
CL     FORMAT(I2,10X,2E12.5)                                              -
C                                                                         -
CD     COLUMNS                          CONTENTS                          -
CD     =======   ========================================================-
CD     1-2       05                                                       -
CD     13-24     RADIUS OF FUEL PIN IF COLS. 19-24 ON CARD TYPE 03 EQUAL-
CD               2. HALF THICKNESS OF FUEL SLAB IF COLS. 19-24 ON CARD   -
CD               TYPE 03 EQUAL 1.                                         -
CD     25-36     RADIUS OF OUTER CLAD-COOLANT REGION IF COLS. 19-24 ON    -
CD               CARD TYPE 03 EQUAL 2. OUTER BOUND OF CLAD-COOLANT        -
CD               REGION RELATIVE TO CENTER OF FUEL SLAB IF COLS.19-24     -
CD               ON CARD TYPE 03 EQUAL 1.                                 -
C                                                                         -
CC     CARD TYPE 05 IS PERTINENT ONLY FOR A HETEROGENEOUS PROBLEM.        -
C                                                                         -
C---------------------------------------------------------------------------

C---------------------------------------------------------------------------
CR              PROBLEM COMPOSITION SPECIFICATIONS                        -
C                                                                         -
CC           CARD TYPE 06 MUST ALWAYS BE PRESENT                          -
C                                                                         -
CL     FORMAT(I2,4X,2A6,I6,4E12.5)                                        -
C                                                                         -
CD     COLUMNS                          CONTENTS                          -
CD     =======   ========================================================-
CD     1-2       06                                                       -
CD     7-12      NUCLIDE IDENTIFICATION LABEL ON LIBRARY.  LABEL MUST     -
CD               BE LEFT JUSTIFIED IN FORMAT FIELD WITH IMBEDDED BLANKS   -
CD               PRESERVED.                                               -
CD     13-18     ISOTOPE NAME.  THIS NAME CAN BE ANY ALIAS NAME USER      -
CD               WISHES.                                                  -
CD     19-24     LEGENDRE TREATMENT SPECIFICATIONS                        -
CD               0=NON-LEGENDRE TREATMENT OF ELASTIC SCATTERING           -
CD               1=ELASTIC SCATTERING FOR NUCLIDE USES THE LEGENDRE       -
CD                 TREATMENT.                                             -
CD     25-36     NUCLIDE CONCENTRATION USED TO COMPUTE HOMOGENIZED        -
CD               MACROSCOPIC CROSS SECTIONS FOR USE IN THE FUNDAMENTAL    -
CD               MODE CALCULATION (ATOMS/CC*E-24).                        -
CD     37-48     NUCLIDE TEMPERATURE (DEGREES K).                         -
CD     49-60     NUCLIDE CONCENTRATION IN THE FUEL PIN (ATOMS/CC*E-24).   -
CD               IF BLANK, THE VALUES GIVEN IN COLS. 25-36 WILL BE USED   -
CD               PROVIDED ALL 06 CARDS USED ARE BLANK IN COLS. 49-60.     -
CD     61-72     NUCLIDE CONCENTRATION IN THE CLAD-COOLANT OUTER REGION   -
CD               (ATOMS/CC*E-24).  IGNORED IF CARD TYPE 05 IS NOT         -
CD               SUPPLIED.                                                -
C                                                                         -
CC     AS MANY TYPE 06 CARDS ARE USED AS ARE NECESSARY TO SPECIFY THE     -
CC     COMPOSITION.                                                       -
C                                                                         -
C---------------------------------------------------------------------------
```

```
C-----------------------------------------------------------------------
CR          FUNDAMENTAL MODE ITERATION SPECIFICATIONS                   -
C                                                                       -
CC          CARD TYPE 07 IS OPTIONAL                                    -
C                                                                       -
CL    FORMAT(I2,10X,3E12.5)                                             -
C                                                                       -
CD    COLUMNS                          CONTENTS                         -
CD    =======   ==========================================================-
CD    1-2       07                                                      -
CD    13-24     FIRST GUESS FOR BUCKLING (1/CM**2)                      -
CD    25-36     SECOND GUESS FOR BUCKLING (1/CM**2)                     -
CD    37-48     CONVERGENCE CRITERION (EPS) FOR KEFF I.E. ABS(KEFF-1).  -
CD              LE.EPS.                                                 -
C                                                                       -
CC    IF EPS=0.0, FIRST BUCKLING GUESS IS USED AND NO ITERATION IS      -
CC    PERFORMED.                                                        -
C                                                                       -
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
CR          THERMAL CROSS SECTION DATA                                  -
C                                                                       -
CC          CARD TYPE 08 IS OPTIONAL                                    -
C                                                                       -
CL    FORMAT(I2,10X,A6,6X,4E12.5)                                       -
C                                                                       -
CD    COLUMNS                          CONTENTS                         -
CD    =======   ==========================================================-
CD    1-2       08                                                      -
CD    13-18     NUCLIDE IDENTIFICATION LABEL                            -
CD    25-36     MICROSCOPIC THERMAL GROUP CAPTURE CROSS SECTION (BARNS)-
CD    37-48     MICROSCOPIC THERMAL GROUP FISSION CROSS SECTION (BARNS)-
CD    49-60     NUMBER OF NEUTRONS EMITTED PER FISSION IN THE THERMAL   -
CD              GROUP                                                   -
CD    61-72     MICROSCOPIC THERMAL GROUP TRANSPORT CROSS SECTION       -
CD              (BARNS).                                                -
C                                                                       -
CC    AS MANY TYPE 08 CARDS ARE USED AS ARE NECESSARY TO SPECIFY THE    -
CC    THERMAL CROSS SECTIONS FOR THE NUCLIDES IN THE PROBLEM.           -
C                                                                       -
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
CR          THERMAL CROSS SECTION DATA                                  -
C                                                                       -
CC          CARD TYPE 09 IS OPTIONAL                                    -
C                                                                       -
CL    FORMAT(I2,10X,A6,6X,2E12.5)                                       -
C                                                                       -
CD    COLUMNS                          CONTENTS                         -
CD    =======   ==========================================================-
CD    1-2       09                                                      -
CD    13-18     NUCLIDE IDENTIFICATION LABEL                            -
CD    25-36     MICROSCOPIC THERMAL N-ALPHA CROSS SECTION (BARNS).      -
CD    37-48     MICROSCOPIC THERMAL N-P CROSS SECTION (BARNS).          -
C                                                                       -
CC    AS MANY TYPE 09 CARDS ARE USED AS ARE NECESSARY TO SPECIFY THE    -
CC    THERMAL CROSS SECTIONS FOR THE NUCLIDES IN THE PROBLEM.           -
C                                                                       -
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
CR          WEIGHTING SPECTRUM DATA                                     -
C                                                                       -
CC          CARD TYPE 10 IS OPTIONAL                                    -
C                                                                       -
CL    FORMAT(I2,10X,3(I6,E12.5))                                        -
C                                                                       -
CD    COLUMNS                          CONTENTS                         -
CD    =======   ==========================================================-
CD    1-2       10                                                      -
CD    13-18     FINE GROUP NUMBER                                       -
CD    19-30     FINE GROUP WEIGHTING SPECTRUM                           -
CD    31-36     FINE GROUP NUMBER                                       -
```

```
CD     37-48      FINE GROUP WEIGHTING SPECTRUM                          -
CD     49-54      FINE GROUP NUMBER                                      -
CD     55-66      FINE GROUP WEIGHTING SPECTRUM                          -
C                                                                        -
CC     AS MANY TYPE 10 CARDS ARE USED AS ARE NECESSARY TO SPECIFY THE    -
CC     WEIGHTING SPECTRUM.                                               -
C                                                                        -
C-------------------------------------------------------------------------

C-------------------------------------------------------------------------
CR           PRINT SELECTION OPTIONS                                     -
C                                                                        -
CC           CARD TYPE 11 IS OPTIONAL                                    -
C                                                                        -
CL     FORMAT(I2,4X,7I6)                                                 -
C                                                                        -
CD     COLUMNS                          CONTENTS                         -
CD     =======   ==========================================================-
CD     1-2       11                                                      -
CD     7-12      IF NON-ZERO, EDIT AVERAGE MICROSCOPIC GROUP CROSS       -
CD               SECTIONS SUMMED OVER ALL CONTRIBUTING RESONANCES IN THE-
CD               RESOLVED RESONANCE REGION.  ALSO EDIT POINT VALUES OF   -
CD               MICROSCOPIC CROSS SECTIONS AVERAGED OVER PORTER-THOMAS   -
CD               DISTRIBUTIONS IN THE UNRESOLVED REGION.                 -
CD     13-18     IF NON-ZERO, EDIT AVERAGE MICROSCOPIC GROUP CROSS       -
CD               SECTIONS FOR EACH RESONANCE IN THE RESOLVED RESONANCE   -
CD               REGION.                                                 -
CD     19-24     IF NON-ZERO, EDIT MICROSCOPIC AVERAGE FINE GROUP CROSS  -
CD               SECTIONS COMPUTED FROM LINEAR-SEGMENT DATA.             -
CD     25-30     IF NON-ZERO, EDIT HOMOGENIZED MACROSCOPIC FINE GROUP    -
CD               AND ULTRAFINE GROUP CROSS SECTIONS.  ALSO EDIT FISSION  -
CD               SPECTRUM.                                               -
CD     31-36     IF NON-ZERO, EDIT FINE AND ULTRAFINE GROUP FLUXES FOR   -
CD               EACH BUCKLING ITERATION.                                -
CD     37-42     IF NON-ZERO, EDIT ULTRAFINE GROUP MATERIAL MACROSCOPIC  -
CD               ELASTIC REMOVAL CROSS SECTIONS, ELASTIC TRANSPORT CROSS-
CD               SECTIONS, AND ELASTIC TRANSFER CROSS SECTIONS.          -
CD     43-48     IF NON-ZERO, A COMPLETE EDIT OF THE MULTIGRP CROSS       -
CD               SECTION DATA SET.                                       -
C                                                                        -
CC     ALL DEFAULT VALUES ARE ZERO.                                      -
C                                                                        -
C-------------------------------------------------------------------------

C-------------------------------------------------------------------------
CR           ADDITIONAL INFORMATION NEEDED FOR WRITING MULTIGRP FILE     -
C                                                                        -
CC           CARD TYPE 12 MUST ALWAYS BE PRESENT                         -
C                                                                        -
CL     FORMAT(I2,4X,A6,3I6,3E12.5)                                       -
C                                                                        -
CD     COLUMNS                          CONTENTS                         -
CD     =======   ==========================================================-
CD     1-2       12                                                      -
CD     7-12      NUCLIDE IDENTIFICATION LABEL ON LIBRARY.                -
CD     13-18     NUCLIDE IDENTIFICATION NUMBER ON MULTIGRP FILE.         -
CD     19-24     MATERIAL TYPE FLAG (0/1/2/3/4/5=UNDEFINED/FISSILE/      -
CD               FERTILE/OTHER HEAVY MATERIAL/STRUCTURAL/FISSION         -
CD               PRODUCT).                                               -
CD     25-30     NUCLIDE ATOMIC NUMBER                                   -
CD     31-42     DECAY CONSTANT FOR NUCLIDE (1/SEC).                     -
CD     43-54     NUCLIDE FISSION ENERGY (W-SEC/FISSION).                 -
CD     55-66     NUCLIDE CAPTURE ENERGY (W-SEC/CAPTURE).                 -
C                                                                        -
CC     A TYPE 12 CARD IS REQUIRED FOR EACH NUCLIDE THAT IS SPECIFIED ON  -
CC     A TYPE 06 CARD.                                                   -
C                                                                        -
C-------------------------------------------------------------------------
CEOF
```

APPENDIX C

FILE HANDLING

The logical unit numbers of the interface-data files are assigned by the codes that create the files. These logical unit numbers are available to the other codes through the COMMON array NFILES.

An input and an output version of a file can exist concurrently. Logical unit numbers of input files are stored in (NFILES(I),I=1,NSTD) and logical unit numbers of output files are stored in (NFILES(NSTD+I),I=1,NSTD). NSTD is the number of interface-data files. It is currently set equal to 16 in DRIVER and is transmitted to all the codes through NFILES(100).

The values of I corresponding to the 16 interface files are:

I	File	I	File
1	ADMNSTR	9	ADJ FLXS
2	SN CONS	10	PERTMTGP
3	GEO DIST	11	ETX INPT
4	GRP FLXS	12	ODX INPT
5	INTQUANT	13	ANI INPT
6	MIX DATA	14	DOT INPT
7	MULTIGRP	15	CLB INPT
8	ZONEDENS	16	DAC INPT

Logical unit numbers for output files are assigned by

```
NFILES(NSTD+I)=NSCT+NSTD+I
```

if

```
NFILES(I).LE.NSCT+NSTD  ,
```

or by

```
NFILES(NSTD+I)=NSCT+I
```

if

```
NFILES(I).GT.NSCT+NSTD  ,
```

where NSCT is the maximum number of scratch files. NSCT is currently set equal to 50 in DRIVER and is transmitted to all the codes through NFILES(99). Because the output file from one code becomes the input file for the next code in the path, NFILES(I) is set equal to NFILES(NSTD+I) after file I is created.

This procedure may become clearer if a particular example is considered. Assume that the ADMNSTR file on logical unit NFILES(1)=51 is to be modified by the INP module. The output ADMNSTR file is then written on logical unit NFILES(17)=67, and NFILES(1) is set equal to 67. However, if the input ADMNSTR file is on logical unit NFILES(1)=67, the output file is written on NFILES(17)=51, and NFILES(1) is set equal to 51.

When an FL1 call is made to copy interface files from disk to magnetic tape, (NFILES(I),I=1, NSTD) is written as the first record on the tape. This is followed by the current versions of the interface files, i.e., those on logical units NFILES(I),I=1,NSTD. When the files are copied from the magnetic tape to disk files in an FLO call, the first record on the tape is read into the NFILES array to restore the logical unit numbers associated with the disk files.

The ENDF/B and ETOX cross-section library files are not included in the file-handling scheme described above. These files must be assigned by the user to specific logical units by control cards.

Because dynamic buffer allocation is not a built-in feature of the CDC 6600, a scheme was developed to rotate a few buffers among the many files used by the codes. This scheme involves the use of a COMPASS language routine, BUFOPEN. Whenever a buffer is to be assigned to a particular file, a call is made to

```
BUFOPEN(I,FNAME,BUF,L)  .
```

This routine initializes the circular buffer parameters (CBP) for file FNAME where FNAME is a seven-character Hollerith name (7HTAPE1^^,7HTAPE2^^, ...,7HTAPE99^). The CBP are the first five words of the file environment table (FET), which occupies the first 17 words of the buffer area. The remainder of the buffer area is used to transmit data between core and the file. I is the relative location in core of the CBP pointer for the file, BUF is the first word address of the buffer area, and L is the length of the buffer. The reader is referred to Ref. 17 for a listing of the BUFOPEN routine and for further details.

APPENDIX D

SAMPLE PROBLEMS

Sample problems involving the various interfaced codes are discussed in this Appendix. These problems illustrate the card input required for the creation and modification of interface files, printing of files, execution of calculational codes in some typical sequences, and continuation of a sequence of calculations from files saved in a previous run.

Sample Problem 1. The first sample problem shows how ETOX could be used to update an isotope in an existing ETOX library. Card input for this sample problem is shown below.

CARD INPUT FOR SAMPLE PROBLEM 1

```
3  T  NUMBER OF PATH ELEMENTS                                          DRIVER01
*INP   PRN   ETX*  T  PATH                                            DRIVER02
R10(4)  1  R5(4)  T  CARD INPUT FILE CONTROLS                          INPCNT01
1  203  26  11  T  DATA COMMON TO ALL ISOTOPES TO BE PROCESSED         ETXINP01
2.26+1 3.727+1 6.144+1 1.013+2 1.67+2 2.754+2 4.54+2 7.485+2 1.234+3   ETXINP02
2.035+3 3.355+3 5.531+3 9.119+3 1.503+4 2.479+4 4.087+4 6.738+4        ETXINP03
1.111+5 1.832+5 3.02+5 4.979+5 8.208+5 1.353+6 2.231+6 3.679+6         ETXINP04
6.065+6 1.0+7  T  ENERGY BOUNDARIES                                    ETXINP05
* FE IN 26 GROUP STRUCTURE FOR UPDATED ETOX LIBRARY                    *ETXINP06
*FE*  1122  1  3  0  T  ISOTOPE-DEPENDENT DATA 1                      ETXINP07
1.0+5  1.0  2.6+6  1.4+6  0.1  0.1  0.5  1.0-3  3.0+2  5.0  5.0+1      ETXINP08
5.0+2  T  ISOTOPE-DEPENDENT DATA 2                                     ETXINP09
1  3  3  1  1  3  3  T  ETOX LIBRARY UPDATE DATA                       ETXINP10
R10(1)  2  R5(1)  T  FILE PRINT CONTROLS                               PRNCNT01
```

DRIVER01 and DRIVER02 are the control input cards for the DRIVER program. In this example, the number of path elements is three, and the path is INP PRN ETX. The next card, INPCNT01, contains the card input file controls for the INP module. These controls instruct INP to read the ETX INPT file from cards ETXINP01 through ETXINP10 and to skip all the other interface files. Finally, PRNCNT01 instructs the PRN module to print the ETX INPT file (see below) and to skip all of the other interface files.

OUTPUT FROM PRN MODULE--SAMPLE PROBLEM 1

ETOX INPUT FILE FILE 61

COMMON FILE PARAMETERS

NISO	NUMBER OF ISOTOPES ----------	1
IDTAP	ENDF/B DATA TAPE I.D. NUMBER ----------	203
NG	NUMBER OF ENERGY GROUPS OF OUTPUT X-SECTIONS	26
LNS	NUMBER OF DOWNSCATTERING GROUPS OUTPUT	11

GROUP ENERGY BOUNDS

I	BOUND
1	.22600E+02
2	.37270E+02
3	.61440E+02
4	.10130E+03
5	.16700E+03
6	.27540E+03
7	.45400E+03
8	.74850E+03
9	.12340E+04
10	.20350E+04
11	.33550E+04
12	.55310E+04
13	.91190E+04
14	.15030E+05
15	.24790E+05
16	.40870E+05
17	.67380E+05

```
18   .11110E+06
19   .18320E+06
20   .30200E+06
21   .49790E+06
22   .82080E+06
23   .13530E+07
24   .22310E+07
25   .36790E+07
26   .60650E+07
27   .10000E+08

ISOTOPE  1 DATA
FE IN 26 GROUP STRUCTURE FOR UPDATED ETOX LIBRARY
NAMEI      ISOTOPE NAME ------------------------------        FE
MAT11      ENDF/B ISOTOPE I.D. NUMBER ----------------       1122
NTEMP      NUMBER OF TEMPERATURES OF SELF-SHIELD FACTORS        1
NSIGO      NUMBER OF SIGO VALUES  OF SELF-SHIELD FACTORS        3
LN6        1/0=CALCULATE AND PRINT FISSION FRACTIONS  -         0
EMAXFF     MAX ENERGY FOR SS FACTOR CALCULATIONS  -----  .10000E+06
EMINFF     MIN ENERGY FOR SS FACTOR CALCULATIONS  -----  .10000E+01
EMN1EF     MIN ENERGY WEIGHT SPECTRUM=FISSION SPECTRUM-  .26000E+07
CFF        FISSION SPECTRUM CONSTANT (EV) ------------   .14000E+07
DELMAX     MAX FINE GROUP LETHARGY -------------------   .10000E+00
DELUMX     MAX UNRESOLVED GROUP LETHARGY -------------   .10000E+00
ANFMPD     NUMBER FINE-GP POINTS/ENDF/B SIGMA TOT POINTS .50000E+00
EPS        ROMBERG INTEGRATION ACCURACY PARAMETER        .10000E-02

           TEMPERATURES  SIGMA ZERO
         1  3.00000E+02  5.00000E+00
         2               5.00000E+01
         3               5.00000E+02

ETOX LIBRARY CONTROLS
NUP        1/0=PRODUCE UPDATED LIB OF ETOX X-SECTIONS/NO        1
NUP1       LIB SEQUENCE NO. OF 1ST ISOTOPE UPDATED  ---        3
NUP2       LIB SEQUENCE NO. OF LAST ISOTOPE UPDATED  --        3
NPR        1/0=PRINT X-SECTIONS/NO  ------------------         1
NPR1       LIB SEQUENCE NO. OF  1ST ISOTOPE PRINTED  --        1
NPR2       LIB SEQUENCE NO. OF LAST ISOTOPE PRINTED  --        3
NLAST      TOTAL NO. OF ISOTOPES ON INPUT LIBRARY  ----        3
```

The input ETOX library and the ENDF/B tape are assigned by control cards to logical units 47 and 48, respectively. In this example, the input ETOX library contains 26-group cross sections for three isotopes in the order ^{235}U, ^{238}U, and Fe. Execution of the path element ETX causes the ETOX code to be loaded and executed. ETOX calculates 26-group cross sections for Fe using input from the ETX INPT file and the Fe data on the ENDF/B tape. The output ETOX library containing the new Fe cross sections is written on logical unit 46.

Sample Problem 2. In this sample problem, the 26-group ETOX library created in Sample Problem 1 is used by 1DX in a one-dimensional calculation to create a 4-group standard MULTIGRP file containing the three isotopes ^{235}U, ^{238}U, and Fe. As a check on the group collapsing, the one-dimensional 1DX calculation is repeated with the 4-group MULTIGRP file.

Card input for this sample problem is shown on the next page. The first two cards define the number of path elements (6) and the path (INP PRN ODX INP ODX FL1) for the DRIVER program. The next card, INPCNT01, contains the controls for the first call to INP. This card instructs the INP module to create the ADMNSTR, GEO DIST, MIX DATA, and ODX INPT files from cards and to skip the other interface files. Cards for the four files created by INP are ADMNST01 through ADMNST04, GEODIS01 through GEODIS04, MIXDAT01 through MIXDAT05, and ODXINP01 through ODXINP15 as shown.

```
6  T  NUMBER OF PATH ELEMENTS                                                    DRIVER01
*INP   PRN   ODX   INP   ODX   FL1*  T  PATH                                    DRIVER02
1  R2(4)  R2(1)  R6(4)  1  R4(4)  T  CARD INPUT FILE CONTROLS                   INPCNT01
    * ADMNSTR FILE FOR 26-GROUP 1DX CALCULATION      */  TITLE                  ADMNST01
1  R3(0)  4  R2(2)  50  R2(1)  -1  1  R2(0.0)  1.0-4  R5(0.0)  1  R5(0)ADMNST02
-1  1  1.0  5  8  0  3  R4(0)  0.0  26  0  30  10  1.0-4  1.0-3  1.0-2 ADMNST03
0.5  1.0  1.0-3  1.0  T  ADMNSTR PARAMETERS                                     ADMNST04
0.0  I29(29.64)  I19(64.2)  T  MESH BOUNDARIES                                  GEODIS01
4  5  T  MATERIAL NUMBERS                                                       GEODIS02
R30(1)  R20(2)  T  ZONE NUMBERS                                                GEODIS03
1.9579-3  T  BUCKLING                                                          GEODIS04
R4(4)  R4(5)  T  MIX NUMBERS                                                   MIXDAT01
0  1  2  3  0  1  2  3  T  MIX COMMANDS                                         MIXDAT02
0.0  4.567-3  3.4392-2  7.167-03  0.0  8.9-5  4.0025-2/                        MIXDAT03
6.121-3  T  MIX DENSITIES                                                      MIXDAT04
1  2  3  T  ISOTOPE NUMBERS                                                    MIXDAT05
    * 1DX 26-GROUP REGULAR PROBLEM USING ETOX LIBRARY TAPE                    *ODXINP01
2  10  0  1  0  R2(4)  0  3  R3(0)  T  TITLE AND CONTROL PARAMETERS           ODXINP02
R2(1.0)  T  BUCKLING MODIFIERS                                                 ODXINP03
2.175-2 9.994-2 1.9746-1 2.2688-1 1.8522-1 1.2228-1 7.085-2 3.789-2           ODXINP04
1.93-2 9.55-3 4.64-3 2.23-3 1.06-3 5.0-4 2.4-4 1.1-4 5.0-5 3.0-5 2.0-5        ODXINP05
R7(0.0)  R26(1.0)  T  FISSION FRACTIONS AND VELOCITIES                         ODXINP06
R4(6)  1  2  3  R3(1)  T  DATA FOR XSEC GROUP COLLAPSING                      ODXINP07
1 1.0 0 1 2 3 R4(300.0) R4(0) R26(0.5) T DATA FOR RESONANCE-SHIELD CALC       ODXINP08
6 *U-235* 233.02 0.0 3.1-11 0.0 27.0 94350 1 -1 *U-238* 236.0 0.0           ODXINP09
3.1-11 0.0 27.0 94380 2 -1 *FE* 55.37 R3(0.0) 27.0 26558 4 0 T EXTRA          ODXINP10
1.24-2 3.05-2 0.111 0.301 1.14 3.01 T DELAY NEUT DECAY CONSTANTS             ODXINP11
0.0 2.2258-4 R3(0.0) 1.4821-3 R3(0.0) 1.3341-3 R3(0.0) 2.6784-3 R3(0.0)ODXINP12
7.8311-4 R3(0.0) 2.8569-4 R2(0.0) T DELAY NEUT YIELD SPECTRUM FOR U-235ODXINP13
0.0 2.2258-4 R3(0.0) 1.4821-3 R3(0.0) 1.3341-3 R3(0.0) 2.6784-3 R3(0.0)ODXINP14
7.8311-4 R3(0.0) 2.8569-4 R2(0.0) T DELAY NEUT YIELD SPECTRUM FOR U-238ODXINP15
2 R2(1) R2(2) R6(1) 2 R4(1) T  FILE PRINT CONTROLS                           PRNCNT01
3  R10(4)  1  R4(4)  T  CARD INPUT FILE CONTROLS                              INPCNT02
* ADMNSTR FILE FOR 4-GROUP 1DX CALCULATION      *  S38  4  T                  ADMNSTR2
    * 1DX 4-GROUP REGULAR PROBLEM USING MULTIGRP FROM PREVIOUS CALC           *ODXIN 01
2  3  R4(0)  5  R5(0)  T  TITLE AND CONTROL PARAMETERS                        ODXIN 02
R2(1.0)  T  BUCKLING MODIFIERS                                                 ODXIN 03
```

The next input card, PRNCNT01, instructs the PRN module to print the four files created in the preceding call to INP. This printed output is shown on the following pages. The next element in the path, ODX, causes the 1DX code to be loaded and executed. 1DX reads the four interface files available at this point and also the ETOX cross-section library. The ETOX library is expected on logical unit 46, which is the logical unit number for the output library from the ETOX code. 1DX performs the 26-group flux calculation and group collapse specified by the interface-data files. New files created by 1DX at this point are GRP FLXS and INTQUANT for the 26-group structure, MULTIGRP containing ^{235}U, ^{238}U, and Fe in the collapsed and resonance-shielded 4-group structure, and ZONEDENS.

Execution of the second call to INP sets up the ADMNSTR and ODX INPT files for repetition of the 1DX flux calculation using the MULTIGRP file created in the previous ODX call. Input card INPCNT02 instructs the INP module to overlay the existing ADMNSTR file with card ADMNSTR2 and to create a new ODX INPT file from cards ODXIN01 through ODXIN03. Note that only the title and parameter IGM are changed in the ADMNSTR file. Note also that the input for the ODX INPT file is considerably shorter when cross sections are read from the MULTIGRP file and no group collapsing is to be done.

In the second call to ODX, the 4-group flux calculation is performed by 1DX. New files created by 1DX at this point are GRP FLXS and INTQUANT for the 4-group structure. Finally, all the current interface files are copied onto a magnetic tape in the call to FL1. The user must assign the tape to logical unit 50 by a control card. This tape is used in Sample Problem 3 to continue the calculations.

ADMINISTRATION FILE FILE 51

ADMINISTRATION AND CONTROL PARAMETERS

ADMNSTR FILE FOR 26-GROUP 1DX CALCULATION

IA01	1/2/3=DIMENSION ----------		1
IA11	TYPE. 0=DIFFUSION, 1=TRANSPORT -----		0
IA02	THEORY. 0=REGULAR, 1=ADJOINT -------		0
IA03	ANISOTROPIC SCATTERING ORDER -------		0
IA04	ORDER OF SN APPROXIMATION ----------		4
IGE	0/1/2/3/6/7/8/9/11/12/13=GEOMETRY---		2
IZM	NUMBER OF ZONES ----------		2
IM	NUMBER OF 1ST DIMENSION INTERVALS---		50
JM	NUMBER OF 2ND DIMENSION INTERVALS---		1
KM	NUMBER OF 3RD DIMENSION INTERVALS---		1
IBK	NUMBER OF BUCKLING SETS ----------		-1
IEVT	0/1/2/3/4/5/6 = EIGENVALUE TYPE ----		1
EV	EIGENVALUE GUESS ----------	0.	
EVM	EIGENVALUE MODIFIER ----------	0.	
EPS	CONVERGENCE CRITERION ----------		.10000E-03
TEMP1	UNDEFINED. ----------	0.	
TEMP2	UNDEFINED. ----------	0.	
TEMP3	UNDEFINED. ----------	0.	
TEMP4	UNDEFINED. ----------	0.	
TEMP5	UNDEFINED. ----------	0.	
IB01	-1/0/1/2/3/4 = LEFT BDRY CONDITION		1
IB02	-1/0/1/2/3/4 = RIGHT BDRY CONDITION		0
IB03	-1/0/1/2/3/4 = TOP BDRY CONDITION		0
IB04	-1/0/1/2/3/4 = BOTTOM BDRY CONDITION		0
IB05	-1/0/1/2/3/4 = FRONT BDRY CONDITION		0
IB06	-1/0/1/2/3/4 = BACK BDRY CONDITION		0
M07	0/1/2/3/4/5 = FLUX INPUT OPTION ----		-1
IFXT	NEGATIVE SOURCE CHECK. 0=NO,1=YES --		1
S01	SOURCE NORMALIZATION FACTOR -------		.10000E+01
MT	NUMBER OF MATERIALS. ----------		5
M01	NUMBER OF MATERIAL SPECIFICATIONS---		8
MCR	NUMBER OF ISOTOPE XS SETS FROM CARDS		0
MSF	NUMBER OF ISOTOPE XS SETS FROM TAPE-		3
IZ	NUMBER OF 1ST DIMENSION ZONE MODFYRS		0
JZ	NUMBER OF 2ND DIMENSION ZONE MODFYRS		0
KZ	NUMBER OF 3RD DIMENSION ZONE MODFYRS		0
IS02	PARAMETRIC EIGENVALUE TYPE --------		0
S03	PARAMETRIC EIGENVALUE.	0.	
IGM	NUMBER OF ENERGY GROUPS. ----------		26
M06	0/1/2/3/4/5/6 = SOURCE INPUT OPTION-		0
ID05	MAXIMUM NUMBER OF OUTER ITERATIONS--		30
ID07	MAXIMUM NUMBER OF INNER ITERATIONS--		10
G05	NEUTRON BALANCE TEST. 0=NO,G05=LIMIT		.10000E-03
G06	POINTWISE FLUX TEST. 0=NO,G06=LIMIT-		.10000E-02
ALAL	LAMDA LOWER LIMIT ----------		.10000E-01
ALAH	LAMDA UPPER LIMIT ----------		.50000E+00
POD	NEW PARAMETER MODIFIER ----------		.10000E+01
EPSA	CONV. CRITERION-CRIT. SEARCHES. ---		.10000E-02
XFAC	EXTRAPOLATION FACTOR. ----------		.10000E+01

GEOMETRY AND MATERIAL DISTRIBUTIONS FILE FILE 53

	BOUNDARIES 1ST DIMENSN		BOUNDARIES 1ST DIMENSN		BOUNDARIES 1ST DIMENSN
1	0	19	1.77840E+01	37	4.00080E+01
2	9.88000E-01	20	1.87720E+01	38	4.17360E+01
3	1.97600E+00	21	1.97600E+01	39	4.34640E+01
4	2.96400E+00	22	2.07480E+01	40	4.51920E+01
5	3.95200E+00	23	2.17360E+01	41	4.69200E+01
6	4.94000E+00	24	2.27240E+01	42	4.86480E+01
7	5.92800E+00	25	2.37120E+01	43	5.03760E+01
8	6.91600E+00	26	2.47000E+01	44	5.21040E+01
9	7.90400E+00	27	2.56880E+01	45	5.38320E+01
10	8.89200E+00	28	2.66760E+01	46	5.55600E+01
11	9.88000E+00	29	2.76640E+01	47	5.72880E+01
12	1.08680E+01	30	2.86520E+01	48	5.90160E+01
13	1.18560E+01	31	2.96400E+01	49	6.07440E+01
14	1.28440E+01	32	3.13680E+01	50	6.24720E+01
15	1.38320E+01	33	3.30960E+01	51	6.42000E+01
16	1.48200E+01	34	3.48240E+01		
17	1.58080E+01	35	3.65520E+01		
18	1.67960E+01	36	3.82800E+01		

MATERIAL NUMBERS

	ZONE	MATERIAL NO.
1	1	4
2	2	5

ZONE NUMBERS

INTVL/ZONE			
1	1	26	1
2	1	27	1
3	1	28	1
4	1	29	1
5	1	30	1
6	1	31	2
7	1	32	2
8	1	33	2
9	1	34	2
10	1	35	2
11	1	36	2
12	1	37	2
13	1	38	2
14	1	39	2
15	1	40	2
16	1	41	2
17	1	42	2
18	1	43	2
19	1	44	2
20	1	45	2
21	1	46	2
22	1	47	2
23	1	48	2
24	1	49	2
25	1	50	2

GROUP AND ZONE INDEPENDENT BUCKLING= .19579E-02

MIXTURE DATA FILE FILE 56

MIXTURE SPECIFICATIONS

	MIX NUMBERS	MIX COMMAND	MIX DENSITY
1	4	0	0
2	4	1	4.56700E-03
3	4	2	3.43920E-02
4	4	3	7.16700E-03
5	5	0	0
6	5	1	8.90000E-05
7	5	2	4.00250E-02
8	5	3	6.12100E-03

ISOTOPE NUMBERS

	ISOTOPE NO.
1	1
2	2
3	3

ONEDX INPUT FILE FILE 62

TITLE AND CONTROL PARAMETERS

1DX 26-GROUP REGULAR PROBLEM USING ETOX LIBRARY TAPE

MAXT	MAX RUNNING TIME (MIN) ----------	2
NXCM	NUMBER OF DOWNSCATTER GROUPS ----------	10
NPRT	PRINT. 0/1/2=NO X-SEC OR FL/NO IN X-SEC/FULL	0
NRCF	NUMBER OF MIXES USED IN GENERATING X-SECTIONS	1
NIFF	NO. SPECTRUM ITERATIONS-ELASTIC DOWNSCATTER -	0
MM01	NO. MIX SPECS-RESONANCE SHIELDED X-SECTIONS -	4
NCR	NUMBER COLLAPSED GROUPS ----------	4
NTR	0/1=NORMALIZED/RECIPROCAL WGT. SIGMA TRANSPT	0
NFGM	NUMBER COLLAPSED MATERIALS ----------	3
IPUN	0/1=PRINT COLLAPSED XSECS/NO ----------	0
MULT1	0/1=READ MULTIGRP/READ PERTURBED MULTIGRP --	0
MULT2	0/1=WRITE MULTIGRP/WRITE PERTURBED MULTIGRP -	0

BUCKLING MODIFIERS

I	MODIFIERS
1	1.10000E+01
2	1.10000E+01

FISSION FRACTIONS AND VELOCITIES

GROUP	FISSION FRACTION	VELOCITY	GROUP	FISSION FRACTION	VELOCITY
1	2.17500E-02	1.00000E+00	14	5.00000E-04	1.00000E+00
2	9.99400E-02	1.00000E+00	15	2.40000E-04	1.00000E+00
3	1.97460E-01	1.00000E+00	16	1.10000E-04	1.00000E+00
4	2.26880E-01	1.00000E+00	17	5.00000E-05	1.00000E+00
5	1.85220E-01	1.00000E+00	18	3.00000E-05	1.00000E+00
6	1.22280E-01	1.00000E+00	19	2.00000E-05	1.00000E+00
7	7.08500E-02	1.00000E+00	20	0	1.00000E+00
8	3.78900E-02	1.00000E+00	21	0	1.00000E+00
9	1.93000E-02	1.00000E+00	22	0	1.00000E+00
10	9.55000E-03	1.00000E+00	23	0	1.00000E+00
11	4.64000E-03	1.00000E+00	24	0	1.00000E+00
12	2.23000E-03	1.00000E+00	25	0	1.00000E+00
13	1.06000E-03	1.00000E+00	26	0	1.00000E+00

XSEC COLLAPSING SPECIFICATIONS
INCLUDES NUMBER OF FINE GROUPS IN ITH BROAD GROUP,
I.D. NUMBER OF ITH MATERIAL TO BE COLLAPSED,AND
ZONE NOS OF FLUX FOR COLLAPSING ITH MATERIAL.

I	NO. FINE GRPS	MAT I.D.	ZONE NOS.
1	6	1	1
2	6	2	1
3	6	3	1
4	6		

RESONANCE SHIELDING SPECIFICATIONS
INCLUDES ZONE NO. OF FLUXES FOR ELASTIC DOWNSCATTER ITERATIONS FOR ITH MIX,
ITH MIX HETEROGENEITY CONSTANT
MIX COMMANDS CONTAINING ABSOLUTE REFERENCES TO ISOTOPES USED IN FORMING RESONANT MIXTURES
(SEE BNWL-954,UC-32),
TEMPERATURES OF NUCLIDES IN MIX COMMAND TABLE,
0/1=FUEL/MODERATOR DESIGNATION FOR MIX COMMAND TABLE,
LETHARGY WIDTH BY GROUP

I	ZONE NOS.	HET CONST	MIX COMMAND	TEMPERATURE	FUEL/MOD	LETHARGY WDTH
1	1	1.00000E+00	0	3.00000E+02	0	5.00000E-01
2			1	3.00000E+02	0	5.00000E-01
3			2	3.00000E+02	0	5.00000E-01
4			3	3.00000E+02	0	5.00000E-01
5						5.00000E-01
6						5.00000E-01
7						5.00000E-01
8						5.00000E-01
9						5.00000E-01
10						5.00000E-01
11						5.00000E-01
12						5.00000E-01
13						5.00000E-01
14						5.00000E-01
15						5.00000E-01
16						5.00000E-01
17						5.00000E-01
18						5.00000E-01
19						5.00000E-01
20						5.00000E-01
21						5.00000E-01
22						5.00000E-01
23						5.00000E-01
24						5.00000E-01
25						5.00000E-01
26						5.00000E-01

DATA NEEDED FOR WRITING COLLAPSED MULTIGRP FILE
(SEE DESCRIPTION OF MULTIGRP FILE)

NFAM= 6

I	ISONME	AWR		DCA	EFIS		ECAP	TDC	IZAS	KBR	ICHI
1	U-235	.23302E+03	0.		.31000E-10	0.		.27000E+02	94350	1	-1
2	U-238	.23600E+03	0.		.31000E-10	0.		.27000E+02	94380	2	-1
3	FE	.55370E+02	0.	0.		0.		.27000E+02	26558	4	0

DECAY CONSTANTS (1/SEC) BY DELAYED NEUTRON FAMILY

1	1.24000E-02
2	3.05000E-02
3	1.11000E-01
4	3.01000E-01
5	1.14000E+00
6	3.01000E+00

DELAYED NEUTRON SPECTRUM FOR U-235

FAMLY	GRP 1	GRP 2	GRP 3	GRP 4
1	0.	2.22580E-04	0.	0.
2	0.	1.48210E-03	0.	0.
3	0.	1.33410E-03	0.	0.
4	0.	2.67840E-03	0.	0.
5	0.	7.83110E-04	0.	0.
6	0.	2.85690E-04	0.	0.

DELAYED NEUTRON SPECTRUM FOR U-238

FAMLY	GRP 1	GRP 2	GRP 3	GRP 4
1	0.	2.22580E-04	0.	0.
2	0.	1.48210E-03	0.	0.
3	0.	1.33410E-03	0.	0.
4	0.	2.67840E-03	0.	0.
5	0.	7.83110E-04	0.	0.
6	0.	2.85690E-04	0.	0.

Sample Problem 3. Some of the interface files saved on magnetic tape in Sample Problem 2 are used in ANISN to obtain regular and adjoint flux solutions in S_4 approximation. The angular fluxes from ANISN are then used in a DAC perturbation calculation. Card input for this sample problem is given below. The first two cards, DRIVER01 and DRIVER02, instruct the DRIVER program to execute the path (FLO INP PRN ANI INP ANI DAC).

In the call to FLO, the interface files on the magnetic tape are copied to separate disk files. The user must assign the magnetic tape to logical unit 49. The next input card, INPCNT01, instructs the INP module to overlay the ADMNSTR file with input card ADMNST01 and to create the SN CONS, ANI INPT, and DAC INPT files from cards labeled SNCONS01 through SNCONS04, ANISN01 through ANISN03, and DACINP01 through DACINP06, respectively. Note that the only modification to the ADMNSTR file is in the title and in the diffusion/transport theory flag (IA11).

CARD INPUT FOR SAMPLE PROBLEM 3

```
7  T  NUMBER OF PATH ELEMENTS                                              DRIVER01
*FLO   INP   PRN   ANI   INP   ANI   DAC*  T  PATH                         DRIVER02
3  1  P10(4)  1  R2(4)  1  T  INPUT FILE CONTROLS (FIRST INP CALL)         INPCNT01
* ADMNSTR FILE FOR 4-GROUP S4 ANISN CALCULATION *  S1  I  T               ADMNST01
-0.471405 -0.333333 0.333333 -0.942809 -0.881917 -0.333333                SNCONS01
0.333333 0.881917  T  MU DIRECTIONS                                       SNCONS02
R8(0.0)  T  ETA DIRECTIONS                                                SNCONS03
0.0  R2(0.166667)  0.0  R4(0.166667)  T  WEIGHTS                          SNCONS04
* ANISN S4 4-GP REGULAR PROBLEM USING FILES SAVED IN SAMPLE PROBLEM 2 *    ANISN 01
1  3  4  7  R11(0)  0.0  0.5  T  ANISN CONTROL PARAMETERS                  ANISN 02
R30(1.0)  R20(0.0)  T  FISSION GUESS                                      ANISN 03
1  1  0  3  2  1  T  DAC CONTROL PARAMETERS                               DACINP01
1  8  2  T  PERTURBATION CASE DATA                                        DACINP02
R30(1)  R20(2)  T                                                         DACINP03
4  5  R4(4)  R4(5)  0  1  2  3  0  1  2  3  0.0  4.567-3  3.4392-2        DACINP04
7.167-3  0.0  8.9-5  4.0025-2  6.121-3  T                                 DACINP05
0.0  5.4804-3  3.4392-2  7.167-3  0.0  8.9-5  4.0025-2  6.121-3  T        DACINP06
R2(2)  R5(1)  2  R4(1)  2  R2(1)  2  T  FILE PRINT CONTROLS               PRNCNT01
3  R15(4)  T  INPUT FILE CONTROLS (SECOND INP CALL)                       INPCNT02
S10  1  T  RESET IA02 FOR ADJOINT CALCULATION                             ADMNST02
```

Input card PRNCNT01 instructs the PRN module to print the ADMNSTR, SN CONS, MULTIGRP, ANI INPT, and DAC INPT files. Output from the PRN module, except for the ADMNSTR file, is shown below.

Execution of the next path element, ANI, causes the ANISN code to be loaded and executed. ANISN performs the regular flux calculation and creates new GRP FLXS and INTQUANT files. The next input card, INPCNT02, instructs the INP module to overlay the ADMNSTR file with input card ADMNST02. At this point, only the regular/adjoint flag (IAD2) is changed. In the second call to ANI, ANISN performs the adjoint calculation and creates the ADJ FLXS file and a new INTQUANT file.

The last path element causes the DAC code to be loaded and executed. DAC performs the perturbation calculation specified by the DAC INPT file using the current versions of the ADMNSTR, GEO DIST, GRP FLXS, ADJ FLXS, INTQUANT, MIX DATA, and MULTIGRP files. In this example, the perturbation is a 20% increase in the ^{235}U atom density in the core.

OUTPUT FROM PRN MODULE--SAMPLE PROBLEM 3

SN CONSTANTS FILE FILE 52

	M	WEIGHT	MU
1	1	0	-4.71405E-01
2	2	1.66667E-01	-3.33333E-01
3	3	1.66667E-01	3.33333E-01
4	4	0	-9.42809E-01
5	5	1.66667E-01	-8.81917E-01
6	6	1.66667E-01	-3.33333E-01
7	7	1.66667E-01	3.33333E-01
8	8	1.66667E-01	8.81917E-01

REFERENCE MULTIGROUP FILE FILE 57

FILE TITLE
CROSS SECTIONS FROM IDX (STANDARD FILE MULTIGRP)

FILE PARAMETERS

NISO	NUMBER OF ISOTOPES. ----------	3
NEG	NUMBER OF GROUPS. ----------	4
NFAM	NUMBER OF DELAYED NEUTRON FAMILIES.	6
NBON	BONDARENKO DATA GIVEN. 1=YES,0=NO.	0
MAXUP	NUMBER OF UPSCATTER GROUPS. ----------	0
MAXDN	NUMBER OF DOWNSCATTER GROUPS. ----------	3
MSEC	SECONDARY X-SECTNS GIVEN. 1=YES,0=NO	0
MORD	NUMBER OF SCATTERING TABLES. ----------	1
MBINT	NUMBER OF SIGMAPO VALUES. ----------	0
MBTEM	NUMBER OF TEMPERATURES. ----------	0
ISL	SCATTERING TABLE LENGTH. ----------	4
IHM	CROSS-SECTION TABLE LENGTH. ----------	11

ISOTOPE IDENTIFICATION

NUMBER	NAME	TEMPERATURE	INDEX
1	U-235	.27000E+02	1
2	U-238	.27000E+02	1
3	FE	.27000E+02	1

GROUP STRUCTURE

	ENERGY LIMITS	LETHARGIES	1/VELOCITY	AV ENERGY	FISSN SPECTR
1	1.00000E+07	0	3.14014E-10	5.24894E+06	8.53530E-01
2	4.97871E+05	3.00000E+00	1.40731E-09	2.61329E+05	1.44460E-01
3	2.47875E+04	6.00000E+00	6.30715E-09	1.30108E+04	1.99000E-03
4	1.23410E+03	9.00000E+00	2.82667E-08	6.47770E+02	2.00000E-05
5	6.14421E+01	1.20000E+01			

DELAYED NEUTRON DECAY CONSTANTS

DELAY GROUP	DECAY CONSTANT
1	.12400E-01
2	.30500E-01
3	.11100E+00
4	.30100E+00
5	.11400E+01
6	.30100E+01

DELAYED NEUTRON SPECTRUM

P GRP	DGRP 1	DGRP 2	DGRP 3	DGRP 4	DGRP 5	DGRP 6
1	0.	0.	0.	0.	0.	0.
2	1.00000E+00	1.00000E+00	1.00000E+00	1.00000E+00	1.00000E+00	1.00000E+00
3 TO 4	0.	0.	0.	0.	0.	0.

DELAYED NEUTRON ABUNDANCES

D GRP	ISO 1	ISO 2	ISO 3
1	2.22580E-04	2.22580E-04	0.
2	1.48210E-03	1.48210E-03	0.
3	1.33410E-03	1.33410E-03	0.
4	2.67840E-03	2.67840E-03	0.
5	7.83110E-04	7.83110E-04	0.
6	2.85690E-04	2.85690E-04	0.

*ISOTOPE DATA BY ISOTOPE

ISOTOPE 1

ISOTOPE PARAMETERS

ISOID	ISOTOPE NUMBER	1
ISONME	ISOTOPE NAME	U-235
TDC	TEMPERATURE	.27000E+02
IRZM	MEDIUM INDEX	1
IZAS	=10000*Z+10*A+S	92350
AWR	ATOMIC WEIGHT	.23302E+03
EFIS	FISSION ENERGY	.31000E-10
ECAP	CAPTURE ENERGY	0.
DCA	DECAY CONSTANT	0.
KBR	MATERIAL TYPE FLAG	1
ICHI	FISSION FLAG	-1
LIN	SCATTERING ORDER, INELASTIC.	1
LFL	SCATTERING ORDER, ELASTIC.	0
LN2N	SCATTERING ORDER,N2N	0
JSXL	SECONDARY XS-LOWEST GROUP	0
JSXH	SECONDARY XS-HIGHEST GROUP	0
JDNL	DELAYED SPECTRUM-LOWEST GROUP	1
JDNH	DELAYED SPECTRUM-HIGHEST GROUP	4
NBINT	NUMBER OF SIGPO VALUES	0
NBTEM	NUMBER OF TEMPERATURES	0

PRINCIPAL CROSS-SECTIONS

POSITION	1	2	3	4	5	6	7
CROSS-SECTION	TOTAL	ABSORBTION	FISSION	NU-FISSION	TRANSPORT	N2N	FISSION-FRACTION

POSN	GRP 1	GRP 2	GRP 3	GRP 4
1	5.03407E+00	8.60212E+00	1.46333E+01	2.38250E+01
2	2.46544E+00	3.34217E+00	6.44198E+00	2.30579E+01
3	1.18451E+00	1.49058E+00	2.75076E+00	9.33568E+00
4	3.05474E+00	3.64389E+00	6.66963E+00	2.26204E+01
5	5.03407E+00	8.60212E+00	1.46333E+01	2.38250E+01
6 TO 7	0.	0.	0.	0.

TOTAL SCATTERING CROSS-SECTIONS, ORDER 1

POSN	GRP 1	GRP 2	GRP 3	GRP 4
1	3.17386E+00	6.73315E+00	1.09419E+01	1.01027E+01
2	0.	5.77974E-01	1.73726E-02	1.63931E-04
3	0.	0.	1.30278E-03	9.24544E-06
4	0.	0.	0.	0.

INELASTIC SCATTERING CROSS-SECTIONS, ORDER 1

POSN	GRP 1	GRP 2	GRP 3	GRP 4
1	3.17386E+00	6.73315E+00	1.09419E+01	1.01027E+01
2	0.	5.77974E-01	1.73726E-02	1.63931E-04
3	0.	0.	1.30278E-03	9.24544E-06
4	0.	0.	0.	0.

ISOTOPE 2

ISOTOPE PARAMETERS

ISOID	ISOTOPE NUMBER	2
ISONME	ISOTOPE NAME	U-238
TDC	TEMPERATURE	.27000E+02
IRZM	MEDIUM INDEX	1
IZAS	=10000*Z+10*A+S	94380
AWR	ATOMIC WEIGHT	.23600E+03
EFIS	FISSION ENERGY	.31000E-10
ECAP	CAPTURE ENERGY	0.
DCA	DECAY CONSTANT	0.
KBR	MATERIAL TYPE FLAG	2
ICHI	FISSION FLAG	-1
LIN	SCATTERING ORDER, INELASTIC.	1
LEL	SCATTERING ORDER, ELASTIC.	0
LN2N	SCATTERING ORDER,N2N	0
JSXL	SECONDARY XS-LOWEST GROUP	0
JSXH	SECONDARY XS-HIGHEST GROUP	0
JDNL	DELAYED SPECTRUM-LOWEST GROUP	1
JDNH	DELAYED SPECTRUM-HIGHEST GROUP	4
NBINT	NUMBER OF SIGPO VALUES	0
NBTEM	NUMBER OF TEMPERATURES	0

PRINCIPAL CROSS-SECTIONS

POSITION	1	2	3	4	5	6	7
CROSS-SECTION	TOTAL	ABSORBTION	FISSION	NU-FISSION	TRANSPORT	N2N	FISSION-FRACTION

POSN	GRP 1	GRP 2	GRP 3	GRP 4
1	5.24866E+00	8.96179E+00	1.20974E+01	9.89575E+00
2	3.87129E-01	1.88941E-01	5.23039E-01	7.34704E-01
3	1.39995E-01	0.	0.	0.
4	3.89284E-01	0.	0.	0.
5	5.24866E+00	8.96179E+00	1.20974E+01	9.89575E+00
6 TO 7	0.	0.	0.	0.

TOTAL SCATTERING CROSS-SECTIONS, ORDER 1

POSN	GRP 1	GRP 2	GRP 3	GRP 4
1	4.19103E+00	8.75480E+00	1.15742E+01	9.16105E+00
2	0.	8.07098E-01	1.80550E-02	1.35627E-04
3	0.	0.	3.39506E-03	0.
4	0.	0.	0.	0.

INELASTIC SCATTERING CROSS-SECTIONS, ORDER 1

POSN	GRP 1	GRP 2	GRP 3	GRP 4
1	4.19103E+00	8.75480E+00	1.15742E+01	9.16105E+00
2	0.	8.07098E-01	1.80550E-02	1.35627E-04
3	0.	0.	3.39506E-03	0.
4	0.	0.	0.	0.

ISOTOPE 3

ISOTOPE PARAMETERS

ISOID	ISOTOPE NUMBER	3
ISONME	ISOTOPE NAME	FE
TDC	TEMPERATURE	.27000E+02
IRZM	MEDIUM INDEX	1
IZAS	=10000*Z+10*A+S	26558
AWR	ATOMIC WEIGHT	.55370E+02
EFIS	FISSION ENERGY	0.
ECAP	CAPTURE ENERGY	0.
DCA	DECAY CONSTANT	0.
KBR	MATERIAL TYPE FLAG	4
ICHI	FISSION FLAG	0
LIN	SCATTERING ORDER, INELASTIC.	1
LEL	SCATTERING ORDER, ELASTIC.	0
LN2N	SCATTERING ORDER,N2N	0
JSXL	SECONDARY XS-LOWEST GROUP	0
JSXH	SECONDARY XS-HIGHEST GROUP	0
JDNL	DELAYED SPECTRUM-LOWEST GROUP	1
JDNH	DELAYED SPECTRUM-HIGHEST GROUP	4
NBINT	NUMBER OF SIGPO VALUES	0
NBTEM	NUMBER OF TEMPERATURES	0

PRINCIPAL CROSS-SECTIONS

POSITION	1	2	3	4	5	6	7
CROSS-SECTION	TOTAL	ABSORBTION	FISSION	NU-FISSION	TRANSPORT	N2N	FISSION-FRACTION

POSN	GRP 1	GRP 2	GRP 3	GRP 4
1	2.17940E+00	3.77882E+00	2.29673E+00	3.21855E+00
2	6.18155E-03	1.02199E-02	2.23880E-02	1.49746E-01
3 TO 4	0.	0.	0.	0.
5	2.17940E+00	3.77882E+00	2.29673E+00	3.21855E+00
6 TO 7	0.	0.	0.	0.

TOTAL SCATTERING CROSS-SECTIONS, ORDER 1

POSN	GRP 1	GRP 2	GRP 3	GRP 4
1	1.98985E+00	3.72476E+00	2.27419E+00	3.06880E+00
2	0.	1.83111E-01	4.38451E-02	1.61491E-04
3	0.	0.	2.56202E-04	0.
4	0.	0.	0.	0.

INELASTIC SCATTERING CROSS-SECTIONS, ORDER 1

POSN	GRP 1	GRP 2	GRP 3	GRP 4
1	1.98985E+00	3.72476E+00	2.27419E+00	3.06880E+00
2	0.	1.83111E-01	4.38451E-02	1.61491E-04
3	0.	0.	2.56202E-04	0.
4	0.	0.	0.	0.

ANISN INPUT FILE FILE 63

ANISN CONTROL PARAMETERS

ANISN S4 4-GP REGULAR PROBLEM USING FILES SAVED IN SAMPLE PROBLEM 2

ID	PROBLEM ID NUMBER ----------	1
IHT	XSEC TABLE POSN-SIGMA TOTAL ----	3
IHS	XSEC TABLE POSN-SIGMA SELF SCATT	4
IHM	XSEC TABLE LENGTH ----------	7
IDFM	1/0=DENSITY FACTORS USED/NO ---	0
IPM	IM/1/0=SHL SRC-E+G+A/G+A ONLY/NO	0
IPP	INTRVL WITH SHL SRC IF IPM=1 --	0
ID1	1/0= PRINT ANGULAR FLUX/NO ----	0
ID3	N/0=N ACTVTYS BY ZONE/NO ACTVTYS	0
ID4	1/0=N ACTVTYS BY INT (N=ID3)/NO	0
IDAT2	1/0=DIFF FOR GIVEN GPS/NO -----	0
IFG	1/0=COLLAPSE X-SECTIONS/NO ----	0
IFLU	0/1/2=NEG FLX FXUP-MIXD/LIN/STEP	0
IFN	1/0=FLUX GUESS/FISSION GUESS --	0
IPRT	0/1=PRINT X-SECTIONS/NO -------	0
DFM1	TRNSVRS DIR-VOID STRMG CORR. --	0.
RYF	NORMALLY 0.5. EPS/RYF=SCAT.CONV.	.50000E+00

FISSION GUESS

INTERVAL	GUESS	INTERVAL	GUESS
1	.10000E+01	26	.10000E+01
2	.10000E+01	27	.10000E+01
3	.10000E+01	28	.10000E+01
4	.10000E+01	29	.10000E+01
5	.10000E+01	30	.10000E+01
6	.10000E+01	31	0.
7	.10000E+01	32	0.
8	.10000E+01	33	0.
9	.10000E+01	34	0.
10	.10000E+01	35	0.
11	.10000E+01	36	0.
12	.10000E+01	37	0.
13	.10000E+01	38	0.
14	.10000E+01	39	0.
15	.10000E+01	40	0.
16	.10000E+01	41	0.
17	.10000E+01	42	0.
18	.10000E+01	43	0.
19	.10000E+01	44	0.
20	.10000E+01	45	0.
21	.10000E+01	46	0.
22	.10000E+01	47	0.
23	.10000E+01	48	0.
24	.10000E+01	49	0.
25	.10000E+01	50	0.

DAC INPUT FILE FILE 66

CONTROL PARAMETERS

ITP	MLTGRP FILE. 1/2=READ REF ONLY/READ REF+PERT	1
ID1	1/0=USE ANG FLUX/USE TOT FLUX AND CURRENT --	1
MAXLP	MAX NO. UPSCATTER GROUPS. ----------	0
MAXLD	MAX NO. DOWNSCATTER GROUPS. ----------	3
NFI	NO. FISSION ISOTOPES ----------	2
NCAS	NO. PERTURBATION CASES ----------	1

PERTURBATION CASE 1

PARAMETERS

ITPP	TYPE PERT. 1/2/3=DENSITY/X-SEC/BOTH ------	1
NPM	NO. PERT. MIX SPECIFICATIONS ----------	8
NPR	NO. PERT. ZONES ----------	2

PERTURBATION ZONE NUMBERS

1D/2D	1	1D/2D	1
1	1	26	1
2	1	27	1
3	1	28	1
4	1	29	1
5	1	30	1
6	1	31	2
7	1	32	2
8	1	33	2
9	1	34	2
10	1	35	2
11	1	36	2
12	1	37	2
13	1	38	2
14	1	39	2
15	1	40	2
16	1	41	2
17	1	42	2
18	1	43	2
19	1	44	2
20	1	45	2
21	1	46	2
22	1	47	2
23	1	48	2
24	1	49	2
25	1	50	2

PERTURBATION MIXTURE SPECIFICATIONS

	MAT NO./ZONE	MIX NUMBERS	MIX COMMANDS	DENSITIES	PT DENSITIES
1	4	4	0	0	0
2	5	4	1	4.56700E-03	5.48040E-03
3		4	2	3.43920E-02	3.43920E-02
4		4	3	7.16700E-03	7.16700E-03
5		5	0	0	0
6		5	1	8.90000E-05	8.90000E-05
7		5	2	4.00250E-02	4.00250E-02
8		5	3	6.12100E-03	6.12100E-03

Sample Problem 4. In this problem, the diffusion option of DOT2DB is invoked to obtain regular and adjoint flux files that are then input to DAC to compute the reactivity of a core fuel density perturbation. The model used is a 4-group, finite cylinder containing core and blanket regions.

The calculations are performed in two runs. In run 1, the path

```
*INP DOT INP DOT FL1* T PATH
```

is executed, and, in run 2, the path

```
*FLO DAC* T PATH
```

is executed.

The first call to INP in run 1 is used to read the input shown below. This input creates the files ADMNSTR, SN CONS, GEO DIST, MIX DATA, GRP FLXS, MULTIGRP, and DOT INPT for use in the first DOT call to calculate the regular case. In addition, the input creates an ADJ FLXS file that serves as a flux guess for the second DOT call and creates a DAC INPT file that defines the perturbation specifications for eventual input to DAC.

OUTPUT FROM FIRST INP CALL--SAMPLE PROBLEM 4

(Lines labeled on the far right by CARD and an integer are card images.)

```
****STANDARD FILE CARD INPUT****


FILE CONTROL

  1  1  4  1  1  1  1  1  4  4  4  4  4  1  4  1  T INP FILE CONTRL              CARD     1
IREAD 1/2/3/4=READ FILE FROM CARDS/STANDARD FILE/BOTH/SKIP FILE

            FILE NAME                IREAD
            ADMNSTR.                     1
            SN CONS                      1
            INTQUANT                     4
            GEO DIST                     1
            MIX DATA                     1
            GRP FLXS (REGULAR)           1
            GRP FLXS (ADJOINT)           1
            MULTIGRP (REFERENCE)         1
            MULTIGRP (PERTURBED)         4
            ZONE DENS                    4
            ETX INPT                     4
            ODX INPT                     4
            ANI INPT                     4
            DOT INPT                     1
            CLR INPT                     4
            DAC INPT                     1

**ADMINISTRATION FILE**

FILES-INPUT=  0. OUTPUT= 51


ADMNSTR DATA

* IDX SAMPLE PROBLEM FOR 2D CHECK OF DOT2DB.     *                            CARD     1

$DIM.TYPE.THEORY.SCAT.SYM.GEO.ZONES 2 0 0 0 4 7 2 MESH$ 15 15 1               CARD     2

$BUCK.EV TYPE.EVM.CONV= 1 1 1.0 0.0 1.0-04 $IGNORE$R5(0.0)                    CARD     3

$BCS$ 1 0 0 1 0 0  $AQ.IBI.SOU$ 3 1 1.0  $MT.MOI.MCR.MXF$ 11 11 0 9            CARD     4

$ZONE MODS$ M3(0)  $EA- CV$ 0 0.0 $NG$ 4 $SOURCE OP$ 00                       CARD     5

$CONV SPECS$90 10 0.0 0.0 0.0 0.0 1.0 0.0 0.0  T                              CARD     6
```

```
**SN CONSTANTS FILE**
FILES-INPUT=  0. OUTPUT= 52

MU DIRECTNS
-.9428093 -.881917 -.3333333 .3333333 .881917 -.4714045 -.3333333          CARD  1
.3333333 -.9428093 -.881917 -.3333333 .3333333 .881917 -.4714045           CARD  2
-.3333333 .3333333 T                                                       CARD  3
ETA DIRECTNS
R5(-.3333333) R3(-.881917) R5(.3333333) R3(.881917) T                      CARD  1
WEIGHTS
R2(0.0,R4(.08333332),0.0,R2(0.08333332)) T                                 CARD  1


**GEOMETRY AND MATERIAL DISTRIBUTIONS FILE**
FILES-INPUT=  0. OUTPUT= 53
1 DIM BDRYS
  0.0 I9(60.0)  I4(90.0)  T                                                CARD  1
2 DIM BDRYS
  0.0 I9(60.0)  I4(90.0)  T                                                CARD  1
MAT NUMBERS
 10 11 T                                                                   CARD  1
ZONE NUMBERS
R10(R10(1),R5(2)) R5(R15(2)) T                                             CARD  1


**MIXTURE DATA FILE**
FILES-INPUT=  0. OUTPUT= 56
MIX NUMBERS
  R6(10) R5(11) T                                                          CARD  1
MIX COMMAND
  0 1 2 3 4 5 6 7 8 -1                                                     CARD  1
MIX DENSITYS
  0.0 2.0-3 8.0-3 1.4-2 1.2-2 1.1-2 0.0 1.5-2 3.0-2 2.0-2 5.0-3 T          CARD  1
ISOTOPE NUMS
  1 2 3 4 5 6 7 8 9 T                                                      CARD  1
```

```
**REGULAR FLUX FILE**
FILES-INPUT=  0. OUTPUT= 59
GROUP FLUX
 121.0  604.0  362.0  5.73    T   FLUX GUESS. GROUP FACTORS.                    CARD    1
1 DIM FLUX
 1.0  1.0  0.971  0.944  0.908  0.864  0.812  0.752  0.685  0.612  0.527       CARD    1
      0.431  0.328  0.222  0.113  T   FLUX GUESS.  CF FACTORS=10.               CARD    2
2 DIM FLUX
 1.0  1.0  0.971  0.944  0.908  0.864  0.812  0.752  0.685  0.612  0.527       CARD    1
      0.431  0.328  0.222  0.113  T   FLUX GUESS.  SPACE FACTORS=10.           CARD    2


**ADJOINT FLUX FILE**
FILES-INPUT=  0. OUTPUT= 59
GROUP FLUX
 121.0  604.0  362.0  5.73    T   FLUX GUESS. GROUP FACTORS.                    CARD    1
1 DIM FLUX
 1.0  1.0  0.971  0.944  0.908  0.864  0.812  0.752  0.685  0.612  0.527       CARD    1
      0.431  0.328  0.222  0.113  T   FLUX GUESS.  SPACE FACTORS=10.           CARD    2
2 DIM FLUX
 1.0  1.0  0.971  0.944  0.908  0.864  0.812  0.752  0.685  0.612  0.527       CARD    1
      0.431  0.328  0.222  0.113  T   FLUX GUESS.  SPACE FACTORS=10.           CARD    2
```

```
**REFERENCE MULTIGROUP FILE**
FILES-INPUT=  0. OUTPUT= 57
FILE NAME
*FOUR-GROUP.[MM=6.3 DOWN GR=5 AS FROM ETOX=10X          * T                    CARD   1
MLTG CONTROL
 1 1 0 1 0 0 1 1 R4(0)   T                                                     CARD   1
DIMENSIONS
 9 4 6 1 0 0 8 4 5 3 2 0 1 R7(0) T                                             CARD   1
ISO NUMBERS
 1 2 3 4 5 6 7 8 9 T                                                           CARD   1
FIS ISOTOPES
 -1 -1 0 0 0 -1 0 0 0 T                                                        CARD   1
ANI ISOTOPES
 R9(0) T                                                                       CARD   1
ISOTOP NAMES
1 *PU239* 0.0 0   2 *U238* 0.0 0    3 *O* 0.0 0   4 *FE* 0.0 0                 CARD   1
5 *NA* 0.0 0   6 *U238* 0.0 0   7 *O* 0.0 0   8 *FE* 0.0 0   9 *NA* 0. 0T     CARD   2
GROUP STRUCT
0 0 R10(0.0) 3.0213-10 -.4915-10 3.2742-9 3.3147-8 R4(0.0) .576 .411           CARD   1
 .013 0.0 T                                                                    CARD   2
DELAY SPECTR
 R6(0.,1.0,0.,0.) T                                                            CARD   1
DLY ABUNDNCS
 7.752-05 5.713-04 4.4064-04 6.0912-4 2.1012-4 7.14-5 T                        CARD   1
PRINCIPAL XS
1.98243 2.0057529 6.41664 4.70947 1.635527 R3(0.)                              CARD   1
1.66228 3.48326   4.66681 7.7d001 4.2009378 1.02292 R2(0.)                      CARD   2
1.89936 4.4338    5.45816 12.9072 8.47043631 0.0958122 0.0452701 0.            CARD   3
8.11876 21.5555  23.3008  24.2078 2.6523  0.00296469 R2(0.) T                  CARD   4
DLY ABUNDNCS
 1.924-4 2.0274-3 2.3[illegible] 3.7424-3 3.33-3 1.11-3 T                      CARD   1
PRINCIPAL XS
.543109 1.10529  1.[illegible] 4.85537 1.1876641 R3(0.)                        CARD   1
 .00249434 .150954 .0364154 7.85158 7.326946 2.44899 R2(0.)                    CARD   2
0. .490207 0. 12.7358 12.2322655 .173613 .0734259 0.                           CARD   3
0. 1.43591 0. 12.4795 11.44359 .003372 0. 0. T                                 CARD   4
```

```
PRINCIPAL XS
 0. 1.60557-2 0. 1.25644  .9460043 R3(0.)                                  CARD  1
 R3(0.) 3.43451 3.270247 .31936 0. 0.                                     CARD  2
 R3(0.) 3.45356 3.4383222 .104263 0. 0.                                   CARD  3
 R3(0.) P2(3.6) 1.52375-2 0. 0. T                                         CARD  4
PRINCIPAL XS
 0. 8.78392-3 0. 2.32329 1.63722431 R3(0.)                                CARD  1
 0. 5.65896-3 0. 2.02003 2.56272314 .675723 0. 0.                         CARD  2
 0. 1.69589-2 0. 4.38577 4.3594398M .0516479 1.55877-3 0.                 CARD  3
 0. 2.80772-2 0. 10.2036 10.173722M 8.97122-3 0. 0. T                     CARD  4
PRINCIPAL XS
 0. 1.90861-3 0. 1.92068 1.48744439 R3(0.)                                CARD  1
 0. 5.46017-4 0. 3.50531 3.373617983 .431327 0. 0.                        CARD  2
 0. 2.83647-3 0. 4.89105 4.87320233 .131146 0. 0.                         CARD  3
 0. 5.40367-3 0. 3.15086 3.14545633  .0150112 0. 0. T                     CARD  4
DLY ABUNDNCS
 1.924-4 2.0276-3 2.3976-3 5.7424-3 3.33-3 1.11-3 T                       CARD  1
PRINCIPAL XS
 .543111 1.10485 1.53871 4.57344 1.1922549 R3(0.)                         CARD  1
 1.3443-3  .152249 2.4643-3 M.09663 7.728416 2.50276 0. 0.                CARD  2
 0. .508403 0. 12.7594 12.247088M .215965 7.35751-2 0.                    CARD  3
 0. 1.24617 0. 11.9635 10.71733 4.40623-3 0. 0. T                         CARD  4
PRINCIPAL XS
 0. 1.58622-2 0. 1.25327 .9134268 R3(0.)                                  CARD  1
 R3(0.)  3.39329 3.14850M .323481 0. 0.                                   CARD  2
R3(0.)  3.4626  3.4421274 .226768 0. 0.                                   CARD  3
 R3(0.) P2(3.6) 2.04726-2 0. 0. T                                         CARD  4
 PRINCIPAL XS
 0. 8.69661-3 0. 2.31702 1.6242547M R3(0.)                                CARD  1
 0. 5.82306-3 0. 2.67634 2.5998391M4 .67854 0. 0.                         CARD  2
 0. 1.83485-2 0. 4.45275 4.4319241 7.21256-2 1.32M53-3 0.                 CARD  3
 0. 3.07616-2 0. 13.4454 10.4190384 1.24774-2 0. 0. T                     CARD  4
 PRINCIPAL XS
 0. 1.92P34-3 0. 1.9244) 1.M3397M5 R3(0.)                                 CARD  1
 0. 6.825-4   0. 3.M4145 3.M58920) .438527 0. 0.                          CARD  2
 0. 4.20041-3 0. 3.M4541 3.M7108229 .142247 0. 0.                         CARD  3
 0. 6.06512-3 0. 3.11537 3.1090M4M 2.31273-2  0.  0.T                     CARD  4
```

```
**DOT2DR INPUT FILE**
FILES-INPUT=  0. OUTPUT= 66
PARAMETERS
  *  SAMPLE DOT2DR PROBLEM                                              *        CARD    1
  *     * 1  1  4  5  =  0  10 1  0  -1 1  0  0  1  T  CNTRL PARAMS              CARD    2
DIFF MARKERS
R4(1)  T DIFF MARKERS                                                          CARD    1


**DAC INPUT FILE**
FILES-INPUT=  0. OUTPUT= 66
CONTRL PRAMS
  1  0  0  3  3  1  T  DAC PARAMETERS                                         CARD    1
CASE PARMTRS
  1  11  2  T  CASE PARAMETERS                                               CARD    1
PT ZONE NOS
  R10(R10(1)*R5(2))  R5(R15(2))  T  ZONE NUMBERS                            CARD    1
PT MAT SPECS
  10  11  /  MATERIAL NUMBERS                                               CARD    1
  R6(10)  R5(11)  /  MIX NUMBERS                                            CARD    2
  0  1  2  3  4  5  0  6  7  8  9  /  MIX COMMAND                            CARD    3
  0.   .002  .008  .0192  .012  .011  0.  .015  .03  .02  .005  T  REF 0     CARD    4
PT MIX DENS
  0.   .0022 .008  .0192  .012  .011  0.  .015  .03  .02  .005  T PRT 0      CARD    1
```

In the second INP call of run 1, the card input shown below is read. This input alters the ADMNSTR file previously created to request the adjoint option in the second DOT call.

With a 10^{-4} convergence specification, k_{eff}'s of 0.96272 and 0.96279 are obtained for the regular and adjoint cases, respectively. In the DOT executions, the original flux guesses in the flux files are supplanted by the final converged fluxes. At the end of run 1, FL1 is called to store the existing set of files on tape.

In run 2, FL0 is called to recover the files from tape. These existing files provide all the input needed for the DAC execution. The DAC INPT file defines a perturbation in the ^{239}Pu atom density from 0.002 to 0.0022. This perturbation yields a reactivity of \$10.04. An effective delayed neutron fraction of 0.003117 and a generation time of 9.71×10^{-8} sec are also obtained.

OUTPUT FROM SECOND INP CALL--SAMPLE PROBLEM 4

(Lines labeled on the far right by CARD and an integer are card images.)

```
****STANDARD FILE CARD INPUT****

FILE CONTROL

   3  A15(4)  T  INP  FILE CONTROL                                    CARD    1
IREAD 1/2/3/4=READ FILE FROM CARDS/STANDARD FILE/OUTP/SKIP FILE

          FILE NAME                    IREAD
          ADMNSTR.                        3
          SN CONS                         4
          INITIANT                        4
          CRS DATA                        4
          MIX DATA                        4
          GRD FILES (UNFORMATTED)         4
          GRD FILES (FORMATTED)           4
          MULTIGEN (UNFORMATTED)          4
          MULTIGEN (FORMATTED)            4
          ZONE MAPS                       4
          FTX INPT                        4
          QLX INPT                        4
          ANI INPT                        4
          DOT INPT                        4
          CLC INPT                        4
          DAC INPT                        4

**ADMINISTRATIVE FILE**

FILES-INPUT= S1, ...

ADMNSTR DATA

   S10  1  SAN  T  ... STATE FILE                                      CARD    1
```

Sample Problem 5. In this sample problem, CLUB is used in a 3-group, 9-zone, single-cycle burnup calculation involving 5 chain equations and 16 isotopes. Zone-averaged fluxes are computed at the beginning of each burnup step with the DOT2DB code. Diffusion theory is used for the X-Y, 9 × 12 mesh flux calculation.

The first two input cards, DRIVER01 and DRIVER02, instruct the DRIVER program to execute the path FLO INP PRN CLB. It is assumed that a 3-group MULTIGRP file containing the 16 isotopes has been previously generated and stored on tape. This tape must be assigned by the user to logical unit 49. In the call to FLO, the MULTIGRP file is copied from the tape to a disk file.

The next input card, INPCNT01, instructs the INP module to create the ADMNSTR, SN CONS, GEO DIST, MIX DATA, GRP FLXS, ZONEDENS, DOT INPT, and CLB INPT files from card input. Input cards for these files are labeled ADMNST01 through ADMNST03, SNCONS01 through SNCONS03, GEODIS01 through GEODIS05, MIXDAT01 through MIXDAT06, GRPFLX01, ZONDEN01 and ZONDEN02, DOTINP01 through DOTINP03, and CLBINP01 through CLBINP17. The SN CONS file is always required by DOT2DB because of the possibility of mixed diffusion/S_n computations. In this example, however, the S_n constants are not used because diffusion theory is specified for all groups. DOT2DB always obtains a flux guess from the GRP FLXS file. The GRP FLXS file created with input card GRPFLX01 is a flat flux guess for the first DOT2DB calculation.

CARD INPUT FOR SAMPLE PROBLEM 5

```
4  T  NUMBER OF PATH ELEMENTS                                                    DRIVER01
*FLO   INP   PRN   CLB*  T  PATH                                                 DRIVER02
R2(1)  4  R3(1)  R3(4)  1  R3(4)  R2(1)  4  T  CARD INPUT FILE CONTROLS         INPCNT01
* ADMNSTR FILE FOR CLUB CALCULATION USING DOT2DB *  2  R3(0)  2  6              ADMNST01
R2(9)  12  1  0  1  R2(0.0)  1.0-4  R5(0.0)  1  R7(0)  1.0  25  153            ADMNST02
0  16  R4(0)  0.0  3  0  20  5  1.0-4  1.0-3  0.1  0.5  0.75 1.0-3 1.5TADMNST03
R2(-0.70711)  R2(0.70711)  -0.70711  0.70711  T  MU DIRECTIONS                  SNCONS01
R3(-0.70711)  R3(0.70711)  T  ETA DIRECTIONS                                    SNCONS02
R2(0.0,R2(0.25))  T  WEIGHTS                                                    SNCONS03
0.0  I3(10.5)  I2(14.85)  I1(26.65)  T  FIRST DIMENSION BOUNDARIES              GEODIS01
0.0  I9(60.0)  I1(66.0)  T  SECOND DIMENSION BOUNDARIES                        GEODIS02
17  18  19  20  21  22  23  24  25  T  MATERIAL NUMBERS BY ZONE                 GEODIS03
R18(1)  R2(R4(5),R3(9),R2(1))  R2(R4(4),R3(8),R2(1))  R2(R4(3),R3(7),R2GEODIS04
(1))  R2(R4(2),R3(6),R2(1))  R18(1)  T  ZONE NUMBERS BY INTERVAL                GEODIS05
R17(17)  R17(18)  R17(19)  R17(20)  R17(21)  R17(22)  R17(23)  R17(24)          MIXDAT01
R17(25)  T  MIX NUMBERS                                                         MIXDAT02
R9(0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16)  T  MIX COMMANDS                   MIXDAT03
0.0  0.06  R7(0.0)  0.03  0.0  0.001  R5(0.0)  R8(0.0,2.5-2,1.0-20,1.0-MIXDAT04
2,R3(0.0),4.9768-4,0.0,1.5-2,0.0,1.0-2,R5(0.0))  T  MIX DENSITIES              MIXDAT05
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 T ISOTOPE NOS ON MULTIGRP FILE           MIXDAT06
R3(1.0)  T  FLAT FLUX GUESS FOR DOT2DB                                          GRPFLX01
.06  R7(0.0)  .03  .0  0.001  R5(0.0)  R8(2.5-2,1.0-20,1.0-2,R3(0.0),4.ZONDEN01
9768-4,0.0,1.5-2,0.0,1.0-2,R5(0.0))  T  ATOM DENS BY ISOTOPE AND ZONE           ZONDEN02
* 3-GRP,X-Y,9-ZONE,9X12 MESH,DOT2DB DIFFUSION PROBLEM FOR USE WITH CLB*DOTINP01
R2(1)  4  5  6  0  5  R2(0)  -1  1  R3(0)  T  DOT2DB CONTROL PARAMETERSDOTINP02
R3(1)  T  DIFFUSION MARKERS                                                     DOTINP03
* CLUB 3-GROUP,9-ZONE,DEPLETION PROBLEM USING DOT2DB TO                         *CLBINP01
* COMPUTE ZONE-AVERAGE FLUXES AT BEGINNING OF EACH BURNUP STEP                  *CLBINP02
5  *DOT*  T  TITLE AND NEUTRONICS SELECTION                                     CLBINP03
* SINGLE CYCLE, 5 CHAIN EQUATIONS, END-OF-CYCLE KEFF=1.0                        *CLBINP04
1 10 R2(0) 1 R7(0) 1 R2(0) 3 9 3.6+4 R2(1.0) R3(0.0) 5.0+3 0.0 1.0+9           CLBINP05
1.0 0.0 R2(20.,40.,60.)  1 0 1 0 R2(1) R2(0) R4(1) T  DEPLET HIST              CLBINP06
2 T  NUMBER OF ZONE SETS                                                        CLBINP07
1 1 1 2 -1 *REFLECTOR  * 2 9 1 1 0 *CORE ZONES  * T  ZONE CLASSIFICA           CLBINP08
6 4 T  NUMBER OF FISSIONABLE AND FISSION-PRODUCT NUCLIDES                       CLBINP09
3 4 5 6 7 8 9  T  NUMBERS OF FISSIONABLE NUCLIDES                               CLBINP10
12  5.39-02  5.5-02  5.62-2  5.8-2  6.17-2  6.3-2  13  2.1-3  2.2-3  2.2-3    CLBINP11
2.3-3  2.3-3  2.4-3  14  2.0  2.2  2.4  2.6  2.8  3.0  15  1.0  1.1           CLBINP12
1.2  1.3  1.4  1.5  T  FISS-PROD ID NOS AND YIELDS FROM FISS NUCLIDES          CLBINP13
5  T  NUMBER OF NUCLIDE CHAINS                                                  CLBINP14
11  9  R3(3)  T  LENGTH OF CHAINS                                               CLBINP15
3 1 4 -1 5 1 6 1 7 1 8 1 9 1 200006 1 200007 1 200008 12 -1 13 15 1            CLBINP16
14  9  1  10  T  CHAIN SPECIFICATIONS                                           CLBINP17
2  R2(1)  R2(2)  R4(1)  2  R5(1)  R2(2)  -1  T  FILE PRINT CONTROLS            PRNCNT01
```

The last input card, PRNCNT01, instructs the PRN module to print the ADMNSTR, GEO DIST, MIX DATA, ZONEDENS, DOT INPT, and CLB INPT files created in the preceding call to INP. This printed output is shown below. The last element in the path, CLB, causes the CLUB code to be loaded and executed. For this particular problem, the depletion cycle is terminated when k_{eff} has been reduced to 1.0. This occurs at 135.7 days after four burnup steps.

OUTPUT FROM PRN MODULE--SAMPLE PROBLEM 5

ADMINISTRATION FILE FILE 51

ADMINISTRATION AND CONTROL PARAMETERS

ADMNSTR FILE FOR CLB CALCULATION USING DOT2D5

IA01	1/2/3=DIMENSION ----------		2
IA11	TYPE. 0=DIFFUSION, 1=TRANSPORT -----		0
IA02	THEORY. 0=REGULAR, 1=ADJOINT -------		0
IA03	ANISOTROPIC SCATTERING ORDER -------		0
IA04	ORDER OF SN APPROXIMATION ----------		2
IGE	0/1/2/4/6/7/8/9/11/12/13=GEOMETRY---		6
IZM	NUMBER OF ZONES ----------		9
IM	NUMBER OF 1ST DIMENSION INTERVALS---		9
JM	NUMBER OF 2ND DIMENSION INTERVALS---		12
KM	NUMBER OF 3RD DIMENSION INTERVALS---		1
IBK	NUMBER OF BUCKLING SETS ----------		0
IEVT	0/1/2/3/4/5/6 = EIGENVALUE TYPE ----		1
EV	EIGENVALUE GUESS ----------	0.	
EVM	EIGENVALUE MODIFIER ----------	0.	
EPS	CONVERGENCE CRITERION ----------	.10000E-03	
TEMP1	UNDEFINED. ----------	0.	
TEMP2	UNDEFINED. ----------	0.	
TEMP3	UNDEFINED. ----------	0.	
TEMP4	UNDEFINED. ----------	0.	
TEMP5	UNDEFINED. ----------	0.	
IB01	-1/0/1/2/3/4 = LEFT BDRY CONDITION		1
IB02	-1/0/1/2/3/4 = RIGHT BDRY CONDITION		0
IB03	-1/0/1/2/3/4 = TOP BDRY CONDITION		0
IB04	-1/0/1/2/3/4 = BOTTOM BDRY CONDITION		0
IB05	-1/0/1/2/3/4 = FRONT BDRY CONDITION		0
IB06	-1/0/1/2/3/4 = BACK BDRY CONDITION		0
M07	0/1/2/3/4/5 = FLUX INPUT OPTION ----		0
IFXT	NEGATIVE SOURCE CHECK. 0=NO,1=YES --		0
S01	SOURCE NORMALIZATION FACTOR --------	.10000E+01	
MT	NUMBER OF MATERIALS. ----------		25
M01	NUMBER OF MATERIAL SPECIFICATIONS---		153
MCR	NUMBER OF ISOTOPE XS SETS FROM CARDS		0
MSF	NUMBER OF ISOTOPE XS SETS FROM TAPE-		16
IZ	NUMBER OF 1ST DIMENSION ZONE MODFYRS		0
JZ	NUMBER OF 2ND DIMENSION ZONE MODFYRS		0
KZ	NUMBER OF 3RD DIMENSION ZONE MODFYRS		0
IS02	PARAMETRIC EIGENVALUE TYPE --------		0
S03	PARAMETRIC EIGENVALUE.	0.	
IGM	NUMBER OF ENERGY GROUPS. ----------		3
M06	0/1/2/3/4/5/6 = SOURCE INPUT OPTION-		6
ID05	MAXIMUM NUMBER OF OUTER ITERATIONS--		20
ID07	MAXIMUM NUMBER OF INNER ITERATIONS--		5
G05	NEUTRON BALANCE TEST. 0=NO,G05=LIMIT	.10000E-03	
G06	POINT-TO-PT FLUX TEST. 0=NO,G06=LIMIT-	.10000E-02	
ALAI	LAMDA LOWER LIMIT ----------	.10000E+00	
ALAH	LAMDA UPPER LIMIT ----------	.50000E+00	
P00	NEW PARAMETER ON 1ST ITER ----------	.75000E+00	
EPSA	CONV. CRITERION FOR IT. SEARCHES. ---	.10000E-02	
XFAC	EXTRAPOLATION FACTOR. ----------	.15000E+01	

GEOMETRY AND MATERIAL DISTRIBUTIONS FILE FILE 53

BOUNDARIES

	1ST DIMENSN	2ND DIMENSN	3RD DIMENSN
1	0	0	
2	2.62500E+00	5.00000E+00	
3	5.25000E+00	1.20000E+01	
4	7.87500E+00	1.80000E+01	
5	1.05000E+01	2.40000E+01	
6	1.19500E+01	3.00000E+01	
7	1.34000E+01	3.60000E+01	
8	1.48500E+01	4.20000E+01	
9	2.08500E+01	4.80000E+01	
10	2.68500E+01	5.40000E+01	
11		6.00000E+01	
12		6.30000E+01	
13		6.60000E+01	

MATERIAL NUMBERS

	ZONE	MATERIAL NO.
1	1	17
2	2	18
3	3	19
4	4	20
5	5	21
6	6	22
7	7	23
8	8	24
9	9	25

ZONE NUMBERS

ID/ 2D	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	5	5	4	4	3	3	2	2	1	1
2	1	1	5	5	4	4	3	3	2	2	1	1
3	1	1	5	5	4	4	3	3	2	2	1	1
4	1	1	5	5	4	4	3	3	2	2	1	1
5	1	1	9	9	8	8	7	7	6	6	1	1
6	1	1	9	9	8	8	7	7	6	6	1	1
7	1	1	9	9	8	8	7	7	6	6	1	1
8	1	1	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1	1	1

MIXTURE DATA FILE FILE 56

MIXTURE SPECIFICATIONS

MIX NUMBERS		MIX COMMAND	MIX DENSITY	MIX NUMBERS		MIX COMMAND	MIX DENSITY
1	17	0	0	11	17	10	0
2	17	1	5.00000E-02	12	17	11	1.60000E-03
3	17	2	0	13	17	12	0
4	17	3	0	14	17	13	0
5	17	4	0	15	17	14	0
6	17	5	0	16	17	15	0
7	17	6	0	17	17	16	0
8	17	7	0	18	18	0	0
9	17	8	0	19	19	1	2.50000E-02
10	17	9	4.00000E-02	20	19	2	1.00000E-20

MIX NUMBERS		MIX COMMAND	MIX DENSITY
21	18	3	1.00000E-02
22	18	4	0
23	18	5	0
24	18	6	0
25	18	7	4.97680E-04
26	18	8	0
27	18	9	1.50000E-02
28	18	10	0
29	18	11	1.00000E-02
30	18	12	0
31	18	13	0
32	18	14	0
33	18	15	0
34	18	16	0
35	19	0	0
36	19	1	2.50000E-02
37	19	2	1.00000E-20
38	19	3	1.00000E-02
39	19	4	0
40	19	5	0
41	19	6	0
42	19	7	4.97680E-04
43	19	8	0
44	19	9	1.50000E-02
45	19	10	0
46	19	11	1.00000E-02
47	19	12	0
48	19	13	0
49	19	14	0
50	19	15	0
51	19	16	0
52	20	0	0
53	20	1	2.50000E-02
54	20	2	1.00000E-20
55	20	3	1.00000E-02
56	20	4	0
57	20	5	0
58	20	6	0
59	20	7	4.97680E-04
60	20	8	0
61	20	9	1.50000E-02
62	20	10	0
63	20	11	1.00000E-02
64	20	12	0
65	20	13	0
66	20	14	0
67	20	15	0
68	20	16	0
69	21	0	0
70	21	1	2.50000E-02
71	21	2	1.00000E-20
72	21	3	1.00000E-02
73	21	4	0
74	21	5	0
75	21	6	0
76	21	7	4.97680E-04
77	21	8	0
78	21	9	1.50000E-02
79	21	10	0
80	21	11	1.00000E-02
81	21	12	0
82	21	13	0
83	21	14	0
84	21	15	0
85	21	16	0
86	22	0	0
87	22	1	2.50000E-02

MIX NUMBERS		MIX COMMAND	MIX DENSITY
88	22	2	1.00000E-20
89	22	3	1.00000E-02
90	22	4	0
91	22	5	0
92	22	6	0
93	22	7	4.97680E-04
94	22	8	0
95	22	9	1.50000E-02
96	22	10	0
97	22	11	1.00000E-02
98	22	12	0
99	22	13	0
100	22	14	0
101	22	15	0
102	22	16	0
103	23	0	0
104	23	1	2.50000E-02
105	23	2	1.00000E-20
106	23	3	1.00000E-02
107	23	4	0
108	23	5	0
109	23	6	0
110	23	7	4.97680E-04
111	23	8	0
112	23	9	1.50000E-02
113	23	10	0
114	23	11	1.00000E-02
115	23	12	0
116	23	13	0
117	23	14	0
118	23	15	0
119	23	16	0
120	24	0	0
121	24	1	2.50000E-02
122	24	2	1.00000E-20
123	24	3	1.00000E-02
124	24	4	0
125	24	5	0
126	24	6	0
127	24	7	4.97680E-04
128	24	8	0
129	24	9	1.50000E-02
130	24	10	0
131	24	11	1.00000E-02
132	24	12	0
133	24	13	0
134	24	14	0
135	24	15	0
136	24	16	0
137	25	0	0
138	25	1	2.50000E-02
139	25	2	1.00000E-20
140	25	3	1.00000E-02
141	25	4	0
142	25	5	0
143	25	6	0
144	25	7	4.97680E-04
145	25	8	0
146	25	9	1.50000E-02
147	25	10	0
148	25	11	1.00000E-02
149	25	12	0
150	25	13	0
151	25	14	0
152	25	15	0
153	25	16	0

ISOTOPE NUMBERS

	ISOTOPE NO.
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16

ZONE DENSITIES FILE FILE 58

ATOM DENSITIES

ISOTP	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5
1	6.00000E-02	2.50000E-02	2.50000E-02	2.50000E-02	2.50000E-02
2	0.	1.00000E-20	1.00000E-20	1.00000E-20	1.00000E-20
3	0.	1.00000E-02	1.00000E-02	1.00000E-02	1.00000E-02
4 TO 6	0.	0.	0.	0.	0.
7	0.	4.97680E-04	4.97680E-04	4.97680E-04	4.97680E-04
8	0.	0.	0.	0.	0.
9	3.00000E-02	1.50000E-02	1.50000E-02	1.50000E-02	1.50000E-02
10	0.	0.	0.	0.	0.
11	1.00000E-03	1.00000E-02	1.00000E-02	1.00000E-02	1.00000E-02
12 TO 16	0.	0.	0.	0.	0.

ZONE 6	ZONE 7	ZONE 8	ZONE 9
2.50000E-02	2.50000E-02	2.50000E-02	2.50000E-02
1.00000E-20	1.00000E-20	1.00000E-20	1.00000E-20
1.00000E-02	1.00000E-02	1.00000E-02	1.00000E-02
0.	0.	0.	0.
4.97680E-04	4.97680E-04	4.97680E-04	4.97680E-04
0.	0.	0.	0.
1.50000E-02	1.50000E-02	1.50000E-02	1.50000E-02
0.	0.	0.	0.
1.00000E-02	1.00000E-02	1.00000E-02	1.00000E-02
0.	0.	0.	0.

DOT2DB INPUT FILE FILE 64

```
DOT2DB CONTROL PARAMETERS

 3-GRP,X-Y,9-ZONE,FIXED MESH,DOT2DB DIFFUSION PROBLEM FOR USE WITH CLUB
A01          PROBLEM I.D. NUMBER  ----------              1
EXT          0/1/2=LIN/LIN-BUMP NEG FLX/STP FN           1
IHT          POSN SIGMA TOTAL  ---------------           4
IHS          POSN SIGMA SELF-SCATTER                     5
ITL          X-SECTION TABLE LENGTH  --------            6
M05          NO. REGIONWISE ACTIVITIES  -----            0
S04          INITIAL INNER IT MAX/GROUP  ----            5
IAFT         2/0=PRINT FLUX MOMENTS/NO  -----            0
M04          NO. POINTWISE ACTIVITIES  ------            0
M06          -1/0/1/2/3/4=DIST SOURCE OPTION            -1
IB01         0/1/2/3=LEFT BOUNDARY CONDITION             1
IB02         0/1/2/3/4=RIGHT BOUND CONDITION             0
IB03         0/1/2/3/4=TOP BOUNDARY CONDITION            0
IB04         0/1/2/3=BOTTOM BOUND CONDITION              0

DIFFUSION MARKERS

GROUP  MARKER
  1        1
  2        1
  3        1
```

CLUB INPUT FILE FILE 65

```
TITLE AND NEUTRONICS SELECTION

 CLUB 3-GROUP,9-ZONE,DEPLETION PROBLEM USING DOT2DB TO
 COMPUTE ZONE-AVERAGE FLUXES AT BEGINNING OF EACH BURNUP STEP
LIM          CPU TIME LIMIT (MIN)                       5
SEL          NEUTRONICS SELECTION (A3)                DOT
             ZAF=NO FLUX CALC. USE ZONE FLUX
                 ON INTEGRANT FILE.
             AIM=INFINITE MEDIUM CALCULATION.
             ODX=USE ONEDX CODE.
             ANI=USE ANISN CODE.
             DOT=USE DOT2DB CODE.
               (ANY OTHER FLUX CODE CAN BE
                ACCESSED BY PUTTING SEGMENTED
                BINARY VERSION OF CODE ON A
                FILE WITH 3-CHARACTER NAME.


  DEPLETION HISTORY AND EDITING OPTIONS

   SINGLE CYCLE, 5 CHAIN EQUATIONS, END-OF-CYCLE KEFF=1.0
  ND(1)      NUMBER OF CYCLES  -------------------------      1
  ND(2)      MAX NO. DEPLETION TIME STEPS FOR FIRST CYCLE    10
  ND(3)      MAX NO. DEPLETION TIME STEPS FOR 2ND CYCLE  -    0
  ND(4)      MAX NO. DEPLETION TIME STEPS FOR OTHER CYCLES    0
  ND(5)      NUMBER OF SUBSTEPS FOR EACH DEPLETION STEP  -    1
  ND(6)      1/0=RECALCULATE FLUX AT END OF TIME STEP  ---    0
                 AND USE LINEAR AVERAGED FLUX OVER SUBSTEP
                 INTERVALS/NO
  ND(7)      0/1=SAVE START-OF-STEP NUCLIDE DENSITIES FOR-    0
                 END OF CYCLE RECOVERY/NO
  ND(8)      0/1=RENORMALIZE FLUX AFTER EACH SUBSTEP TO --    0
                 ACHIEVE DESIRED POWER LEVEL/NO
```

ND(9)	1/0=RETURN POWER LEVEL TO ORIGINAL S.TES --- (SEE DD(1) AND DD(8)) AFTER EACH FLUX CALCULATION/ADJUST POWER LEVEL TO GIVE DESIRED AVERAGE OVER THE TIME STEPS (SEE DD(5) AND DD(6))	0
ND(10)	OPTION ON LIMITING POWER DENSITY (SEE DD(4))- 0=TERMINATE IF LIMIT EXCEEDED 1=CONTINUE WITH UNCHANGED PROCEDURE 2=ADJUST POWER TO LIMIT POWER DENSITY 3=ADJUST POWER TO MAINTAIN POWER DENSITY	0
ND(11)	0/1=LIMITING POWER DENSITY DD(4) APPLIES TO-- ZONES/SUBZONES	0
ND(12)	0/1=LIMITING AVERAGE EXPOSURE DD(9) APPLIES-- TO ZONES/ZONE CLASSES	0
ND(13)	1/0=DO FLUX CALC FOR END-OF-CYCLE CONDTNS/NO-	1
ND(14)	OPTION ON END-OF-CYCLE EXTRAPOLATION ------- -2=EXTRAPOLATE ON EXPOSURE -1=EXTRAPOLATE ON CONTROL POISON 0=EXTRAPOLATE ON EXCESS REACTIVITY 1=DO NOT EXTRAPOLATE	0
ND(15)	OPTION FOR CALCULATION OF CONVERSION RATIO 0=USE CAPTURE RATE IN FERTILE MATERIAL 1=USE N•GAMMA RATE IN FERTILE MATERIAL	0
ND(16)	NUMBER OF ENERGY GROUPS ----------	3
ND(17)	NUMBER OF MATERIAL ZONES ----------	9
DD(1)	REFERENCE CORE POWER (WT) FOR FIRST CYCLE ---	.30000E+05
DD(2)	RATIO OF THERMAL TO FISSION ENERGY ---------	.10000E+01
DD(3)	FRACTION OF CORE INCLUDED IN MODEL ---------	.10000E+01
DD(4)	LIMITING POWER DENS.TY (W/CC). USE OF DD(4) - DEPENDS ON ND(10) AND ND(11) OPTIONS.	0.
DD(5)	DESIRED POWER (MWT) FOR CLASS 1 ZONES ------	0.
DD(6)	SAME AS DD(5) BUT FOR CLASS 1 AND CLASS 2 --- ZONES SUMMED. FLUX ADJUSTED TO HIGHEST LEVEL TO MAINTAIN DD(5) OR DD(6)	0.
DD(7)	MAXIMUM DAYS EXPOSURE ANY CYCLE ----------	.50000E+04
DD(8)	CORE POWER (WT) FOR ALL BUT FIRST CYCLE ----	0.
DD(9)	LIMITING AVER HEAVY METAL MWT/METRIC TON --- TERMINATING CYCLE	.10000E+10
DD(10)	DESIRED END-OF-CYCLE MULTIPLICATION FACTOR -	.10000E+01
DD(11)	DESIRED END-OF-CYCLE FRACTION NEUTRON LOSS - IN CONTROL ABSORBER	0.
DD(12)	DAYS DEPLETION TIME STEP 1• CYCLE 1 --------	.20000E+02
DD(13)	DAYS DEPLETION TIME STEP 2• CYCLE 1 --------	.40000E+02
DD(14)	DAYS DEPLETION REMAINING TIME STEPS• CYCLE 1-	.60000E+02
DD(15)	SAME AS DD(12) BUT FOR REMAINING CYCLES ----	.20000E+02
DD(16)	SAME AS DD(13) BUT FOR REMAINING CYCLES ----	.40000E+02
DD(17)	SAME AS DD(14) BUT FOR REMAINING CYCLES ----	.60000E+02
IEDT(1)	N/0=PRINT ZONE NUCL DENS EVERY NTH TIME STEP- /NO	1
IEDT(2)	SAME AS IEDT(1) BUT BY SUBZONE ----------	0
IEDT(3)	N/0=PRNT TOT NUCL REAC RATES EVERY N STEPS/NO	1
IEDT(4)	SAME AS IEDT(3) BUT BY ZONE ----------	0
IEDT(5)	N/0=PRNT ZONE FLUX EVERY N STEPS/NO --------	1
IEDT(6)	N/0=PRNT ZONE POWER EVERY N STEPS/NO -------	1
IEDT(7)	N/0=PRNT DECAY ACTIVITIES EVERY N STEPS/NO---	0
IEDT(8)	1/0=DEBUGGING PRINT/NO ----------	0
IEDT(9)	1/0=PRNT MULTIGRP FILE X-SECTS USED/NO -----	1
IEDT(10)	1/0=PRNT START OF CYCLE NUCL DENS BY ZONE/NO-	1
IEDT(11)	1/0=PRNT END OF CYCLE NUCL DENS BY SUBZONE/NO	1
IEDT(12)	1/0=PRNT END OF CYCLE FISSILE LOADINGS/NO --	1

ZONE CLASSIFICATION DATA

NUMBER OF ZONE SETS= 2

1ST ZONE NO.	LAST ZONE NO	NO. SUBZONES	ZONE CL NO.	DEPLETE FLAG	ZONE CLASS NAME (2A6)
1	1	1	2	-1	REFLECTOR
2	9	1	1	0	CORE ZONES

FISSION YIELD DATA

NUMBER OF FISSION NUCLIDES= 6

NUMBER OF FISSION PRODUCT NUCLIDES= 4

FISSION NUCLIDE I.D. NUMBERS

I	I.D.
1	3
2	4
3	5
4	6
5	7
6	8

FISSION PRODUCT I.D. NUMBERS

J	I.D.
1	12
2	13
3	14
4	15

YIELD OF JTH FISSION PRODUCT FROM ITH FISSION NUCLIDE

I	J 1	J 2	J 3	J 4
1	5.39000E-02	2.10000E-03	2.00000E+00	1.00000E+00
2	5.50000E-02	2.20000E-03	2.20000E+00	1.10000E+00
3	5.62000E-02	2.20000E-03	2.40000E+00	1.20000E+00
4	5.80000E-02	2.30000E-03	2.60000E+00	1.30000E+00
5	6.17000E-02	2.30000E-03	2.80000E+00	1.40000E+00
6	6.30000E-02	2.40000E-03	3.00000E+00	1.50000E+00

NUCLIDE CHAIN SPECIFICATIONS

NUMBER OF CHAINS= 5

CHAIN	LENGTH
1	11
2	9
3	3
4	3
5	3

CHAIN SPECIFICATIONS

TYPE TRANSITIONS
-1=DECAY
1=TOTAL CAPTURE
2=N,GAMMA
3=N,ALPHA
4=N,2N
5=N,P
8=NONDEPLETION
-3=PARTS/100000 FISSION TREATED AS CAPTURE
10=PARTS/1,000,000 TOTAL CAPTURE

CHAIN 1

NUCLIDE I.D.	TRANSITION TYPE
3	1
4	-1
5	1
6	1
7	1
8	

```
CHAIN  2

NUCLIDE I.D.   TRANSITION TYPE
      3              1
      4              1
 200006              1
 200007              1
 200008

CHAIN  3

NUCLIDE I.D.   TRANSITION TYPE
     12             -1
     13

CHAIN  4

NUCLIDE I.D.   TRANSITION TYPE
     15              1
     14

CHAIN  5

NUCLIDE I.D.   TRANSITION TYPE
      9              1
     10
```

REFERENCES

1. B. J. Toppel, A. L. Rago, and D. M. O'Shea, "MC^2, A Code to Calculate Multigroup Cross Sections," ANL-7318, Argonne National Laboratory (1967).
2. R. E. Schenter, J. L. Baker, and R. B. Kidman, "ETOX, A Code to Calculate Group Constants for Nuclear Reactor Calculations," BNWL-1002, Battelle Northwest Laboratory (1969).
3. R. W. Hardie and W. W. Little, Jr., "1DX, A One-Dimensional Diffusion Code for Generating Effective Nuclear Cross Sections," BNWL-954, Pacific Northwest Laboratory (1969).
4. W. W. Engle, Jr., "A Users Manual for ANISN: A One Dimensional Discrete Ordinates Transport Code with Anisotropic Scattering," K-1693, Union Carbide Corporation (1967).
5. R. Protsik and E. G. Leff, "Users Manual for DOT2DB: A Two-Dimensional Multigroup Discrete Ordinates Transport/Diffusion Code with Anisotropic Scattering," GEAP-13537, General Electric, Sunnyvale (1969).
6. B. M. Carmichael, "DAC1, A One-Dimensional S_n Perturbation Code," LA-4342, Los Alamos Scientific Laboratory (1970).
7. G. C. Hopkins, "DAC2, A Two-Dimensional S_n Perturbation Code," LA-4703, Los Alamos Scientific Laboratory (1971).
8. T. B. Fowler, D. R. Vondy, and G. W. Cunningham, "Nuclear Reactor Core Analysis Code: CITATION," ORNL-TM-2496, Oak Ridge National Laboratory (1969).
9. FORTRAN Reference Manual, Control Data 6400/6500/6600 Computer Systems, CDC Publication No. 60174900, Control Data Corporation (1969).
10. USA Standard FORTRAN, USAS X3.9-1966, United States of America Standards Institute (1966).
11. Clarice W. Cox, "GENRD: A Free-Format Card Input Processor," LA-4793, Los Alamos Scientific Laboratory (1972).
12. COMPASS Reference Manual, Control Data 6400/6500/6600 Computer Systems, CDC Publication No. 60190900, Control Data Corporation (1969).
13. Henry C. Honeck, "ENDF/B: Specifications for an Evaluated Nuclear Data File for Reactor Applications," BNL-50066 (ENDF-102), Brookhaven National Laboratory (1966).
14. I. I. Bondarenko (Ed.), Group Constants for Nuclear Reactor Calculations, (Consultants Bureau, New York, 1964).
15. W. W. Little, Jr. and R. W. Hardie, "2DB, A Two-Dimensional Diffusion-Burnup Code for Fast Reactor Analysis," BNWL-640, Battelle Northwest Laboratory (1968).
16. F. R. Mynatt, "A User's Manual for DOT: A Two-Dimensional Discrete Ordinates Transport Code with Anisotropic Scattering," K-1694, Union Carbide Corporation (1967).
17. John C. Vigil, "Dynamic Buffer Allocation on the CDC 6600: The DYNBUF Program," LA-4721, Los Alamos Scientific Laboratory (1971).
18. George C. Hopkins, "CONVERT: An IBM-to-CDC Program Conversion Code," LA-4555, Los Alamos Scientific Laboratory (1970).
19. "Reactor Development Program Progress Report, March 1971," ANL-7798, Argonne National Laboratory (1971).

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