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INFORMAL REPORT

Standard Interface Files and Procedures for Reactor Physics Codes, Version III

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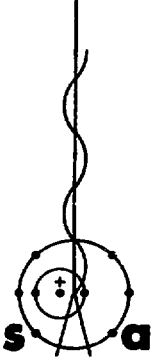

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Compiled by

B. M. Carmichael

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CONTENTS

STANDARD INTERFACE FILES AND PROCEDURES FOR REACTOR PHYSICS CODES, VERSION III

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ABSTRACT

Standards and procedures for promoting the exchange of reactor physics codes are updated to Version-III status. Standards covering program structure, interface files, file handling subroutines, and card input format are included. The implementation status of the standards in codes and the extension of the standards to new code areas are summarized.

I. INTRODUCTION

A. Background

The work of the Committee on Computer Code Coordination has been summarized by Hannum and Lewellen.[1] This committee consisted of representatives of DRRD contractors assembled at the request of the Advisory Committee on Reactor Physics to establish procedures for coordinating the development of Fast Reactor Physics codes. The procedures recommended by the Committee are described in detail in three informal reports covering the standard procedures,[2] standard interface files,[3] and card format recommendations.[4]

Implementation and extension of the procedures have continued under guidelines established by the Reactor Physics Branch of DRRD. This report contains the status of the standards (Version III) evolved under these guidelines to July 1, 1973. Much of the material presented earlier in Refs. 2, 3, and 4 is restated herein in order to provide a complete updated formal report on the standards.

B. Tests in Progress

Application of the standards to several new codes is in progress. A new diffusion code VENTURE[5] is under development at ORNL as a standardized extension of the CITATION code.[6] VENTURE is being linked to the LASL Service Modules[7] for processing standard interface data files. These Service Modules provide implementation of the standards on Program Structure in III and Card Format in VI. The modules will be tested at ORNL in

*See APPENDIX A: ORGANIZATIONS.

conjunction with the VENTURE development. The Service Modules are also under test at GE-BRD.

The composition independent code, MINX,[8] for processing cross sections is near completion at LASL. MINX will be linked to the WARD code SPHINX[9] through the nuclear data standard interface files ISOTXS and BRKOXS (see IV.B.1 and 3). SPHINX interpolates MINX prepared cross sections and uses one-dimensional diffusion theory to obtain a space-energy collapse of the interpolated cross sections. WARD has already merged the Service Modules into SPHINX and the integrated SPHINX package is being implemented on LASL computers.

A preliminary implementation of the ANL code MC^2-2[10] has been performed at LASL. The ANL code package ETOE-2/MC^2-2/SDX is being developed to provide cross-section processing to the highest precision permitted by the state-of-the-art. The implementation of MC^2-2 at LASL was considerably eased through the application of the IBM to CDC code conversion module[11] developed by ANL. The code conversion module will be used to facilitate the exchange of other codes including the REBUS[12] fuel cycle code. REBUS is being adapted to the standard interface files at ANL.

An interfaced version of the two-dimensional discrete ordinates code TWOTRAN[13] has been prepared at LASL. This code is on file at the Argonne Code Center.

C. New Code Areas

Preliminary investigations of the extension of the standard interface files and other standards to new code areas have been made. Draft proposals describing the types of data required for a fuel management/fuel cost interface have been formulated by B. A. Hutchins, GE-BRD, and H. Alter and K. Buttrey, AI. A similar study of the interface between fuel management and thermal/mechanical design has been made by B. A. Hutchins and D. B. Atcheson, GE-BRD. In both these new interface areas it is concluded that useful and appropriate standard interface files can be defined.

In addition, D. R. Ferguson, ANL, has found that some of the existing standard interface files can be used to interface Reactor Physics and Reactor Safety Codes, and has proposed some new files for specific application to Safety codes. In tests involving linking the quasi-static two-dimensional Kinetics code FX-2[14] to the VENUS diassembly code, Ferguson has demonstrated a special need for efficient linkage techniques in the Safety Code area.

II. GENERAL PROGRAMMING STANDARDS

The standards for reactor codes specified herein are designed to maximize the exchangeability of such codes. The common existing language called Standard FORTRAN (see below) is adopted as the first standard. However, most of the standards described herein involve special procedures for coping with problems associated with linking of codes, peripheral storage of data, and differences in memory types and capacities. Brief summaries with references to more detailed discussions on these procedures are given below.

A. Language

With certain exceptions and additions as noted below, the Standard of Programming Practice, ANS-10.2, will be followed. This standard adopts the FORTRAN language as described by USA Standard X3.9-1966[15] published by the United States of America Standard Institute as the programming language to be used.

B. Structure

A standard structure for programs is adopted which separates input and output functions from the main calculation section. A detailed discussion of program structure is given in III.

C. Interfaces

Codes are written to accept as input and produce as output data in standardized form. Standard interface files designed for this purpose are defined in IV.

D. Input/Output

All input and output of data to central memory is by block transfer implemented through a set of standard subroutines called SEEK, REED, and RITE. Specifications for these routines are in V. Accommodation of codes to various computer storage configurations is accomplished through localized changes to

or adaptations of these standard subroutines.*

E. Card Input Format

Free-format conventions detailed in VI provide standardization of card input codes.

F. Central Memory Restrictions

Programs are designed to be operable within a 50,000 word central memory limitation. At the same time, however, codes are made adaptable to efficient operation with larger memories. This means the number and type of data arrays stored in core are varied to maximize in-core storage for different memory and array sizes. In an ultimately optimized code, the in-core storage of overlays would also be varied. Such techniques are required in any case for efficient operation of codes over a wide range of problem sizes.

G. Word Size

Codes are designed to minimize the word size problems arising in exchanges between short word and long word computers. Six-character Hollerith words are adopted as the standard identifier word size used for file names, isotope names, etc. The six-character word is a single-precision word on long word machines and a double-precision word on short word machines. This effects the length of mixed arrays, for example.

At ANL a parameter called MULT has been introduced and tested which, with proper use, permits code exchanges between long and short word machines to be accomplished by changing only the value assigned to MULT. MULT = 1 on long word machines, and MULT = 2 on short word machines. MULT is invoked in expressions for evaluating lengths of mixed arrays, and is also involved in evaluating pointers. Branches on MULT similarly are used to select single or double precision functions.

Specification statements of the type

```
REAL*8 List
```

are required on short word machines where double precision variables are identified in List. If codes are exchanged with some identifier like CSW in the first few columns on such specification statements, the statements are nullified on MULT = 1 machines, but can be activated on MULT = 2 machines using a very simple preprocessor for deleting the CSW.

H. Documentation

Complete documentation as set forth in "A Code of Good Practice for the Documentation of Digital Computer Programs," ANS Standard 2-1967, is required. Emphasis should be placed on documenting:

1. The use of the standard interface data files.
2. The substructure of programs involving links, chains, overlays, or segments.
3. The structure and contents of temporary scratch data files and code-dependent interface files used by the program. This documentation should be of the same form as that used for standard interface files in IV.

I. Other Special Standards

The following specifications avoid difficulties on some computers or provide special advantages.

1. Hollerith constants must be set in data statements.
2. Print lines are limited to 132 characters.
3. Comment statements are limited to the first 72 columns on cards.
4. The number of integer variables preceding real variables in a common block must be even to insure alignment if double precision is required.
5. Octal and hexadecimal constants should be avoided.
6. Both the use of an array name, or the use of the implicit Do notation is permitted in DATA statements. For example:

```
DIMENSION A(6)
DATA A/1.0, 2.0, 3.0, 4.0, 5.0, 6.0/
```

7. Entry points to subroutines or functions must be of the form

```
ENTRY NAME
```

with no list appended. Calls to the entry NAME must be of the form

```
CALL NAME (List)
```

for subroutine entries, or

```
B = NAME (List)
```

for function entries where List contains the same parameters as the parent subroutine or function.

*On some computers large or extended core memories are used for data storage. In these systems techniques such as file simulation or implicit referencing of variables in the large memories may be available for retrieving data. Such techniques are inefficient and there is no common implementation of these techniques even on computers of the same type. Thus, the explicit method of data retrieval by block transfer is universally the preferred method.

8. END OF FILE checks are forbidden since they are not needed when the standard subroutines REED and RITE are used.

9. Use of statement numbers on RETURN statements as in

RETURN i

is forbidden.

10. The number of levels of overlay in programs must be ≤3.

11. Entry points to overlays must contain no arguments.

J. Recommended Standards

The following procedures are strongly endorsed by the organizations cited. Therefore, it is recommended that due consideration be given to the implementation of these procedures.

1. Dynamic Storage. ANL has developed and tested very extensively a storage management package POINTR for control of variable dimensioning. A similar approach to variable dimensioning has been used by WARD. Automated repacking of the container block when arrays are purged is an attractive feature of this technique.

2. Numbering of Statements. GE-BRD has recommended limiting the numbering of statements to CONTINUE, RETURN, and FORMAT statements. This greatly simplifies certain types of code preprocessing. ANL also favors this procedure

III. PROGRAM STRUCTURE

The basic program structure recommended for code exchange is shown in Fig. 1. The code block or sections shown are defined below.

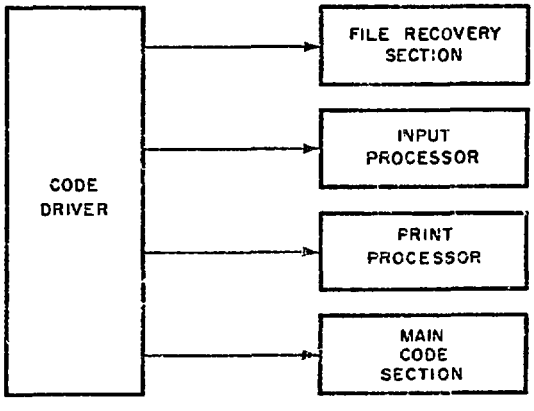

Fig. 1. Free-standing code structure.

A. Driver

The form of the Driver section will depend strongly upon the local environment; consequently, its functions should be limited if possible to that of calling the other sections in the appropriate sequence. Data linkages between the various sections are solely by means of standard and code-dependent interface files.

B. File Recovery

The File Recovery section would in the normal sequence be called first if pertinent interface files are available from previous runs. This section performs any activities required to store and recover files between runs. Since these recovery procedures vary widely at different installations, the File Recovery section, similar to the Driver, is exempt from the standards except for the limits on data linkages to other sections.

C. Input

The Input Processor uses cards supplied by the user to configure files for input to the main code section. Existing files may be overlayed by the card input or new files may be created entirely from card input. The reference files for overlays may be derived from previous runs or from the same run. Thus, sets of files may be created which define any number of input cases.

All the service modules including the Input and Print Processors and the File Recovery section are organized in modular form with respect to the files. Each file is handled by a separate subroutine in each of the service modules so that new files may readily be added to the system. The file handling is to be flexible so that any of the files may be called in any order in a given run.

Other specifications on the Input Processor are given in VI., Card Format Specifications. The latter specifications define explicitly the input conventions for identifying specific files and particular records within a file, and in addition defines the various free format conventions governing card input.

A standardized procedure is used in the subroutines that process the input of the records contained in files. In the case of an overlay:

(1) The record is transferred from the reference file into a buffer array,

(2) A standardized subroutine is called to use the card input to overlay or load the buffer array,

(3) The buffer array is transferred onto a new file.

Step 1 is omitted if the new file is to be created entirely from cards and step 2 is omitted in the overlay case if no modifications to the given record are contained in the card input. The standardized routine referenced in step 2 provides the free format card reading facilities described in VI.

In addition to the pertinent standard interface files, one or more code-dependent interface files will generally be required to completely define the input for specific codes. These code-dependent files contain data required by a given code that is not provided in the standard files. Such files will contain control information of the type that is generally difficult to standardize. Control options on the outputting of files are examples of such control data. Special options for formulating input starting guesses on flux arrays, for example, would also be treated as code-dependent data. Unique input required for newly developed numerical techniques also must of necessity be treated as code-dependent data.

D. Main Code

The Main Code Section or Calculation Module operates between two sets of interface files: an upper or input set, and a lower or output set. To avoid incompatibilities under code exchange, communication between the main code section and the service modules is restricted to that provided by interface files. A Main Code Section may consist of a Subdriver and two or more interfaced calculation sections which are operated in a closed loop mode. Fuel cycle calculations are an application of this operational mode wherein a fuel management and depletion module is coupled to a flux module. Here again the most compatible coupling is by means of interface files rather than through common arrays or subroutine argument lists.

E. Printing

Upon completion of the execution of the Main Code Section, the Print Processor is called to edit any of the existing interface files. This processor should provide flexible control of printing of files and records within files. Some internal editing of the progress of the calculations in a Main Code Section will always be required for problem debugging and for monitoring restarts. However, bulk printing of interface files should be performed in the generalized print processor. Printing unique to a given code can be accommodated by a code-dependent output file.

F. Wrap-up

The File Recovery Section would normally be called again at the end of a run to store files for future use.

G. Code Systems and Code Exchange

The proposed program structure discussed above facilitates both the exchange of free-standing individual codes and the ultimate formulation of linked systems of codes. As mentioned previously, a separate subroutine is contained in each of the service modules for handling each file. This makes easy the construction of free-standing codes from parts of a code system and facilitates the integration of free-standing codes into a system. System service modules should have at the outset the capability to process any standard interface files used by a new code. Subroutines for processing any code-dependent files required for any given code are transferred from the service modules of the code to the system service modules.

IV. STANDARD INTERFACE FILES

A. General Description

Version III standard interface files and their general descriptions are given in Table I. The list of files is unchanged from Version II except a new file, ISOGXS, containing nuclide ordered microscopic broad-group gamma ray cross sections has been added.

The Version III files contain several internal changes which were adopted as a result of the extensive experience gained in adapting reactor codes to the Version II files. These changes are discussed for the most part in the remarks prefacing the individual file specifications.

A general change in all the files is the introduction of the MULT parameter in the files to facilitate the exchange of codes between long and short word computers. (See II.G for general comments on

TABLE I

STANDARD INTERFACE FILE NAMES
AND GENERAL CONTENTS

Name	General Description of Contents
ISOTXS	Nuclide-ordered microscopic broad-group neutron cross-section data.
GRUPXS	Group-ordered microscopic broad-group neutron cross-section data.
BROKXS	Microscopic neutron cross-section data in the Bondarenko form.
DLAYXS	Delayed neutron precursor data.
ISOGXS	Nuclide-ordered microscopic broad-group gamma cross-section data.
GEODST	Geometry description.
NDXSRF	Nuclide density and cross-section referencing parameters.
ZNATDN	Zone nuclide atomic densities, including subzone or subassembly scale.
SEARCH	Criticality search data.
SNCONS	Sn constants
FIXSRC	Distributed and surface fixed sources.
RTFLX	Regular total (scalar) neutron flux.
ATFLUX	Adjoint total (scalar) neutron flux.
RCURNT	Regular neutron current.
ACURNT	Adjoint neutron current.
RAFLUX	Regular angular flux.
AAFLUX	Adjoint angular flux.
RZFLUX	Regular zone flux by neutron group, averaged over each zone.
PWDINT	Power density by interval.

MULT.) In terms of MULT the Identification record at the head of each file is of the form:

```
C*****************************************************************
CR          FILE IDENTIFICATION                                    *
C                                                                  *
CL     HNAME,(HUSE(I),I=1,2),IVERS                                 *
C                                                                  *
CW     1+3*MULT                                                    *
C                                                                  *
CD     HNAME              HOLLERITH FILE NAME - FILNAM - (A6)      *
CD     HUSE               HOLLERITH USER IDENTIFICATION (A6)       *
CD     IVERS              FILE VERSION NUMBER                      *
CD     MULT               DOUBLE PRECISION PARAMETER               *
CD                           1- A6 WORD IS SINGLE WORD              *
CD                           2- A6 WORD IS DOUBLE PRECISION WORD    *
C                                                                  *
C*****************************************************************
```

As in the file identification record below, all records containing Hollerith words will have word counts (CW entries) that are dependent upon the MULT parameter. On floating point data, the MULT parameter is only used in three instances in the files where higher precision is deemed essential. The floating point data defined in terms of MULT are the coarse mesh interval boundaries in the geometry distribution file, GEODST, and the fluxes in the regular and adjoint total flux files, RTFLUX and ATFLUX, respectively.

Another change affecting several files; namely ISOTXS, BROKOXS, DLAYXS, and ISOGXS, is the addition of format definitions to the records of these nuclear data files. These files may then be written in either BCD form for exchanging data between laboratories, or in binary form for interfacing between codes. Codes producing the nuclear data files should provide both options. The formats specified are compatible with the card free-format specifications, VI. The formats are also defined so that the data can be read by a fixed format FORTRAN code. The formats are given in entries in the file specifications containing CB in columns 1 and 2.

B. Nuclear Data Files

1. ISOTXS - Nuclide-Ordered Neutron Cross Sections

Revisions in this file affect the fission yield matrices (CHI data), and the transport and total cross sections. An optional number of vector fission yield spectra may be defined where each spectrum may be assigned to any incident group. In practice this reduces the CHI matrix to a rectangular

matrix requiring greatly reduced storage space where a large number of groups are involved. The variable blocking provided on the Version II full CHI matrix is, therefore, no longer required in the Version III formulation.

P_ℓ weighted transport and total cross-section arrays

$$(1)\quad \sigma_{tr_\ell}^{G} = \sigma_{t_\ell}^{G} - \sum_{G'} \sigma_{S_\ell}^{G\to G'} \qquad \ell=1,\ldots,LTRN$$

$$(2)\quad \sigma_{t_\ell}^{G} = \frac{\int_G \sigma_t\, \phi_\ell\,(E)\, dE}{\bar{\phi}_\ell^{G}} \qquad \ell=0,1,\ldots,LTOT$$

are supplied in place of the derived quantities

(3) STRSN = $\sigma_{t_0}^{G}$, $\sigma_{t_1}^{G}$, $\sigma_{tr_K}^{G}$ ($K \le LTOT$), or other recipe

(4) STRDIF = $\sigma_{tr_1}^{G}$

(5) STOT = $\sigma_{t_0}^{G}$

provided in the Version II file. The P_ℓ weighted scattering cross sections

$$(6)\quad \sigma_S^{G\to G'} - \frac{\int_G \int_{G'} \sigma_{S_\ell}(E\to E')\, \phi_\ell\,(E)\, dE'\, dE}{\bar{\phi}_\ell^{G}}$$

are now given in the file scattering blocks instead of derived matrices. The only difference in the old and new scattering blocks is in in-group terms for Sn applications which formerly contained

$$\sigma_{S_\ell}^{G\to G} + \sigma_{t_0}^{G} - \sigma_{t_\ell}^{G}, \ell=0,1,\ldots,L,$$

(7) $\sigma_{S_\ell}^{G\to G} + \sigma_{t_1}^{G} - \sigma_{t_\ell}^{G}$, $\ell=0,1,\ldots,L$, or

$$\sigma_{S_\ell}^{G\to G} + \sigma_{tr_K}^{G} - \sigma_{t_0}^{G}, \quad \ell=0,1,\ldots,K-1,$$

respectively, depending upon the approximation used in STRSN. In Version III, the in-group terms in the file are simply $\sigma_{S_\ell}^{G\to G}$, consequently, transport approximations as in equation (7) are left as options to be provided in flux codes.

Data added to ISOTXS include identifiers for the cross-section data source such as ENDF/B, the capture thermal energy yield, and coordinate dependent transport cross sections. The identifiers, HIDENT and HMAT, the capture energy, ECAPT, and the number of coordinate directions, ISTRPD, for which coordinate-dependent transport cross sections are given, have been added to the Isotope Control and Group Independent Data record. The new coordinate-dependent transport cross sections are contained in the PRINCIPAL CROSS SECTIONS record.

Some problems arise in the interpretation of the vectors IDSCT(N) and LORD(N) in the ISOTOPE CONTROL AND GROUP INDEPENDENT DATA record. IDSCT(N) specifies the identity and ordering of scattering blocks, and LORD(N) specifies the number of orders contained in each block N. Elaborate sorting would be required to use the data if the most general interpretation of IDSCT(N) and LORD(N) is made. However, it seems reasonable to assume that the data will always be logically ordered.

Considerable programming convenience is achieved if the same IDSCT vector is used on all isotopes. At least one would expect to find a consistent ordering of the types of cross sections, total, elastic, inelastic, and n,2n, and would expect to find all the cross sections for a given type contained in contiguous blocks. We note that any given type may be deleted in an isotope either by setting the appropriate LORD(N)=0 or by omitting the pertinent blocks in IDSCT. One would expect in the latter case, however, the ordering of types to be preserved except for the deletions.

Similarly, one would expect the ordering and blocking of cross-section orders, except for deletions, to be consistent over all the isotopes.

Finally, one would not expect to find subblocking used (NSBLOK>1) if the individual major blocks defined by IDSCT and LORD contain more than one order.

```
C*****************************************************************************
C                          REVISED*07/01/73                                    *
C                                                                              *
CF          ISOTXS*III                                                         *
CE          MICROSCOPIC GROUP NEUTRON CROSS SECTIONS                           *
C                                                                              *
CN                         THIS FILE PROVIDES A BASIC BROAD GROUP              *
CN                         LIBRARY, ORDERED BY ISOTOPE                         *
CN                         FORMATS*GIVEN*ARE*FOR*FILE*EXCHANGE*PURPOSES*       *
CN                         ONLY.                                               *
C                                                                              *
C*****************************************************************************

C*------------------------------------------------------------------------------*
CS          FILE STRUCTURE                                                     *
CS                                                                             *
CS             RECORD TYPE                              PRESENT IF             *
CS             ===========================              ==========             *
CS             FILE IDENTIFICATION                      ALWAYS                 *
CS             FILE CONTROL                             ALWAYS                 *
CS             FILE DATA                                ALWAYS                 *
CS             SET CHI DATA                             ICHIST.GT.1            *
CS                                                                             *
CS   *************(REPEAT FOR ALL ISOTOPES)                                    *
CS   *         ISOTOPE CONTROL AND GROUP                                       *
CS   *                        INDEPENDENT DATA          ALWAYS                 *
CS   *         PRINCIPAL CROSS SECTIONS                 ALWAYS                 *
CS   *         ISOTOPE CHI DATA                         ICHI.GT.1              *
CS   *                                                                         *
CS   *  **********(REPEAT TO NSCMAX SCATTERING BLOCKS)                         *
CS   *  *  *******(REPEAT FROM 1 TO NSBLOK)                                    *
CS   *  *  *    SCATTERING SUB*BLOCK                  LORD(N).GT.0             *
CS   *************                                                             *
C                                                                              *
C*------------------------------------------------------------------------------*

C*------------------------------------------------------------------------------*
CR          FILE IDENTIFICATION                                                *
C                                                                              *
CL    HNAME,(HUSE(I),I=1,2),IVERS                                              *
C                                                                              *
CW    1*3*MULT                                                                 *
C                                                                              *
CB    FORMAT(11H 0V ISOTXS ,A6,1H*,                                            *
CB   12A6,1H*,I6)                                                              *
C                                                                              *
CD    HNAME          HOLLERITH FILE NAME = ISOTXS = (A6)                       *
CD    HUSE           HOLLERITH USER IDENTIFICATION (A6)                        *
CD    IVERS          FILE VERSION NUMBER                                       *
CD    MULT           DOUBLE PRECISION PARAMETER                                *
CD                       1= A6 WORD IS SINGLE WORD                             *
CD                       2= A6 WORD IS DOUBLE PRECISION WORD                   *
C                                                                              *
C*------------------------------------------------------------------------------*
```

```
C*****************************************************************
CR          FILE CONTROL                                          *
C                                                                 *
CL     NGROUP,NISO,MAXUP,MAXDN,MAXORD,ICHIST,NSCMAX,NSBLOK        *
C                                                                 *
CW     8                                                          *
C                                                                 *
CB     FORMAT(4H 1D ,8I6)                                         *
C                                                                 *
CD     NGROUP          NUMBER OF ENERGY GROUPS IN SET             *
CD     NISO            NUMBER OF ISOTOPES IN SET                  *
CD     MAXUP           MAXIMUM NUMBER OF UPSCATTER GROUPS         *
CD     MAXDN           MAXIMUM NUMBER OF DOWNSCATTER GROUPS       *
CD     MAXORD          MAXIMUM SCATTERING ORDER (MAXIMUM VALUE OF *
CD                        LEGENDRE EXPANSION INDEX USED IN FILE).  *
CD     ICHIST          SET FISSION SPECTRUM FLAG                  *
CD                        ICHIST.EQ.0,      NO FISSION SPECTRUM    *
CD                        ICHIST.EQ.1,      SET VECTOR             *
CD                        ICHIST.GT.1,      SET MATRIX             *
CD     NSCMAX          MAXIMUM NUMBER OF BLOCKS OF SCATTERING DATA *
CD     NSBLOK          BLOCKING CONTROL FOR SCATTER MATRICES.  THE *
CD                        SCATTERING DATA ARE BLOCKED INTO NSBLOK  *
CD                        RECORDS PER SCATTERING BLOCK.            *
C                                                                 *
C*****************************************************************
```

```
C*****************************************************************
CR          FILE DATA                                             *
C                                                                 *
CL     (HSETID(I),I=1,12),(HISONM(I),I=1,NISO),                   *
CL    1(CHI(J),J=1,NGROUP),(VEL(J),J=1,NGROUP),                   *
CL    2(EMAX(J),J=1,NGROUP),EMIN,(LOCA(I),I=1,NISO)               *
C                                                                 *
CW     (NISO+12)*MULT+1+NISO                                      *
CW     +NGROUP*(2+ICHIST*(2/(ICHIST+1)))                          *
C                                                                 *
CB     FORMAT(4H 2D ,1H*,11A6,1H*/       HSETID,HISONM            *
CB    11H*,A6,1H*,9(1X,A6)/(10(1X,A6)))                          *
CB     FORMAT(1P6E12.5)                  CHI (PRESENT IF ICHIST.EQ.1)
CB     FORMAT(1P6E12.5)                  VEL,EMAX,EMIN            *
CB     FORMAT(12I6)                      LOCA                     *
C                                                                 *
CD     HSETID          HOLLERITH IDENTIFICATION OF SET (A6)       *
CD     HISONM(I)       HOLLERITH ISOTOPE LABEL FOR ISOTOPE I (A6) *
CD     CHI(J)          SET FISSION SPECTRUM (PRESENT IF ICHIST.EQ.1)
CD     VEL(J)          MEAN NEUTRON VELOCITY IN GROUP J (CM/SEC)  *
CD     EMAX(J)         MAXIMUM ENERGY BOUND OF GROUP J (EV)       *
CD     EMIN            MINIMUM ENERGY BOUND OF SET (EV)           *
CD     LOCA(I)         NUMBER OF RECORDS TO BE SKIPPED TO READ DATA FOR
CD                        ISOTOPE I.  LOCA(1)=0                    *
C                                                                 *
C*****************************************************************
```

```
C*****************************************************************
CR          SET CHI DATA                                          *
C                                                                 *
CC        PRESENT IF ICHIST.GT.1                                  *
C                                                                 *
CL     ((CHI(K,J),K=1,ICHIST),J=1,NGROUP),(ISSPEC(I),I=1,NGROUP)  *
C                                                                 *
CW     NGROUP*(ICHIST+1)                                          *
C                                                                 *
CB     FORMAT(4H 3D ,1P5E12.5/(6E12.5)) CHI                       *
CB     FORMAT(12I6)                     ISSPEC                    *
C                                                                 *
CD     CHI(K,J)        FRACTION OF NEUTRONS EMITTED IN GROUP J AS A
CD                        RESULT OF FISSION IN ANY GROUP USING SPECTRUM K
CD     ISSPEC          ISSPEC(I)=K IMPLIES THAT SPECTRUM K IS USED *
CD                        TO CALCULATE EMISSION SPECTRUM FROM FISSION
CD                        IN GROUP I                               *
C                                                                 *
C*****************************************************************
```

```
C*****************************************************************
CR          ISOTOPE CONTROL AND GROUP INDEPENDENT DATA            *
C                                                                 *
CL    HABSID,HIDENT,HMAT,AMASS,EFISS,ECAPT,TEMP,SIGPOT,ADENS,KBR,ICHI,  *
CL   1IFIS,IALF,INP,IN2N,IND,INT,LTOT,LTRN,ISTRPD,                *
CL   2(IDSCT(N),N=1,NSCMAX),(LORD(N),N=1,NSCMAX),                 *
CL   3((JBAND(J,N),J=1,NGROUP),N=1,NSCMAX),                       *
CL   4((IJJ(J,N),J=1,NGROUP),N=1,NSCMAX)                          *
C                                                                 *
CW    3*MULT+17+NSCMAX*(2*NGROUP+2)                               *
C                                                                 *
CB    FORMAT(4H 4D ,3(1X,A6)/1P6E12.5/                            *
CB   1(12I6))                                                     *
C                                                                 *
CD    HABSID        HOLLERITH ABSOLUTE ISOTOPE LABEL - SAME FOR ALL   *
CD                        VERSIONS OF THE SAME ISOTOPE IN SET (A6)  *
CD    HIDENT        IDENTIFIER OF LIBRARY FROM WHICH BASIC DATA       *
CD                        CAME(E,G, ENDF/B) (A6)                    *
CD    HMAT          ISOTOPE IDENTIFICATION (E,G, ENDF/B MAT NO,) (A6) *
CD    AMASS         GRAM ATOMIC WEIGHT                                *
CD    EFISS         TOTAL THERMAL ENERGY YIELD/FISSION (W,SEC/FISS)   *
CD    ECAPT         TOTAL THERMAL ENERGY YIELD/CAPTURE (W,SEC/CAPT)   *
CD    TEMP          ISOTOPE TEMPERATURE (DEGREES KELVIN)              *
CD    SIGPOT        AVERAGE EFFECTIVE POTENTIAL SCATTERING IN         *
CD                        RESONANCE RANGE (BARNS/ATOM)              *
CD    ADENS         DENSITY OF ISOTOPE IN MIXTURE IN WHICH ISOTOPE    *
CD                        CROSS SECTIONS WERE GENERATED (A/BARN,CM)  *
CD    KBR           ISOTOPE CLASSIFICATION                            *
CD                     0=UNDEFINED                                  *
CD                     1=FISSILE                                    *
CD                     2=FERTILE                                    *
CD                     3=OTHER ACTINIDE                             *
CD                     4=FISSION PRODUCT                            *
CD                     5=STRUCTURE                                  *
CD                     6=COOLANT                                    *
CD                     7=CONTROL                                    *
CD    ICHI          ISOTOPE FISSION SPECTRUM FLAG                     *
CD                      ICHI.EQ.0,     USE SET CHI                  *
CD                      ICHI.EQ.1,     ISOTOPE CHI VECTOR           *
CD                      ICHI.GT.1,     ISOTOPE CHI MATRIX           *
CD    IFIS          (N,F) CROSS SECTION FLAG                          *
CD                     IFIS=0, NO FISSION DATA IN PRINCIPAL CROSS    *
CD                                    SECTION RECORD                *
CD                         =1, FISSION DATA PRESENT IN PRINCIPAL     *
CD                                    CROSS SECTION RECORD          *
CD    IALF          (N,ALPHA) CROSS SECTION FLAG                      *
CD                     SAME OPTIONS AS IFIS                         *
CD    INP           (N,P) CROSS SECTION FLAG                          *
CD                     SAME OPTIONS AS IFIS                         *
CD    IN2N          (N,2N) CROSS SECTION FLAG                         *
CD                     SAME OPTIONS AS IFIS                         *
CD    IND           (N,D) CROSS SECTION FLAG                          *
CD                     SAME OPTIONS AS IFIS                         *
CD    INT           (N,T) CROSS SECTION FLAG                          *
CD                     SAME OPTIONS AS IFIS                         *
CD    LTOT          NUMBER OF MOMENTS OF TOTAL CROSS SECTION PROVIDED *
CD                     IN PRINCIPAL CROSS SECTIONS RECORD           *
CD    LTRN          NUMBER OF MOMENTS OF TRANSPORT CROSS SECTION      *
CD                     PROVIDED IN PRINCIPAL CROSS SECTIONS RECORD  *
CD    ISTRPD        NUMBER OF COORDINATE DIRECTIONS FOR WHICH         *
CD                     COORDINATE DEPENDENT TRANSPORT CROSS SECTIONS *
CD                     ARE GIVEN, IF ISTRPD=0, NO COORDINATE DEPENDENT *
CD                     TRANSPORT CROSS SECTIONS ARE GIVEN,          *
CD    IDSCT(N)      SCATTERING MATRIX TYPE IDENTIFICATION FOR         *
CD                     SCATTERING BLOCK N,  SIGNIFICANT ONLY IF     *
CD                     LORD(N).GT.0                                 *
CD                     IDSCT(N)=000 + NN, TOTAL SCATTERING (SUM OF  *
CD                     ELASTIC, INELASTIC, AND N, 2N SCATTERING)    *
CD                             =100 + NN, ELASTIC SCATTERING        *
CD                             =200 + NN, INELASTIC SCATTERING      *
```

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CD                              =300 + NN, (N,2N) SCATTERING PER EMITTED
CD                                                          NEUTRON,
CD                           WHERE NN IS THE LEGENDRE EXPANSION INDEX OF THE
CD                           FIRST MATRIX IN BLOCK N
CD     LORD(N)            NUMBER OF SCATTERING ORDERS IN BLOCK N,  IF
CD                           LORD(N)=0, THIS BLOCK IS NOT PRESENT FOR THIS
CD                           ISOTOPE,  IF NN IS THE VALUE TAKEN FROM
CD                           IDSCT(N), THEN THE MATRICES IN THIS BLOCK
CD                           HAVE LEGENDRE EXPANSION INDICES OF NN,NN+1,
CD                           NN+2,...,NN+LORD(N)-1
CD     JBAND(J,N)         SCATTERING BAND-WIDTH FOR GROUP J, SCATTERING
CD                           BLOCK N
CD     IJJ(J,N)           POSITION OF IN-GROUP SCATTERING CROSS SECTION IN
CD                           SCATTERING DATA FOR GROUP J, SCATTERING BLOCK
CD                           N,COUNTED FROM THE FIRST WORD OF GROUP J DATA.
C
C*****************************************************************
C*****************************************************************
CR           PRINCIPAL CROSS SECTIONS
C
CL     ((STRPL(J,L),J=1,NGROUP),L=1,LTRN),
CL    1((STOTPL(J,L),J=1,NGROUP),L=1,LTOT),(SNGAM(J),J=1,NGROUP),
CL    2(SFIS(J),J=1,NGROUP),(SNUTOT(J),J=1,NGROUP),
CL    3(CHISO(J),J=1,NGROUP),(SNALF(J),J=1,NGROUP),
CL    4(SNP(J),J=1,NGROUP),(SN2N(J),J=1,NGROUP),
CL    5(SND(J),J=1,NGROUP),(SNT(J),J=1,NGROUP)
CL    6((STRPD(J,I),J=1,NGROUP),I=1,ISTRPD)
C
CW     (1+LTRN+LTOT+IALF+INP+IN2N+IND+INT+ISTRPD+2*IFIS+
CW     ICHI*(2/(ICHI+1)))*NGROUP
C
CB     FORMAT(4H 5D ,1P5E12.5/(6E12.5)) LENGTH OF LIST AS ABOVE
C
CD     STRPL              PL WEIGHTED TRANSPORT CROSS SECTION
CD                           THE FIRST ELEMENT OF ARRAY STRPL IS THE
CD                           CURRENT (P1) WEIGHTED TRANSPORT CROSS SECTION
CD     STOTPL             PL WEIGHTED TOTAL CROSS SECTION
CD                           THE FIRST ELEMENT OF ARRAY STOTPL IS THE
CD                           FLUX (P0) WEIGHTED TOTAL CROSS SECTION
CD     SNGAM              (N,GAMMA)
CD     SFIS               (N,F)              (PRESENT IF IFIS.GT.0)
CD     SNUTOT             TOTAL NEUTRON YIELD/FISSION  (PRESENT IF IFIS.GT.0)
CD     CHISO              ISOTOPE CHI  (PRESENT IF ICHI.EQ.1)
CD     SNALF              (N,ALPHA)    (PRESENT IF IALF.GT.0)
CD     SNP                (N,P)        (PRESENT IF INP.GT.0)
CD     SN2N               (N,2N)(LOSS) (PRESENT IF IN2N.GT.0)
CD     SND                (N,D)        (PRESENT IF IND.GT.0)
CD     SNT                (N,T)        (PRESENT IF INT.GT.0)
CD     STRPD              COORDINATE DIRECTION I TRANSPORT CROSS SECTION
CD                                      (PRESENT IF ISTRPD.GT.0)
C
C*****************************************************************
C*****************************************************************
CR           ISOTOPE CHI DATA
C
CC           PRESENT IF ICHI.GT.1
C
CL     ((CHIISO(K,J),K=1,ICHI),J=1,NGROUP),(ISOPEC(I),I=1,NGROUP)
C
CW     NGROUP*(ICHI+1)
C
CB     FORMAT(4H 6D ,1P5E12.5/(6E12.5)) CHIISO
CB     FORMAT(12I6)                     ISOPEC
C
CD     CHIISO(K,J)    FRACTION OF NEUTRONS EMITTED IN GROUP J AS A
CD                       RESULT OF FISSION IN ANY GROUP USING SPECTRUM K
CD     ISOPEC(I)      ISOPEC(I)=K IMPLIES THAT SPECTRUM K IS USED
CD                       TO CALCULATE EMISSION SPECTRUM FROM FISSION
CD                       IN GROUP I
C
C
C*****************************************************************
```

```
C*****************************************************************
CR          SCATTERING SUB-BLOCK                                  *
C                                                                 *
CC        PRESENT IF LORD(N).GT.0                                 *
C                                                                 *
CL     ((SCAT(K,L),K=1,KMAX),L=1,LORDN)                           *
C                                                                 *
CC     KMAX=SUM OVER J OF JBAND(J) WITHIN THE J-GROUP RANGE OF THIS *
CC        SUB-BLOCK.  IF M IS THE INDEX OF THE SUB-BLOCK, THE J-GROUP *
CC        RANGE CONTAINED WITHIN THIS SUB-BLOCK IS                *
CC        JL=(M-1)*((NGROUP-1)/NSBLOK+1)+1 TO JU=M*((NGROUP-1)/NSBLOK+1) *
CC     LORDN=LORD(N)                                              *
C                                                                 *
CW     KMAX*LORDN                                                 *
C                                                                 *
CB     FORMAT(4H 7D ,1P5E12.5/(6E12.5))                           *
C                                                                 *
CD     SCAT(K,L)      SCATTERING MATRIX OF SCATTERING ORDER L, FOR *
CD                       REACTION TYPE IDENTIFIED BY IDSCT(N) FOR THIS *
CD                       BLOCK.  JBAND(J) VALUES FOR SCATTERING INTO *
CD                       GROUP J ARE STORED AT LOCATIONS K=SUM FROM 1 *
CD                       TO (J-1) OF JBAND(I) PLUS 1 TO K-1+JBAND(J), *
CD                       THE SUM IS ZERO WHEN J=1.  J-TO-J SCATTER IS *
CD                       THE IJJ(J)-TH ENTRY IN THE RANGE JBAND(J),  *
CD                       VALUES ARE STORED IN THE ORDER (J+JUP),     *
CD                       (J+JUP-1),...,(J+1),J,(J-1),...,(J-JDN),    *
CD                       WHERE JUP=IJJ(J)-1 AND JDN=JBAND(J)-IJJ(J)  *
C                                                                 *
C*****************************************************************

CEOF
```

2. GRUPXS - Group-Ordered Neutron Cross Sections

The basic data revisions and additions to the ISOTXS file apply also to the GRUPXS file because GRUPXS has the same data ordered by group that ISOTXS has ordered by nuclide. In addition, as the result of actual experience in using the file at ORNL, the file has been reorganized extensively. Since GRUPXS-II was never actually implemented, it will be more useful here to compare GRUPXS-III with ISOTXS-III than to discuss differences in GRUPXS-III and GRUPXS-II.

The ISOTXS file is structured for use both as an interface file and as a library file. It is, therefore, ordered by isotope so that cross sections for additional isotopes may conveniently be added to an existing version of the file. It is expected that GRUPXS will be produced by a conversion module from ISOTXS; then other modules will access GRUPXS for further calculations. GRUPXS is ordered by group because multidimensional codes frequently process cross sections one group at a time. In many applications GRUPXS may contain only a subset of the isotopes available on an ISOTXS library file. GRUPXS is structured for convenience in formulating macroscopic cross sections, whereas ISOTXS is organized to readily accept microscopic cross sections as they are generated by a cross-section processor code.

The data in ISOTXS are stored compactly. Consequently, array dimensions vary from isotope to isotope. In GRUPXS-III many of the dimensions are made constants of the file. Such dimensions must, therefore be the maximum values for the isotopes converted from ISOTXS. This means zeros are used in arrays where necessary to expand them to the maximum dimensions. The affected dimensions are:

ISOTXS	GRUPXS	Description
(by isotope)	(maximum)	
LTRN	MAXT=MAXORD+1	Number of moments of transport cross sections
LTOT	MAXT=MAXORD+1	Number of moments of total cross sections
ISTRPD	NSTRPD	Number of coordinate directions for transport cross sections
IDSCT(N)	IDSCT(N)	Identifier for scattering block N
LORD(N)	LORD(N)	Number of orders in scattering block N

A consequence of these changes with respect to the ISOTXS file is that storage requirements for all data except the scattering data are known after reading the FILE CONTROL record, and scattering data storage requirements may be determined from reading the ISOTOPE CONTROL AND GROUP INDEPENDENT DATA record. This permits the establishment of a storage strategy prior to beginning the processing of the major blocks of data.

```
C*************************************************************************
C                        REVISED 07/01/73                                 *
C                                                                         *
CF          GRUPXS-III                                                    *
CE          MICROSCOPIC GROUP NEUTRON CROSS SECTIONS                      *
C                                                                         *
CN                       THIS FILE PROVIDES A BASIC BROAD GROUP           *
CN                       LIBRARY, ORDERED BY GROUP                        *
C                                                                         *
C*************************************************************************


C-------------------------------------------------------------------------*
CS          FILE STRUCTURE                                                *
CS                                                                        *
CS             RECORD TYPE                          PRESENT IF            *
CS             ============================         ==========            *
CS             FILE IDENTIFICATION                  ALWAYS                *
CS             FILE CONTROL                         ALWAYS                *
CS             FILE DATA                            ALWAYS                *
CS             SET CHI DATA                         ICHIST.GT.1           *
CS             ISOTOPE CONTROL AND GROUP                                  *
CS                             INDEPENDENT DATA     ALWAYS                *
CS   ************(REPEAT OVER ALL ENERGY GROUPS)                          *
CS   *         PRINCIPAL CROSS SECTIONS            ALWAYS                *
CS   *************                                                        *
CS   *************(REPEAT OVER NCHIN ISOTOPES)    NCHIN.GT.0            *
CS   *         ISOTOPE CHI DATA                    ICHI(I).GT.1          *
CS   *************                                                        *
CS   ************(REPEAT OVER ALL ENERGY GROUPS)                         *
CS   *         SCATTERING CONTROL                  ALWAYS                *
CS   *  **********(REPEAT TO NSCMAX SCATTERING BLOCKS)                    *
CS   *  *  ********(REPEAT FROM 1 TO NSBLOK)                              *
CS   *  *  *    SCATTERING SUB-BLOCK               LORD(N).GT.0          *
CS   *************                                                        *
C                                                                         *
C-------------------------------------------------------------------------*


C-------------------------------------------------------------------------*
CR          FILE IDENTIFICATION                                           *
C                                                                         *
CL    HNAME,(HUSE(I),I=1,2),IVERS                                         *
C                                                                         *
CW    1+3*MULT                                                            *
C                                                                         *
CD    HNAME          HOLLERITH FILE NAME - GRUPXS - (A6)                  *
CD    HUSE           HOLLERITH USER IDENTIFICATION (A6)                   *
CD    IVERS          FILE VERSION NUMBER                                  *
CD    MULT           DOUBLE PRECISION PARAMETER                           *
CD                       1- A6 WORD IS SINGLE WORD                        *
CD                       2- A6 WORD IS DOUBLE PRECISION WORD              *
C                                                                         *
C-------------------------------------------------------------------------*
```

```
C*****************************************************************
CR          FILE CONTROL                                          *
C                                                                 *
CL    NGROUP,NISO,MAXUP,MAXDN,MAXORD,ICHIST,NPSCS,NSTRPD,NCHIN,NICHI,*
CL    NSCMAX,NSBLOK,NRG,NRH                                       *
C                                                                 *
CW    14                                                          *
C                                                                 *
CD    NGROUP        NUMBER OF ENERGY GROUPS IN SET                *
CD    NISO          NUMBER OF ISOTOPES IN SET                     *
CD    MAXUP         MAXIMUM NUMBER OF UPSCATTER GROUPS            *
CD    MAXDN         MAXIMUM NUMBER OF DOWNSCATTER GROUPS          *
CD    MAXORD        MAXIMUM SCATTERING ORDER (MAXIMUM VALUE OF    *
CD                     LEGENDRE EXPANSION INDEX USED IN FILE)     *
CD    ICHIST        SET FISSION SPECTRUM FLAG                     *
CD                     1= SET FISSION SPECTRUM VECTOR             *
CD                     .GT.1= NUMBER OF SPECTRA FOR RANGES IN INCIDENT*
CD                            ENERGY DEPENDENT CHI                *
CD    NPSCS         LENGTH OF THE PRINCIPAL CROSS SECTION RECORDS *
CD    NSTRPD        NUMBER OF COORDINATE DIRECTIONS FOR WHICH TRANSPORT*
CD                     CROSS SECTIONS ARE GIVEN, .LE.3            *
CD    NCHIN         NUMBER OF ISOTOPES FOR WHICH THERE ARE INCIDENT*
CD                     ENERGY DEPENDENT CHI DATA                  *
CD    NICHI         NUMBER OF INCIDENT ENERGY SPECTRA FOR ISOTOPE CHI*
CD                     DATA (MAXIMUM)                             *
CD    NSCMAX        MAXIMUM NUMBER OF BLOCKS OF SCATTERING DATA   *
CD                     FOR EACH GROUP SCATTERED INTO - CAN BE THE *
CD                     NUMBER OF TYPES OF SCATTERING FOR WHICH THERE*
CD                    ARE DATA                                    *
CD    NSBLOK        BLOCKING CONTROL FOR SCATTER MATRICES.  THE   *
CD                     SCATTERING DATA ARE BLOCKED INTO NSBLOK    *
CD                     RECORDS PER SCATTERING BLOCK.              *
CD    NRG           RESERVED                                      *
CD    NRH           RESERVED                                      *
C                                                                 *
C*****************************************************************

C*****************************************************************
CR          FILE DATA                                             *
C                                                                 *
CL    (HSETID(I),I=1,12),(HISONM(I),I=1,NISO),                    *
CL    ( CHI(J),J=1,NGROUP),(VEL(J),J=1,NGROUP),                   *
CL    (EMAX(J),J=1,NGROUP),EMIN                                   *
C                                                                 *
CW    MULT*(NISO+12)+1+NGROUP*(2+ICHIST*(2/(ICHIST+1)))           *
C                                                                 *
CD    HSETID        HOLLERITH IDENTIFICATION OF SET (A6)          *
CD    HISONM(I)     HOLLERITH ISOTOPE LABEL FOR ISOTOPE I (A6)    *
CD    CHI(J)        SET FISSION SPECTRUM (PRESENT IF ICHIST.EQ.1) *
CD    VEL(J)        MEAN NEUTRON VELOCITY IN GROUP J (CM/SEC)     *
CD    EMAX(J)       MAXIMUM ENERGY BOUND OF GROUP J (EV)          *
CD    EMIN          MINIMUM ENERGY BOUND OF SET (EV)              *
C                                                                 *
C*****************************************************************

C*****************************************************************
CR          SET CHI DATA                                          *
C                                                                 *
CC        PRESENT IF ICHIST.GT.1                                  *
C                                                                 *
CL    ((CHII(K,J),K=1,ICHIST),J=1,NGROUP),(ISSPEC(I),I=1,NGROUP)  *
C                                                                 *
CW    NGROUP*(ICHIST+1)                                           *
C                                                                 *
CD    CHII(K,J)     FRACTION OF NEUTRONS EMITTED IN GROUP J AS A  *
CD                     RESULT OF FISSION IN ANY GROUP USING SPECTRUM K*
CD    ISSPEC(I)     ISSPEC(I)=K IMPLIES THAT SPECTRUM K IS USED TO*
CD                     CALCULATE EMISSION SPECTRUM FROM FISSION IN *
CD                     GROUP I                                    *
C                                                                 *
C*****************************************************************
```

```
C*****************************************************************
CR          ISOTOPE CONTROL AND GROUP INDEPENDENT DATA           *
C                                                                *
CL    (HABSID(I),I=1,NISO),(HIDENT(I),I=1,NISO),(HMAT(I)=1,NISO),*
CL    (AMASS(I),I=1,NISO),                                       *
CL    (EFISS(I),I=1,NISO),(ECAPT(I),I=1,NISO),(XN(I),I=1,NISO),  *
CL    (TEMP(I),I=1,NISO),(SIGPOT(I),I=1,NISO),(ADENS(I),I=1,NISO),*
CL    (KBR(I),I=1,NISO),(IDSCT(N),N=1,NSCMAX),(LORD(N),N=1,NSCMAX),*
CL    (ICHI(I),I=1,NISO),(LTRN(I),I=1,NISO),(LTOT(I),I=1,NISO),IALF,*
CL    INP,IN2N,IND,INT,IX,IY                                     *
C                                                                *
CW    NISO*(3*MULT+11)+2*NSCMAX+7                                *
C                                                                *
CD    HABSID(I)      HOLLERITH ABOSLUTE ISOTOPE LABEL (A6)       *
CD    HIDENT         IDENTIFIER, USUALLY ENDF NUMBER (A6)        *
CD    HMAT(I)        MATERIAL REFERENCE FOR IDENTIFICATION (A6)  *
CD    AMASS(I)       GRAM ATOMIC WEIGHT                          *
CD    EFISS(I)       TOTAL THERMAL ENERGY YIELD/FISSION (W,SEC/FISS)*
CD    ECAPT(I)       THERMAL ENERGY YIELD PER CAPTURE (W,SEC/CAP)*
CD    XN(I)          RESERVED                                    *
CD    TEMP(I)        ISOTOPE TEMPERATURE (DEGREES KELVIN)        *
CD    SIGPOT(I)      AVERAGE EFFECTIVE POTENTIAL SCATTERING I.   *
CD                       RESONANCE RANGE (BARNS/ATOM)           *
CD    ADENS(I)       DENSITY OF ISOTOPE IN MIXTURE IN WHICH ISOTOPE*
CD                       CROSS SECTIONS WERE GENERATED (A/BARN/CC)*
CD    KBR(I)         ISOTOPE CLASSIFICATION                      *
CD                       0=UNDEFINED                            *
CD                       1=FISSILE                              *
CD                       2=FERTILE                              *
CD                       3=OTHER ACTINIDE                       *
CD                       4=FISSION PRODUCT                      *
CD                       5=STRUCTURE                            *
CD                       6=COOLANT                              *
CD                       7=CONTROL                              *
CD    IDSCT(N)       SCATTERING MATRIX TYPE IDENTIFICATION FOR   *
CD                       SCATTERING BLOCK N,  SIGNIFICANT ONLY IF*
CD                       LORD(N).GT.0                           *
CD                       IDSCT(N)=000+ NN, TOTAL SCATTERING(SUM OF*
CD                          ELASTIC, INELASTIC, AND N, 2N SCATTERING)*
CD                               =100 + NN, ELASTIC SCATTERING  *
CD                               =200 + NN, INELASTIC SCATTERING*
CD                               =300 + NN, (N,2N) SCATTERING PER*
CD                                          EMITTED NEUTRON     *
CD                       WHERE NN IS EXPANSION ORDER OF BLOCK N DATA,*
CD                       DATA ORDERED BY INCREASING EXPASION ORDER*
CD                       FOR EACH OF THE TYPES IN THE ABOVE ORDER*
CD    LORD(N)        NUMBER OF SCATTERING ORDERS IN BLOCK N,  IF *
CD                     LORD(N)=0, THIS BLOCK IS NOT PRESENT FOR THIS*
CD                     ISOTOPE BLOCK,  IF NN IS THE VALUE TAKEN FROM*
CD                     IDSCT(N), THEN THE MATRICES IN THIS BLOCK *
CD                     HAVE LEGENDRE EXPANSION INDICES OF NN,NN+1,*
CD                     ....,LORD(N)                             *
CD    ICHI(I)        ISOTOPE FISSION SPECTRUM FLAG               *
CD                       0= USE SET CHI                         *
CD                       1= ISOTOPE CHI VECTOR                  *
CD                       .GT.1= NUMBER OF SPECTRA FOR RANGES IN INCIDENT*
CD                            ENERGY DEPENDENT CHI              *
CD    LTRN(I)        NUMBER OF MOMENTS OF TRANSPORT CROSS SECTION*
CD                     PROVIDED FOR ISOTOPE I                   *
CD    LTOT(I)        NUMBER OF MOMENTS OF TOTAL CROSS SECTION    *
CD                     PROVIDED FOR ISOTOPE I                   *
CD    IALF           (N,ALPHA) CROSS SECTION FLAG                *
CD                       IALF=0, NO (N,ALPHA) DATA IN THE FILE  *
CD    INP            (N,P) CROSS SECTION FLAG                    *
CD                       INP=0, NO (N,P) DATA IN THE FILE       *
CD    IN2N           (N,2N) CROSS SECTION FLAG                   *
CD                       IN2N=0, NO (N,2N) DATA IN THE FILE     *
CD    IND            (N,D) CROSS SECTION FLAG                    *
CD                       IND=0, NO ( N,D) DATA IN THE FILE      *
CD    INT            (N,T) CROSS SECTION FLAG                    *
CD                       INT=0, NO (N,T) DATA IN THE FILE       *
```

```
CD     IX              RESERVED                                          *
CD     IY              RESERVED                                          *
C                                                                        *
C*****************************************************************     *
C*****************************************************************     *
CR           PRINCIPAL CROSS SECTIONS                                    *
C                                                                        *
CL     (STRPL(L),L=1,NTRN),(STOTPL(L),L=1,NTOT),(SNGAM(I),I=1,NISO),     *
CL     (SFIS(I),I=1,NISO),(SNUTOT(I),I=1,NISO),                          *
CL     (CHISO(I),I=1,NICH),SNALF(I),I=1,NISO),                           *
CL     (SNP(I),I=1,NISO),(SN2N(I),I=1,NISO),                             *
CL     (SND(I),I=1,NISO),(SNT(I),I=1,NISO),                              *
CL     (STRPD(I,J),I=1,NISO),J=1,NSTRPD)                                 *
C                                                                        *
CW     NPSCS=NTRN+NTOT+NICH+NISO*(NSTRPD+9)                              *
C                                                                        *
CD     STRPL           PL WEIGHTED TRANSPORT CROSS SECTIONS              *
CD     STOTPL          PL WEIGHTED TOTAL CROSS SECTIONS                  *
CD     SNGAM           (N,GAMMA) CROSS SECTION                           *
CD     SFIS            (N,FISSION) CROSS SECTION                         *
CD     SNUTOT          TOTAL NEUTRON YIELD/FISSION                       *
CD     CHISO           ISOTOPE CHI VECTOR (PRESENT FOR ISOTOPE I IF      *
CD                        ICHI(I).EQ.1)                                  *
CD     SNALF           (N,ALPHA)           (PRESENT IF IALF.GT.0)        *
CD     SNP             (N,P)               (PRESENT IF INP.GT.0)         *
CD     SN2N            (N,2N) (LOSS)       (PRESENT IF IN2N.GT.0)        *
CD     SND             (N,D)               (PRESENT IF IND.GT.0)         *
CD     SNT             (N,T)               (PRESENT IF INT .GT.0)        *
CD     STRPD(I,J)      COORDINATE DIRECTION J DEPENDENT TRANSPORT CROSS   *
CD                        SECTION( PRESENT  IF NSTRPD.GT.0)              *
CD     NTRN            NUMBER OF TRANSPORT CROSS SECTIONS GIVEN PER      *
CD                        GROUP = EQUALS SUM OF LTRN(I) OVER ALL ISOTOPES *
CD     NTOT            NUMBER OF TOTAL CROSS SECTIONS GIVEN PER GROUP =  *
CD                        EQUALS SUM OF LTOT(I) OVER ALL ISOTOPES        *
CD     NICH            NUMBER OF ISOTOPE CHI VALUES GIVEN PER GROUP =    *
CD                        EQUALS SUM OF ICHI(I)*(2/(ICHI(I)+1)) OVER ALL *
CD                        ISOTOPES                                       *
C                                                                        *
C*****************************************************************     *
C*****************************************************************     *
CR           ISOTOPE CHI DATA                                            *
C                                                                        *
CC           PRESENT IF NCHIN.GT.0 AND ICHI(I).GT.1                      *
C                                                                        *
CL     ((CHISI(K,J),K=1,ICHII,J=1,NGROUP),(ISOPEC(I),I=1,NGROUP)         *
C                                                                        *
C*     NGROUP*(ICHII + 1)                                                *
C                                                                        *
CW     ICHII           =ICHI(I)                                          *
CD     CHISI(K,J)      FRACTION OF NEUTRONS EMITTED IN GROUP J AS A RESULT*
CD                        OF FISSION IN ANY GROUP USING SPECTRUM K       *
CD     ISOPEC(I)       ISOPEC(I)=K IMPLIES THAT SPECTRUM K IS USED TO    *
CD                        CALCULATE EMISSION SPECTRUM FROM FISSION IN    *
CD                        GROUP I                                        *
C                                                                        *
C*****************************************************************     *

C*****************************************************************     *
CR           SCATTERING CONTROL                                          *
C                                                                        *
CL     ((JBAND(I,N),I=1,NISO),N=1,NSCMAX)                                *
CL     ((IJJ(I,N),I=1,NISO), N=1,NSCMAX)                                 *
C                                                                        *
C*     2*NISO*NSCMAX                                                     *
C                                                                        *
CD     JBAND(I,N)      SCATTERING BANDWIDTH FOR ISOTOPE I, BLOCK N       *
CD     IJJ(I,N)        POSITION OF IN-GROUP SCATTERING CROSS SECTION IN  *
CD                        SCATTERING DATA FOR ISOTOPE I, SCATTERING BLOCK*
CD                        N,COUNTED FROM THE FIRST WORD OF ISOTOPE I DATA*
C                                                                        *
C*****************************************************************     *
```

```
C*****************************************************************
CR          SCATTERING SUB-BLOCK                                  *
C                                                                 *
CC        PRESENT IF LORD(N).GT.0                                 *
C                                                                 *
CL    ((SCAT(K,L),K=1,KMAX),L=1,LORDN)                            *
C                                                                 *
CC     KMAX=SUM OVER I OF JBAND(I,N) WITHIN THE I-RANGE OF SUB-BLOCK M,*
CC         THE I-RANGE IS IL=(M-1)*((NISO-1)/NSBLOK+1)+1          *
CC         TO IU=M*((NISO-1)/NSBLOK+1).  LORDN=LORD(N)            *
C                                                                 *
CW    KMAX*LORDN                                                  *
C                                                                 *
CD    SCAT(K,L)      SCATTERING MATRIX OF SCATTERING ORDER L, FOR  *
CD                      REACTION TYPE IDENTIFIED BY IDSCT(N) FOR THIS *
CD                      BLOCK,  JBAND(I) VALUES FOR SCATTERING INTO *
CD                      GROUP J ARE STORED AT LOCATIONS K=SUM FROM 1 *
CD                      TO (I-1) OF JBAND(I) PLUS 1 TO K=1+JBAND(I), *
CD                      THE SUM IS ZERO WHEN I=1.  J=TO=J SCATTER IS *
CD                      THE IJJ(I)-TH ENTRY IN THE RANGE JBAND(I),  *
CD                      VALUES ARE STORED IN THE ORDER (J+JUP),     *
CD                      (J+JUP-1),...,(J+1),J,(J-1),...,(J-JDN),    *
CD                      WHERE JUP=IJJ(I)-1 AND JDN=JBAND(I)-IJJ(I)  *
C                                                                 *
CN                       BLOCKING OVER ISOTOPES FOR EACH ORDER IS  *
CN                       NECESSARY IF THE DATA IS TO BE PROCESSED ONCE *
CN                       SEQUENTIALLY AND THE MACROSCOPIC DATA STORED *
CN                       ONE ORDER AT A TIME.  IN THIS EVENT, EITHER *
CN                       VALUES OF LORD(N) MUST BE LIMITED TO 1 OR  *
CN                       NSBLOK BE 1.                              *
C                                                                 *
C*****************************************************************

CEOF
```

3. BROKXS - Bondarenko Cross-Section Data

This file is required as an adjunct to the ISOTXS file when the Bondarenko self-shielding method is to be used. Only those isotopes which have interpolation tables need be included in BROKXS. No changes in BROKXS-II other than the introduction of the MULT parameter are present in BROKXS-III.

```
C*****************************************************************
C                       REVISED 07/01/73                          *
C                                                                 *
CF          BRKOXS-III                                            *
CE          BONDARENKO SELF-SHIELDING TABLES                      *
C                                                                 *
CN                       THIS FILE PROVIDES DATA NECESSARY FOR    *
CN                       BONDARENKO TREATMENT IN ADDITION TO      *
CN                       THOSE DATA IN FILE ISOTXS                *
CN                       FORMATS GIVEN ARE FOR FILE EXCHANGE PURPOSES *
CN                       ONLY.                                    *
C                                                                 *
C*****************************************************************


C*****************************************************************
CS          FILE STRUCTURE                                        *
CS                                                                *
CS             RECORD TYPE                          PRESENT IF    *
CS             ============================         ==========    *
CS             FILE IDENTIFICATION                  ALWAYS        *
CS             FILE CONTROL                         ALWAYS        *
CS             FILE DATA                            ALWAYS        *
CS    ************(REPEAT FROM 1 TO NISOSH)                       *
CS    *        SELF-SHIELDING FACTORS               ALWAYS        *
```

```
CS    *          CROSS SECTIONS                        ALWAYS
CS    **************
CS
C
C*****************************************************************

C*****************************************************************
CR           FILE IDENTIFICATION
C
CL     HNAME,(HUSE(I),I=1,2),IVERS
C
CW     1+3*MULT
C
CB     FORMAT(11H 0V BRKOXS ,A6,1H*,
CB    12A6,1H*,I6)
C
CD     HNAME           HOLLERITH FILE NAME = BRKOXS = (A6)
CD     HUSE            HOLLERITH USER IDENTIFICATION (A6)
CD     IVERS           FILE VERSION NUMBER
CD     MULT            DOUBLE PRECISION PARAMETER
CD                        1= A6 WORD IS SINGLE WORD
CD                        2= A6 WORD IS DOUBLE PRECISION WORD
C
C*****************************************************************

C*****************************************************************
CR           FILE CONTROL
C
CL     NGROUP,NISOSH,NSIGPT,NTEMPT
C
CW     4
C
CB     FORMAT(4H 1D ,4I6)
C
CD     NGROUP          NUMBER OF ENERGY GROUPS IN SET
CD     NISOSH          NUMBER OF ISOTOPES WITH SELF-SHIELDING FACTORS
CD     NSIGPT          TOTAL NUMBER OF VALUES OF VARIABLE X (SEE FILE DATA-
CD                        RECORD) WHICH ARE GIVEN,  NSIGPT IS EQUAL TO
CD                        THE SUM FROM 1 TO NISOSH OF NTABP(I)
CD     NTEMPT          TOTAL NUMBER OF VALUES OF VARIABLE TB (SEE FILE
CD                        DATA RECORD) WHICH ARE GIVEN,  NTEMPT IS EQUAL
CD                        TO THE SUM FROM 1 TO NISOSH OF NTABT(I)
C
C*****************************************************************

C*****************************************************************
CR           FILE DATA
C
CL     (HISONM(I),I=1,NISOSH),(X(K),K=1,NSIGPT),(TB(K),K=1,NTEMPT),
CL    1(EMAX(J),J=1,NGROUP),EMIN,(JBFL(I),I=1,NISOSH),
CL    2(JBFH(I),I=1,NISOSH),(NTABP(I),I=1,NISOSH),(NTABT(I),I=1,NISOSH)
C
CW     (4+MULT)*NISOSH+NSIGPT+NTEMPT+NGROUP+1
C
CB     FORMAT(4H 2D ,9(1X,A6)/          HISONM
CB    1(10(1X,A6)))
CB     FORMAT(1P6E12.5)                 X,TB,EMAX,EMIN
CB     FORMAT(12I6)                     JBFL,JBFH,NTABP,NTABT
C
CD     HISONM(I)       HOLLERITH ISOTOPE LABEL FOR ISOTOPE I (A6).  THESE
CD                        LABELS MUST BE A SUBSET OF THOSE IN FILE ISOTXS
CD                        OR GRUPXS, IN THE CORRESPONDING ARRAY.
CD     X               ARRAY OF LN(SIGP0)/LN(10) VALUES FOR ALL ISOTOPES,
CD                        WHERE SIGP0 IS THE TOTAL CROSS SECTION OF THE
CD                        OTHER ISOTOPES IN THE MIXTURE IN BARNS PER ATOM
CD                        OF THIS ISOTOPE.  FOR ISOTOPE I, THE NTABP(I)
CD                        VALUES OF X FOR WHICH SELF-SHIELDING FACTORS
CD                        ARE GIVEN ARE STORED STARTING AT LOCATION L=1+
CD                        SUM FROM 1 TO I-1 OF NTABP(K).
CD     TB              ARRAY OF TEMPERATURES (DEGREES C) FOR ALL ISOTOPES,
CD                        FOR ISOTOPE I, THE NTBT(I) VALUES OF TB FOR
CD                        WHICH SELF-SHIELDING FACTORS ARE GIVEN ARE
```

```
CD                    STORED AT LOCATION L=1+SUM FROM 1 TO I-1 OF
CD                    NTABT(K).
CD     EMAX(J)      MAXIMUM ENERGY BOUND OF GROUP J (EV)
CD     EMIN         MINIMUM ENERGY BOUND OF SET (EV)
CD     JBFL         NUMBER OF LOWEST ENERGY GROUP FOR WHICH SELF-
CD                    SHIELDING FACTORS ARE GIVEN.
CD     JBFH         NUMBER OF HIGHEST ENERGY GROUP FOR WHICH SELF-
CD                    SHIELDING FACTORS ARE GIVEN.
CD     NTABP(I)     NUMBER OF SIGP0 VALUES FOR WHICH SELF-SHIELDING
CD                    FACTORS ARE GIVEN FOR ISOTOPE I.
CD     NTABT(I)     NUMBER OF TEMPERATURE VALUES FOR WHICH SELF-
CD                    SHIELDING FACTORS ARE GIVEN FOR ISOTOPE I.
C
C*****************************************************************
C*****************************************************************
CR          SELF-SHIELDING FACTORS
C
CL     (((FTOT(N,K,J),N=1,NBINT),K=1,NBTEM),J=JBFLI,JBFHI),
CL     (((FCAP(N,K,J),N=1,NBINT),K=1,NBTEM),J=JBFLI,JBFHI),
CL     (((FFIS(N,K,J),N=1,NBINT),K=1,NBTEM),J=JBFLI,JBFHI),
CL     (((FTR (N,K,J),N=1,NBINT),K=1,NBTEM),J=JBFLI,JBFHI),
CL     (((FEL (N,K,J),N=1,NBINT),K=1,NBTEM),J=JBFLI,JBFHI)
C
CC     NBINT=NTABP(I)
CC     NBTEM=NTABT(I)
CC     JBFLI=JBFL(I)
CC     JBFHI=JBFH(I)
C
CW     5*NBINT*NBTEM*(JBFHI-JBFLI+1)
C
CB     FORMAT(4H 3D ,1P5E12.5/(6E12.5))
C
CD     FTOT         TOTAL SELF-SHIELDING FACTOR EVALUATED AT
CD                    X(N) AND TB(K).
CD     FCAP         CAPTURE SELF-SHIELDING FACTOR EVALUATED AT
CD                    X(N) AND TB(K).
CD     FFIS         FISSION SELF-SHIELDING FACTOR EVALUATED AT
CD                    X(N) AND TB(K).
CD     FTR          TRANSPORT SELF-SHIELDING FACTOR EVALUATED AT
CD                    X(N) AND TB(K).
CD     FEL          ELASTIC SELF-SHIELDING FACTOR EVALUATED AT
CD                    X(N) AND TB(K).
C
C*****************************************************************


C*****************************************************************
CR          CROSS SECTIONS
C
CL     (XSPD(J),J=1,NGROUP),(XSIN(J),J=1,NGROUP),(XSE(J),J=1,NGROUP),
CL    1(XSMU(J),J=1,NGROUP),(XSED(J),J=1,NGROUP),(XSXI(J),J=1,NGROUP)
C
CW     6*NGROUP
C
CB     FORMAT(4H 4D ,1P5E12.5/(6E12.5))
C
CD     XSPD         POTENTIAL SCATTERING CROSS SECTION (BARNS)
CD     XSIN         INELASTIC CROSS SECTION (BARNS)
CD     XSE          ELASTIC CROSS SECTION (BARNS)
CD     XSMU         AVERAGE COSINE OF ELASTIC SCATTERING ANGLE
CD     XSED         ELASTIC DOWN-SCATTERING TO ADJACENT GROUP
CD     XSXI         AVERAGE ELASTIC SCATTERING LETHARGY INCREMENT
C
C*****************************************************************

CEOF
```

4. DLAYXS - Delayed Neutron Data

This file provides delayed neutron data in multigroup form. The individual data blocks are related to cross-section files in ISOTXS and GRUPXS by the absolute isotope label. No changes in DLAYXS-II other than the introduction of the MULT parameter are present in DLAYXS-III.

Currently users must produce DLAYXS files from card input because no nuclear data processing codes are generally available that produce the DLAYXS file from ENDF/B data. More often than not, delayed neutron yield data are given in standard references in terms of delayed neutron fractions β_N for each family N. These fractions are readily converted to file quantities using

$$SNUDEL(L,N) = SNUTOT(L) \cdot \beta_N$$

where SNUTOT(L) is the total neutron yield per fission in group L found in the PRINCIPAL CROSS SECTIONS records in the ISOTXS or GRUPXS files.

```
C*****************************************************************************
C                          REVISED 07/01/73                                    *
C                                                                              *
CF          DLAYXS-III                                                         *
CE          MICROSCOPIC GROUP DELAYED NEUTRON PRECURSOR DATA                   *
C                                                                              *
CN                         THIS FILE PROVIDES PRECURSOR YIELDS,                *
CN                         EMISSION SPECTRA, AND DECAY CONSTANTS               *
CN                         ORDERED BY ISOTOPE.  ISOTOPES ARE IDENTIFIED        *
CN                         BY ABSOLUTE ISOTOPE LABELS FOR RELATION TO          *
CN                         ISOTOPES IN EITHER FILE ISOTXS OR GRUPXS.           *
CN                         FORMATS GIVEN ARE FOR FILE EXCHANGE PURPOSES        *
CN                         ONLY.                                               *
C                                                                              *
C*****************************************************************************

C------------------------------------------------------------------------------*
CS          FILE STRUCTURE                                                     *
CS                                                                             *
CS             RECORD TYPE                              PRESENT IF             *
CS             ==========================               ==========             *
CS             FILE IDENTIFICATION                      ALWAYS                 *
CS             FILE CONTROL                             ALWAYS                 *
CS             FILE DATA, DECAY CONSTANTS, AND                                 *
CS                EMISSION SPECTRA                      ALWAYS                 *
CS   ************(REPEAT TO NISOD)                                            *
CS   *         DELAYED NEUTRON PRECURSOR                                       *
CS   *            YIELD DATA                            ALWAYS                 *
CS   *************                                                            *
C                                                                              *
C------------------------------------------------------------------------------*

C------------------------------------------------------------------------------*
CR          FILE IDENTIFICATION                                                *
C                                                                              *
CL     HNAME,(HUSE(I),I=1,2),IVERS                                             *
C                                                                              *
CW     1+3*MULT                                                                *
C                                                                              *
CB     FORMAT(11H 0V DLAYXS ,A6,1H*,                                           *
CB    12A6,1H*,I6)                                                             *
C                                                                              *
CD     HNAME          HOLLERITH FILE NAME = DLAYXS =                          *
CD     HUSE           HOLLERITH USER IDENTIFICATION (A6)                      *
CD     IVERS          FILE VERSION NUMBER                                     *
CD     MULT           DOUBLE PRECISION PARAMETER                              *
CD                        1= A6 WORD IS SINGLE WORD                            *
CD                        2= A6 WORD IS DOUBLE PRECISION WORD                  *
C                                                                              *
C------------------------------------------------------------------------------*
```

```
C*****************************************************************
CR          FILE CONTROL                                          *
C                                                                 *
CL    NGROUP,NISOD,NFAM,IDUM                                      *
C                                                                 *
CW    4                                                           *
C                                                                 *
CB    FORMAT(4H 10 ,4I6)                                          *
C                                                                 *
CD    NGROUP        NUMBER OF NEUTRON ENERGY GROUPS IN SET        *
CD    NISOD         NUMBER OF ISOTOPES IN DELAYED NEUTRON SET     *
CD    NFAM          NUMBER OF DELAYED NEUTRON FAMILIES IN SET     *
CD    IDUM          DUMMY TO MAKE UP FOUR WORD RECORD.            *
C                                                                 *
C*****************************************************************
```

```
C*****************************************************************
CR          FILE DATA, DECAY CONSTANTS, AND EMISSION SPECTRA      *
C                                                                 *
CL    (HABSID(I),I=1,NISOD),(FLAM(N),N=1,NFAM),((CHID(J,N),J=1,NGROUP),*
CL    N=1,NFAM),(EMAX(J),J=1,NGROUP),EMIN,(NKFAM(I),I=1,NISOD),   *
CL    (LOCA(I),I=1,NISOD)                                         *
C                                                                 *
CW    (2+MULT)*NISOD+(NGROUP+1)*(NFAM+1)                          *
C                                                                 *
CB    FORMAT(4H 20 ,9(1X,A6)/          HABSID                   *
CB   1(10(1X,A6)))                                               *
CB    FORMAT(1P6E12.5)                 FLAM,CHID,EMAX,EMIN      *
CB    FORMAT(12I6)                     NKFAM,LOCA               *
C                                                                 *
CD    HABSID(I)     HOLLERITH ABSOLUTE ISOTOPE LABEL FOR ISOTOPE I (A6)*
CD    FLAM(N)       DELAYED NEUTRON PRECURSOR DECAY CONSTANT      *
CD                     FOR FAMILY N                               *
CD    CHID(J,N)     FRACTION OF DELAYED NEUTRONS EMITTED INTO NEUTRON *
CD                     ENERGY GROUP J FROM PRECURSOR FAMILY N     *
CD    EMAX(J)       MAXIMUM ENERGY BOUND OF GROUP J (EV)          *
CD    EMIN          MINIMUM ENERGY BOUND OF SET (EV)              *
CD    NKFAM(I)      NUMBER OF FAMILIES TO WHICH FISSION IN ISOTOPE I *
CD                     CONTRIBUTES DELAYED NEUTRON PRECURSORS     *
CD    LOCA(I)       NUMBER OF RECORDS TO BE SKIPPED TO READ DATA FOR *
CD                     ISOTOPE I.  LOCA(1)=0                      *
C                                                                 *
C*****************************************************************
```

```
C*****************************************************************
CR          DELAYED NEUTRON PRECURSOR YIELD DATA                  *
C                                                                 *
CL    (SNUDEL(J,K),J=1,NGROUP),K=1,NKFAMI),(NUMFAM(K),K=1,NKFAMI) *
C                                                                 *
CC    NKFAMI=NKFAM(I)                                             *
C                                                                 *
CW    (NGROUP+1)*NKFAMI                                           *
C                                                                 *
CB    FORMAT(4H 30 ,1P5E12.5/(6E12.5)) SNUDEL                     *
CB    FORMAT(12I6)                     NUMFAM                     *
C                                                                 *
CD    SNUDEL(J,K)   NUMBER OF DELAYED NEUTRON PRECUSORS PRODUCED IN *
CD                     FAMILY NUMBER NUMFAM(K) PER FISSION IN     *
CD                     GROUP J                                    *
CD    NUMFAM(K)     FAMILY NUMBER OF THE K-TH YIELD VECTOR IN     *
CD                     ARRAY SNUDEL(J,K)                          *
C                                                                 *
C*****************************************************************
```

5. ISOGXS - Nuclide-Ordered Gamma Cross Section

This file provides a broad group library for gamma ray cross sections. It serves as the output file of a code that processes ENDF/B gamma data into broad group form for subsequent use in transport calculations. Both the neutron and gamma ray energy group structures are involved. Principal cross sections including P_ℓ weighted transport and total cross sections, absorption cross sections, and energy deposition cross sections, are stored in one record and matrices for neutron production (γ,n), gamma production (n,γ), and gamma scattering (γ,γ') cross sections are stored in separate records. All the data are stored compactly.

The cross sections represent sums of all significant contributing reactions. For example, absorption cross sections include the photoelectric effect, pair production, and any significant nuclear photodisintegration reactions. Gamma production cross sections (n,γ) include gammas from fission, neutron capture, and inelastic scattering of neutrons.

ISOGXS-III is the first version of a gamma ray file to be included in the set of interface files.

```
C*****************************************************************************
C                          REVISED 07/01/73                                    *
C                                                                              *
CF          ISOGXS-III                                                         *
CE          MICROSCOPIC GROUP GAMMA CROSS SECTIONS                             *
C                                                                              *
CN                         THIS FILE PROVIDES A BASIC BROAD GROUP              *
CN                         LIBRARY, ORDERED BY ISOTOPE                         *
CN                         FORMATS GIVEN ARE FOR FILE EXCHANGE PURPOSES        *
CN                         ONLY.                                               *
C                                                                              *
C*****************************************************************************


C*------------------------------------------------------------------------------*
CS          FILE STRUCTURE                                                     *
CS                                                                             *
CS              RECORD TYPE                                PRESENT IF          *
CS          ================================               ==========          *
CS              FILE IDENTIFICATION                        ALWAYS              *
CS              FILE CONTROL                               ALWAYS              *
CS              FILE DATA                                  ALWAYS              *
CS    *************(REPEAT FOR ALL ISOTOPES)                                   *
CS    *         ISOTOPE CONTROL                            ALWAYS              *
CS    *         PRINCIPAL CROSS SECTIONS                   ALWAYS              *
CS    *  ***********(REPEAT FROM 1 TO LGN)                                     *
CS    *  *  ********(REPEAT FROM 1 TO NBLKGN)                                 *
CS    *  *  *    NEUTRON PRODUCTION CROSS SECTIONS         IGN.EQ.1 AND        *
CS    *  *  *                                              NBLKGN.GT.0         *
CS    *  ************                                                          *
CS    *                                                                       *
CS    *  ***********(REPEAT FROM 1 TO LNG)                                   *
CS    *  *  ********(REPEAT FROM 1 TO NBLKNG)                                *
CS    *  *  *    GAMMA PRODUCTION CROSS SECTIONS           ING.EQ.1 AND        *
CS    *  *  *                                              NBLKNG.GT.0         *
CS    *  ************                                                          *
CS    *                                                                       *
CS    *  ***********(REPEAT FROM 1 TO LGG)                                   *
CS    *  *  ********(REPEAT FROM 1 TO NBLKGG)                                *
CS    *  *  *    GAMMA SCATTERING CROSS SECTIONS           IGG.EQ.1 AND        *
CS    *  *  *                                              NBLKGG.NE.0         *
CS    ***************                                                         *
C                                                                              *
C*------------------------------------------------------------------------------*
```

```
C*****************************************************************
CR          FILE IDENTIFICATION                                    *
C                                                                  *
CL     HNAME,(HUSE(I),I=1,2),IVERS                                 *
C                                                                  *
CW     1+3*MULT                                                    *
C                                                                  *
CB     FORMAT(11H 0V ISOGXS ,A6,1H*,                               *
CB    12A6,1H*,I6)                                                 *
C                                                                  *
CD     HNAME          HOLLERITH FILE NAME =ISOGXS = (A6)           *
CD     HUSE           HOLLERITH USER IDENTIFICATION (A6)           *
CD     IVERS          FILE VERSION NUMBER                          *
CD     MULT           DOUBLE PRECISION PARAMETER                   *
CD                        1= A6 WORD IS SINGLE WORD                 *
CD                        2= A6 WORD IS DOUBLE PRECISION WORD       *
C                                                                  *
C*****************************************************************
C*****************************************************************
CR          FILE CONTROL                                           *
C                                                                  *
CL     NGROUP,NGGRUP,NGIS,IDUM                                     *
C                                                                  *
CW     4                                                           *
C                                                                  *
CB     FORMAT(4H 1D ,4I6)                                          *
C                                                                  *
CD     NGROUP         NUMBER OF NEUTRON ENERGY GROUPS              *
CD     NGGRUP         NUMBER OF GAMMA ENERGY GROUPS                *
CD     NGIS           NUMBER OF ISOTOPES WITH GAMMA CROSS SECTIONS *
CD     IDUM           UNDEFINED, USED TO OBTAIN FOUR WORD RECORD   *
C                                                                  *
C*****************************************************************

C*****************************************************************
CR          FILE DATA                                              *
C                                                                  *
CL     (HSETID(I),I=1,12),(HGISON(I),I=1,NGIS),(VEL(J),J=1,NGROUP),*
CL    1(EMAX(J),J=1,NGROUP),EMIN,(EMAXG(K),K=1,NGGRUP),EMING       *
C                                                                  *
CW     2*NGROUP+NGGRUP+MULT*(NGIS+12)+2                            *
C                                                                  *
CB     FORMAT(5H 2D *,11A6,1H*/          HSETID,HGISON            *
CB    1(10(1X,A6)))                                                *
CB     FORMAT(1P6E12.5)                  VEL,EMAX,EMIN,EMAXG,EMING*
C                                                                  *
CD     HSETID         HOLLERITH IDENTIFICATION OF SET (A6)         *
CD     HGISON(I)      HOLLERITH ISOTOPE LABEL FOR ISOTOPE I (A6)   *
CD     VEL(J)         MEAN NEUTRON VELOCITY IN GROUP J (CM/SEC)    *
CD     EMAX(J)        MAXIMUM ENERGY BOUND OF NEUTRON GROUP J (EV) *
CD     EMIN           MINIMUM NEUTRON ENERGY BOUND (EV)            *
CD     EMAXG(K)       MAXIMUM ENERGY BOUND OF GAMMA GROUP K (EV)   *
CD     EMING          MINIMUM GAMMA ENERGY BOUND (EV)              *
C                                                                  *
C*****************************************************************
C*****************************************************************
CR     ISOTOPE CONTROL                                             *
C                                                                  *
CL     HABSID,LGTOT,LGTRN,IGN,ING,IGG                              *
C                                                                  *
CW     MULT+5                                                      *
C                                                                  *
CB     FORMAT(4H 3D ,A6,5I6)                                       *
C                                                                  *
CD     HABSID         HOLLERITH ABSOLUTE ISOTOPE LABEL = SAME FOR ALL *
CD                       VERSIONS OF SAME ISOTOPE IN SFT           *
CD     LGTOT          NUMBER OF MOMENTS OF TOTAL CROSS SECTION     *
CD     LGTRN          NUMBER OF MOMENTS OF TRANSPORT CROSS SECTION *
CD     IGN            GAMMA,N CROSS SECTIONS PRESENT, 1=YES,0=NO   *
CD     ING            N,GAMMA CROSS SECTIONS PRESENT, 1=YES,0=NO   *
CD     IGG            GAMMA SCATTERING CROSS SECTIONS PRESENT, 1=YES,0=NO*
C                                                                  *
C*****************************************************************
```

```
C*****************************************************************
CR          PRINCIPAL CROSS SECTIONS                             *
C                                                                *
CL    ((GTRPL(K,L),K=1,NGGRUP),L=1,LGTRN),                       *
CL   1((GTOTPL(K,L),K=1,NGGRUP),L=1,LGTOT),(GABS(K),K=1,NGGRUP), *
CL   2(GEDEP(K),K=1,NGGRUP),(GDGR(K),K=1,NGGRUP)                 *
C                                                                *
CW    (LGTRN+LGTOT+2)*NGGRUP                                     *
C                                                                *
CB    FORMAT(4H 4D ,1P5E12.5/(6E12.5))                           *
C                                                                *
CD    GTRPL          PL WEIGHTED TRANSPORT CROSS SECTION         *
CD    GTOTPL         PL WEIGHTED TOTAL CROSS SECTION             *
CD    GABS           TOTAL ABSORPTION CROSS SECTION              *
CD    GEDEP          ENERGY DEPOSITION=CROSS SECTION X ENERGY (EV)*
CD                      DEPOSITED                                *
CD    GDGR           SOURCE FROM TOTAL DECAY (PHOTONS/DIS)       *
C                                                                *
C*****************************************************************
C*****************************************************************
CR          NEUTRON PRODUCTION CONTROL                           *
C                                                                *
CC          PRESENT IF IGN.EQ.1                                  *
C                                                                *
CL    LGN,NBLKGN,(JBNDGN(J),J=1,NGROUP),(IJJGN(J),J=1,NGROUP)    *
C                                                                *
CW    2*(NGROUP+1)                                               *
C                                                                *
CB    FORMAT(4H 5D ,11I6/(12I6))                                 *
C                                                                *
CD    LGN            NUMBER OF ORDERS OF GAMMA ,N CROSS SECTIONS *
CD    NBLKGN         NUMBER OF BLOCKS OF GAMMA,N CROSS SECTIONS  *
CD                      PER ORDER                                *
CD    JBNDGN(J)      BANDWIDTH OF GAMMA GROUPS YIELDING NEUTRONS IN*
CD                      GROUP J                                  *
CD    IJJGN(J)       LOWEST ENERGY GAMMA GROUP OF BAND JBNDGN(J) *
C                                                                *
C*****************************************************************

C*****************************************************************
CR          NEUTRON PRODUCTION CROSS SECTIONS                    *
C                                                                *
CC          PRESENT IF IGN.EQ.1 AND NBLKGN.GT.0                  *
C                                                                *
CL    (GGN(L),L=1,LGNMAX)                                        *
C                                                                *
CC    LGNMAX=SUM OVER J OF JBNDGN(J) WITHIN THE J-GROUP RANGE OF THIS *
CC    BLOCK. IF M IS THE INDEX OF THE BLOCK, THE J-GROUP RANGE   *
CC    CONTAINED WITHIN THIS BLOCK IS JL=(M-1)*((NGROUP-1)/NBLKGN+1)*
CC    TO JU=M*((NGROUP-1)/NBLKGN+1)                              *
C                                                                *
CW    LGNMAX                                                     *
C                                                                *
CB    FORMAT(4H 6D ,1P5E12.5/(6E12.5))                           *
C                                                                *
CD    GGN(L)         CROSS SECTIONS FOR PRODUCTION OF NEUTRONS BY *
CD                      GAMMAS. JBNDGN(J) VALUES OF THE CROSS SECTIONS *
CD                      FOR EACH NEUTRON GROUP J ARE STORED ACCORDING TO*
CD                      THE GAMMA GROUP ORDER K=IJJGN(J),IJJGN(J)-1,... *
CD                      ...,IJJGN(J)-JBNDGN(J)+1.  IN EACH BLOCK M,  *
CD                      THE JBNDGN(J) VALUES ARE STORED IN LOCATIONS *
CD                      L=LL TO L=LU WHERE LL=1 PLUS SUM OVER JBNDGN(N) *
CD                      FROM N=JL TO N=J-1 AND LU=LL PLUS JBNDGN(J)-1 *
C                                                                *
C*****************************************************************
```

```
C*****************************************************************
CR          GAMMA PRODUCTION CONTROL                             *
C                                                                *
CC          PRESENT IF ING.EQ.1                                  *
C                                                                *
CL    LNG,NBLKNG,(JBNDNG(J),J=1,NGGRUP),(IJJNG(J),J=1,NGGRUP)    *
C                                                                *
CW    2*(NGGRUP+1)                                               *
C                                                                *
CB    FORMAT(4H 7D ,11I6/(12I6))                                 *
C                                                                *
CD    LNG           NUMBER OF ORDERS OF N,GAMMA  CROSS SECTIONS  *
CD    NBLKNG        NUMBER OF BLOCKS OF N,GAMMA CROSS SECTIONS   *
CD                     PER ORDER                                 *
CD    JBNDNG(K)     BANDWIDTH OF NEUTRON GROUPS YIELDING GAMMAS IN *
CD                     GROUP K                                   *
CD    IJJNG(K)      LOWEST ENERGY NEUTRON GROUP OF BAND JBNDNG(K) *
C                                                                *
C*****************************************************************

C*****************************************************************
CR          GAMMA PRODUCTION CROSS SECTIONS                      *
C                                                                *
CC          PRESENT IF ING.EQ.1 AND NBLKNG.GT.0                  *
C                                                                *
CL    (GNG(L),L=1,LNGMAX)                                        *
C                                                                *
CC    LNGMAX IS SAME AS LGNMAX ABOVE EXCEPT JBNDNG(K) AND NBLKNG ARE *
CC    USED INSTEAD OF JBNDGN(J) AND NBLKGN                       *
C                                                                *
CW    LNGMAX                                                     *
C                                                                *
CB    FORMAT(4H 8D ,1P5E12.5/(6E12.5))                           *
C                                                                *
CD    GNG(L)        CROSS SECTIONS FOR PRODUCTION OF GAMMAS BY   *
CD                     NEUTRONS.  STORAGE IS SIMILAR TO THAT FOR GGN(L) *
CD                     EXCEPT JBNDNG(K) AND IJJNG(K) REPLACE JBNDGN(J) *
CD                     AND IJJGN(J).                             *
C                                                                *
C*****************************************************************

C*****************************************************************
CR          GAMMA SCATTERING CONTROL                             *
C                                                                *
CC          PRESENT IF IGG.EQ.1                                  *
C                                                                *
CL    LGG,NBLKGG,(JBNDGG(J),J=1,NGGRUP),(IJJGG(J),J=1,NGGRUP)    *
C                                                                *
CW    2*(NGGRUP+1)                                               *
C                                                                *
CB    FORMAT(4H 9D ,11I6/(12I6))                                 *
C                                                                *
CD    LGG           NUMBER OF ORDERS OF GAMMA SCATTERING CROSS SECTIONS *
CD    NBLKGG        NUMBER OF BLOCKS OF GAMMA SCATTERING CROSS SECTIONS *
CD                     PER ORDER                                 *
CD    JBNDGG(K)     BANDWIDTH OF GAMMA GROUPS YIELDING GAMMAS IN *
CD                     GROUP K                                   *
CD    IJJGG(K)      LOWEST ENERGY GAMMA GROUP OF BAND JBNDGG(K)  *
C                                                                *
C*****************************************************************

C*****************************************************************
CR          GAMMA SCATTERING CROSS SECTIONS                      *
C                                                                *
CC          PRESENT IF IGG.EQ.1 AND NBLKGG.GT.0                  *
C                                                                *
CL    (GGG(L),L=1,LGGMAX)                                        *
C                                                                *
CC    LGGMAX IS SAME AS LGNMAX ABOVE EXCEPT JBNDGG(K) AND NBLKGG ARE *
CC    USED INSTEAD OF JBNDGN(J) AND NBLKGN.                      *
```

```
C
CW    LGGMAX                                                          -
C                                                                     -
CB    FORMAT(5H 1ØD ,1P5E12.5/(6F12.5))                               -
C                                                                     -
CD    GGG(L)        CROSS SECTIONS FOR GAMMA SCATTERING.  STORAGE IS  -
CD                     SIMILAR TO THAT FOR GGN(L) EXCEPT JBNDGG(K) AND -
CD                     IJJGG(K) REPLACE JBNDGN(J) AND IJJGN(J).     -
C                                                                     -
C---------------------------------------------------------------------
```

CEOF

C. Reactor Specifications Files

1. GEODST - Geometry Description

This file presents a geometric description for a neutronics problem. GEODST-III is changed with respect to GEODST-II to provide for both fine mesh and coarse mesh specifications, and to provide a wider range of hexagonal geometry specifications.

In GEODST-III the mesh is specified in the two records COARSE MESH INTERVAL BOUNDARIES and FINE MESH INTERVALS PER COARSE MESH INTERVAL. Variables NCINTI, NCINTJ, and NCINTK, defining the number of coarse mesh intervals in the first, second, and third dimensions, respectively, have been added to the FILE SPECIFICATIONS record. The latter record in addition contains a new flag NRASS which permits specification of the region assignments on either the coarse mesh or the fine mesh. The optional assignments are contained in the last two records of GEODST-III.

REGION ASSIGNMENTS TO { COARSE MESH / FINE MESH } INTERVALS.

Modifiers for dimension searches contained in the SEARCH-III file are also now assigned on the coarsh mesh.

Specifications on hexagonal and triagonal geometries are clarified and extended in GEODST-III. Hexagonal geometry is used in modeling the full array of subassemblies in a core. In the triagonal geometries various symmetries in the array of subassemblies are exploited. In all cases the origin of coordinates is at the center of the central subassembly. Lines of symmetry are either perpendicular to subassembly flats or pass through subassembly corners.

Triagonal geometry options are specified in GEODST-III by the parameter NTRIAG in the FILE SPECIFICATIONS record. The NTRIAG options are illustrated in Fig. 2. These drawings were provided by B. J. Toppel of ANL.

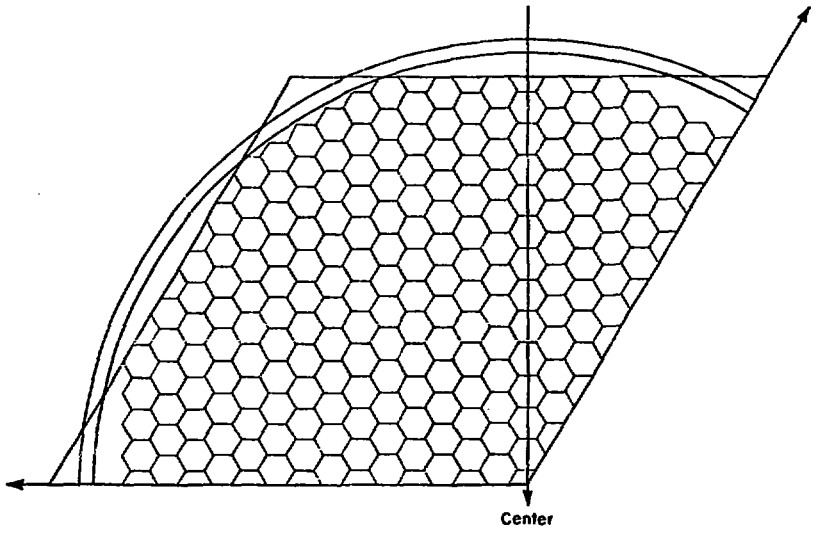

Fig. 2. Triagonal geometry options.
a. 120° axes rhombus region of solution, NTRIAG = 0.

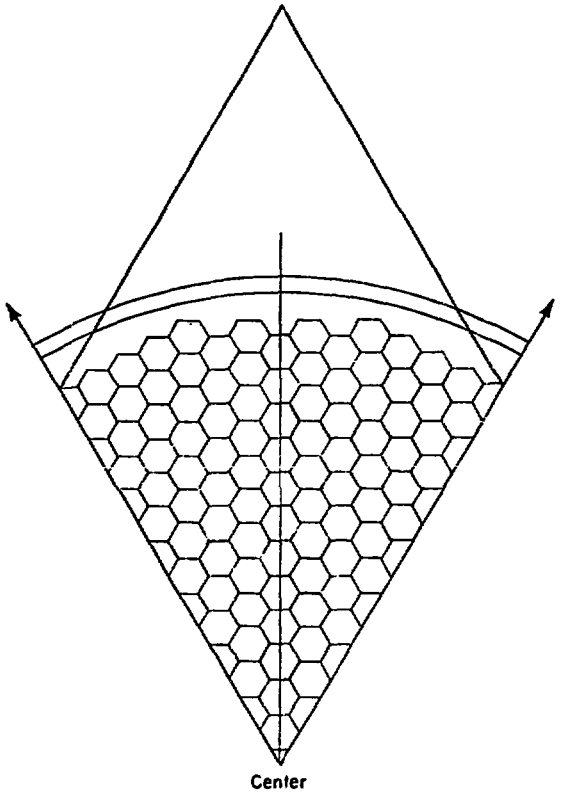

Fig. 2.b. 60° axes rhombus region of solution, NTRIAG = 1.

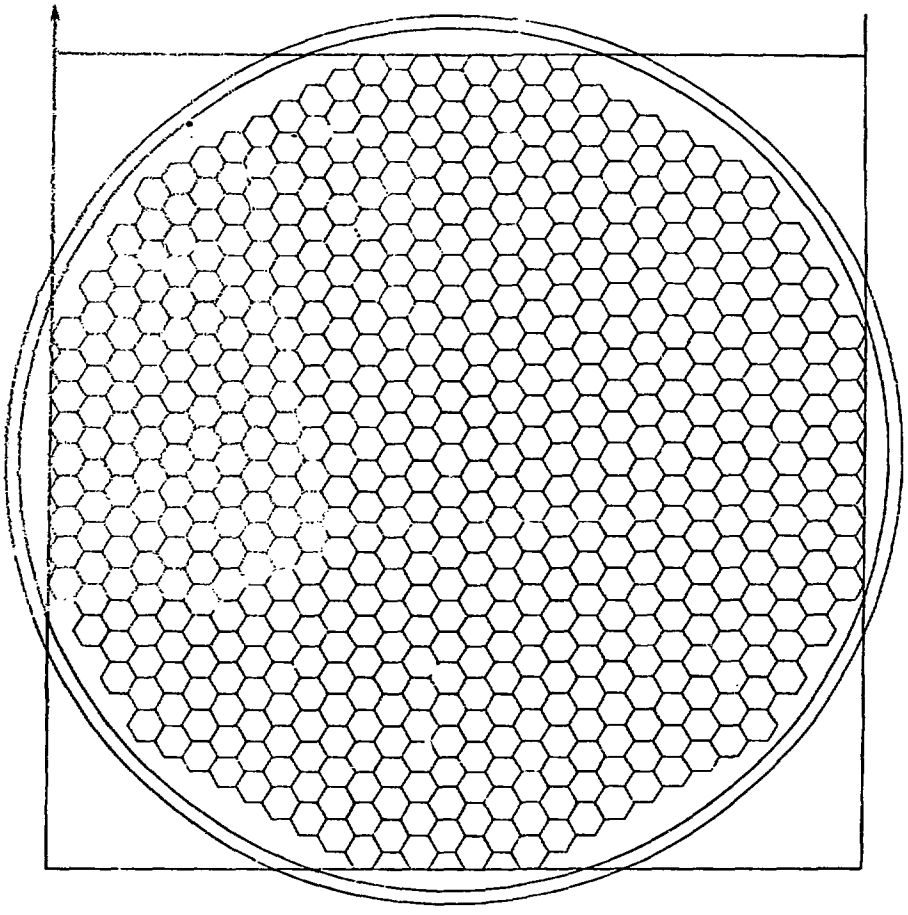

Fig. 2.c. Full rectangular region of solution, NTRIAG = 2.

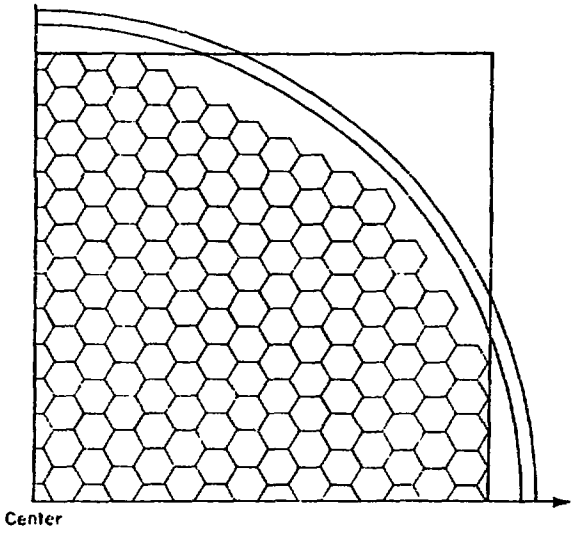

Fig. 2.d. Rectangular region of solution - 90° symmetry NTRIAG = 2.

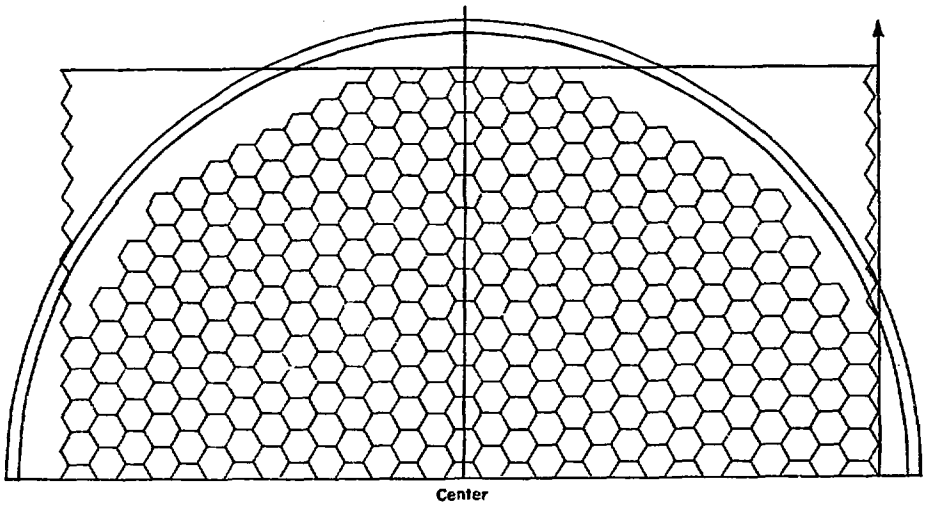

Fig. 2.e. Rectangular region of solution - 180° symmetry, NTRIAG = 2.

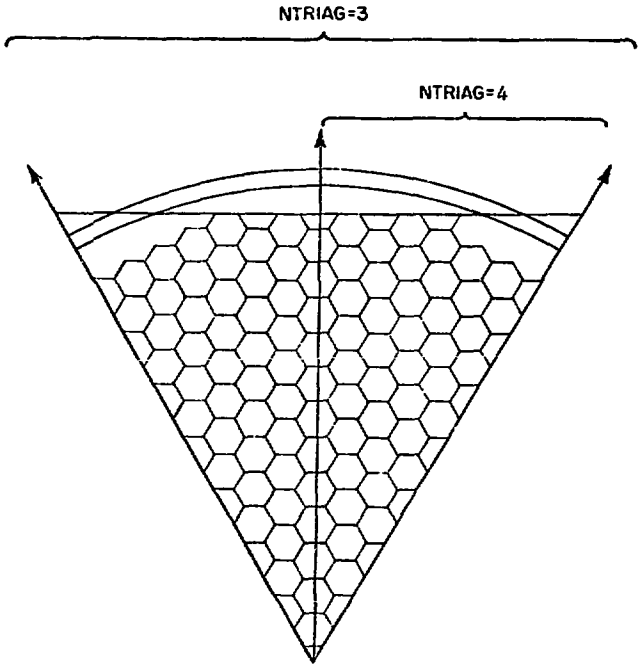

Fig. 2.f. Triangle regions of solution, NTRIAG = 3,4.

```
C*******************************************************************************
C                        REVISED 07/01/73                                      *
C                                                                              *
CF          GEODST - III                                                       *
C                                                                              *
CE          GEOMETRY DESCRIPTION                                               *
C                                                                              *
C*******************************************************************************


C*------------------------------------------------------------------------------*
CR          FILE IDENTIFICATION                                                *
C                                                                              *
CL     HNAME,(HUSE(I),I=1,2),IVERS                                             *
C                                                                              *
CW     1+3*MULT                                                                *
C                                                                              *
CD     HNAME              HOLLERITH FILE NAME - GEODST - (A6)                  *
CD     HUSE               HOLLERITH USER IDENTIFICATION (A6)                   *
CD     IVERS              FILE VERSION NUMBER                                  *
CD     MULT               DOUBLE PRECISION PARAMETER                           *
CD                           1- A6 WORD IS SINGLE WORD                         *
CD                           2- A6 WORD IS DOUBLE PRECISION WORD               *
C                                                                              *
C*------------------------------------------------------------------------------*


C*------------------------------------------------------------------------------*
CR          FILE SPECIFICATIONS                                                *
C                                                                              *
CL     IGOM,NZONE,NREG,NZCL,NCINTI,NCINTJ,NCINTK,NINTI,NINTJ,NINTK,IMB1,-      *
CL     IMB2,JMB1,JMB2,KMB1,KMB2,NBS,NBCS,NIBCS,NZWBB,NTRIAG,NRASS,            *
CL     (NGOP(I),I=1,5)                                                         *
C                                                                              *
CW     27                                                                      *
C                                                                              *
CD     IGOM               GEOMETRY  0- POINT (FUNDAMENTAL MODE)               *
CD                                   1- SLAB                                   *
CD                                   2- CYLINDER                               *
CD                                   3- SPHERE                                 *
CD                                   6- X-Y                                    *
CD                                   7- R-Z                                    *
CD                                   8- THETA-R                                *
CD                                   9- TRIAGONAL (6 MESH POINTS IN EACH       *
CD                                                 HEXAGONAL ELEMENT)          *
CD                                  10- HEXAGONAL (1 MESH POINT IN EACH        *
CD                                                 HEXAGONAL ELEMENT)          *
CD                                  11- R-THETA                                *
CD                                  12- R-THETA-Z                              *
CD                                  13- R-THETA-ALPHA                          *
CD                                  14- X-Y-Z                                  *
CD                                  15- THETA-R-Z                              *
CD                                  16- THETA-R-ALPHA                          *
CD                                  17- TRIAGONAL-Z (MESH POINTS AS IN 9,      *
CD                                                   ABOVE)                    *
CD                                  18- HEXAGON-Z   (MESH POINTS AS IN 10      *
CD                                                   ABOVE)                    *
CD     NZONE              NUMBER OF ZONES (EACH HOMOGENEOUS IN NEUTRONICS-     *
CD                        PROBLEM - A ZONE CONTAINS ONE OR MORE REGIONS)       *
CD     NREG               NUMBER OF REGIONS                                    *
CD     NZCL               NUMBER OF ZONE CLASSIFICATIONS (EDIT PURPOSES)       *
CD     NCINTI             NUMBER OF FIRST DIMENSION COARSE MESH INTERVALS-     *
CD     NCINTJ             NUMBER OF SECOND DIMENSION COARSE MESH               *
CD                          INTERVALS,  NCINTJ.EQ.1 FOR ONE                    *
CD                          DIMENSIONAL CASE,                                  *
CD     NCINTK             NUMBER OF THIRD DIMENSION COARSE MESH INTERVALS-     *
CD                          NCINTK.EQ.1 FOR ONE AND TWO                        *
CD                          DIMENSIONAL CASES,                                 *
CD     NINTI              NUMBER OF FIRST DIMENSION FINE MESH INTERVALS        *
CD     NINTJ              NUMBER OF SECOND DIMENSION FINE MESH INTERVALS       *
CD                          NINTJ.EQ.1 FOR ONE DIMENSIONAL CASE,               *
```

```
CD     NINTK              NUMBER OF THIRD DIMENSION FINE MESH INTERVALS
CD                              NINTK.EQ.1 FOR ONE AND TWO DIMENSIONAL
CD                              CASES.
CD     IMB1               FIRST BOUNDARY ON FIRST DIMENSION
CD                              0= ZERO FLUX (DIFFUSION)
CD                              1= REFLECTED
CD                              2= EXTRAPOLATED (DIFFUSION * DEL PHI
CD                                 /PHI ==C/D WHERE C IS GIVEN AS BNDC
CD                                 BELOW AND D IS THE GROUP DIFFUSION
CD                                 CONSTANT, TRANSPORT = NO RETURN)
CD                              3= REPEATING (PERIODIC) WITH OPPOSITE
CD                                 FACE
CD                              4= REPEATING (PERIODIC) WITH NEXT
CD                                 ADJACENT FACE GOING IN ORDER (90
CD                                 DEGREE ROTATION)
CD                              5= INVERTED REPEATING ALONG THIS FACE
CD                                 (180 DEGREE ROTATION)
CD                              6= ISOTROPIC RETURN (TRANSPORT)
C           NOTE THAT FOR REPEATING BOUNDARIES, THE FIRST BOUNDARY IN
C           ORDER WHICH IS INVOLVED CARRIES THE DESIGNATOR DEFINING
C           THE REPEATING CONDITION.
CD     IMB2               LAST BOUNDARY ON FIRST DIMENSION
CD     JMB1               FIRST BOUNDARY ON SECOND DIMENSION
CD     JMB2               LAST BOUNDARY ON SECOND DIMENSION
CD     KMB1               FIRST BOUNDARY ON THIRD DIMENSION
CD     KMB2               LAST BOUNDARY ON THIRD DIMENSION
CD     NBS                NUMBER OF BUCKLING SPECIFICATIONS
CD                              1= SINGLE VALUE APPLIES EVERYWHERE
CD                              .EQ.NZONE, ZONE-DEPENDENT
CD                              .GT.NZONE, DATA IS GIVEN OVER ALL ZONES FOR
CD                                THE FIRST ENERGY GROUP, THEN FOR THE NEXT
CD                                GROUP, TO END OF LIST = IF THERE ARE MORE
CD                                GROUPS, LAST GROUP DATA GIVEN IS USED
CD     NBCS               NUMBER OF CONSTANTS FOR EXTERNAL BOUNDARIES
CD                              1= SINGLE VALUE USED EVERYWHERE
CD                              6= INDIVIDUAL VALUES FOR EACH POSSIBLE
CD                                SURFACE (BOUNDARY SPECS GIVE ACTUAL USE)
CD                              .GT.6= SIX VALUES ARE GIVEN FOR THE FIRST
CD                                ENERGY GROUP, THEN SIX FOR THE NEXT, TO
CD                                THE END OF THE LIST = THE LAST GROUP DATA
CD                                GIVEN APPLIES TO ALL ADDITIONAL GROUPS
CD     NIBCS              NUMBER OF CONSTANTS FOR INTERNAL BOUNDARIES
CD                              1= SINGLE VALUES USED EVERYWHERE
CD                              .GT.1= VALUES ARE GIVEN BY ENERGY GROUP
CD                                WITH NON-BLACK CONDITION INDICATED BY
CD                                ZERO ENTRY = LAST VALUE APPLIES TO
CD                                ADDITIONAL GROUPS
CD     NZWBB              NUMBER OF ZONES WHICH ARE BLACK ABSORBERS
CD     NTRIAG             TRIAGONAL GEOMETRY OPTION
CD                              0= RHOMBUS WITH COORDINATES AT 120 DEGREES
CD                                 ORIGIN IS AT THE CENTER OF A HEXAGONAL
CD                                 ASSEMBLY.  BOUNDARIES PASS THROUGH
CD                                 CORNERS OF HEXAGONAL ASSEMBLIES.
CD                              1= SAME AS OPTION 0 EXCEPT COORDINATES AT
CD                                 60 DEGREES
CD                              2= RECTANGLE (COORDINATES AT 90 DEGREES).
CD                                 FIRST BOUNDARY PERPENDICULAR TO
CD                                 HEXAGONAL FLAT.
CD                              3= EQUILATERAL (60 DEGREE) TRIANGLE.  TWO
CD                                 BOUNDARIES ORIGINATING AT CENTER OF
CD                                 HEXAGONAL ASSEMBLY PASS THROUGH CORNERS
CD                                 OF HEXAGONAL ASSEMBLIES.
CD                              4= TRIANGLE (30-60 DEGREE), FIRST BOUNDARY
CD                                 PERPENDICULAR TO FLATS.
CD     NRASS              REGION ASSIGNMENTS
CD                              0= TO COARSE MESH
CD                              1= TO FINE MESH
CD     NGOP               RESERVED
C
C-----------------------------------------------------------------------
```

```
C*****************************************************************
CR          ONE DIMENSIONAL COARSE MESH INTERVAL BOUNDARIES AND FINE
CR          MESH INTERVALS
C
CC          PRESENT IF IGOM.GT.0 AND IGOM.LE.3
C
CL    (XMESH(I),I=1,NCBNDI),(IFINTS(I),I=1,NCINTI)
C
CW    NCBNDI*MULT+NCINTI
C
CD    XMESH               COARSE MESH BOUNDARIES, FIRST DIMENSION
CD    IFINTS              NUMBER OF FINE MESH INTERVALS PER COARSE MESH
CD                            INTERVAL, FIRST DIMENSION
CD    NCBNDI              NCINTI+1, NUMBER OF FIRST DIMENSION COARSE MESH
CD                            BOUNDARIES
C
CC        UNITS ARE CM FOR LINEAR DIMENSIONS AND RADIANS FOR ANGULAR
CC        DIMENSIONS
C
C*****************************************************************

C*****************************************************************
CR          TWO DIMENSIONAL COARSE MESH INTERVAL BOUNDARIES AND FINE
CR          MESH INTERVALS
C
CC          PRESENT IF IGOM.GE.6 AND IGOM.LE.11
C
CL    (XMESH(I),I=1,NCBNDI),(YMESH(J),J=1,NCBNDJ),
CL   1(IFINTS(I),I=1,NCINTI),(JFINTS(J),J=1,NCINTJ)
C
CW    (NCBNDI+NCBNDJ)*MULT+NCINTI+NCINTJ
C
CD    YMESH               COARSE MESH BOUNDARIES, SECOND DIMENSION
CD    JFINTS              NUMBER OF FINE MESH INTERVALS PER COARSE MESH
CD                            INTERVAL, SECOND DIMENSION
CD    NCBNDJ              NCINTJ+1, NUMBER OF SECOND DIMENSION COARSE
CD                            MESH BOUNDARIES
C
C*****************************************************************

C*****************************************************************
CR          THREE DIMENSIONAL COARSE MESH INTERVAL BOUNDARIES AND FINE
CR          MESH INTERVALS
C
CC          PRESENT IF IGOM.GE.12
C
CL    (XMESH(I),I=1,NCBNDI),(YMESH(J),J=1,NCBNDJ),
CL   1(ZMESH(K),K=1,NCBNDK),(IFINTS(I),I=1,NCINTI),
CL   2(JFINTS(J),J=1,NCINTJ),(KFINTS(K),K=1,NCINTK)
C
CW    (NCBNDI+NCBNDJ+NCBNDK)*MULT+NCINTI+NCINTJ+NCINTK
C
CD    ZMESH               COARSE MESH BOUNDARIES, THIRD DIMENSION
CD    KFINTS              NUMBER OF FINE MESH INTERVALS PER COARSE MESH
CD                            INTERVAL, THIRD DIMENSION
CD    NCBNDK              NCINTK+1, NUMBER OF THIRD DIMENSION COARSE MESH
CD                            BOUNDARIES
C
C*****************************************************************

C*****************************************************************
CR          GEOMETRY DATA
C
CC          PRESENT IF IGOM.GT.0 OR NBS.GT.0
C
CL    (VOLR(N),N=1,NREG),(BSQ(N),N=1,NBS),(BNDC(N),N=1,NBCS),
CL    (BNCI(N),N=1,NIBCS),(NZHBB(N),N=1,NZWBB),(NZC(N),N=1,NZONE),
CL    (NZNR(N),N=1,NREG)
C
CW    2*NREG+NBS+NBCS+NIBCS+NZWBB+NZONE
C
CD    VOLR                REGION VOLUMES (CC)
CD    BSQ                 BUCKLING (B**2) VALUES (CM**-2)
```

```
CD    BNDC              BOUNDARY CONSTANTS (DEL PHI/PHI =-C/D)
CD    BNCI              INTERNAL BLACK BOUNDARY CONSTANTS
CD    NZHBB             ZONE NUMBERS WITH BLACK ABSORBER CONDITIONS
CD    NZC               ZONE CLASSIFICATIONS
CD    NZNR              ZONE NUMBER ASSIGNED TO EACH REGION
C
C*****************************************************************

C*****************************************************************
CR          REGION ASSIGNMENTS TO COARSE MESH INTERVALS
C
CC          PRESENT IF IGOM.GT.0 AND NRASS.EQ.0
C
CL    ((MR(I,J),I=1,NCINTI),J=1,NCINTJ)----NOTE STRUCTURE BELOW----
C
CW    NCINTI*NCINTJ
C
CS    DO 1 K=1,NCINTK
CS  1 READ(N) *LIST AS ABOVE*
C
CD    MR                REGION NUMBERS ASSIGNED TO COARSE MESH
CD                          INTERVALS
C
C*****************************************************************

C*****************************************************************
CR          REGION ASSIGNMENTS TO FINE MESH INTERVALS
C
CC          PRESENT IF IGOM.GT.0 AND NRASS.EQ.1
C
CL    ((MR(I,J),I=1,NINTI),J=1,NINTJ)----NOTE STRUCTURE BELOW----
C
CW    NINTI*NINTJ
CS    DO 1 K=1,NINTK
CS  1 READ(N) *LIST AS ABOVE*
C
CD    MR                REGION NUMBERS ASSIGNED TO FINE MESH INTERVALS
C
C*****************************************************************

CEOF
```

2. NDXSRF and ZNATDN - Nuclide Density Files

NDXSRF relates the nuclide densities given in the ZNATDN file to their geometric locations (GEODST file) and associated microscopic cross sections (ISOTXS, GRUPXS, ISOGXS files).

Since NDXSRF-III and ZNATDN-III are essentially unchanged from NDXSRF-II and ZNATDN-II except for the introduction of the MULT parameter, the discussion given with the earlier versions remains applicable.

```
C*****************************************************************
C                     REVISED 07/01/75
C
CF          NDXSRF - III
C
CE          NUCLIDE DENSITY, DATA, CROSS SECTION REFERENCING
C
C*****************************************************************
```

```
C*****************************************************************
CR          FILE IDENTIFICATION                                    *
C                                                                  *
CL     HNAME,(HUSE(I),I=1,2),IVERS                                 *
C                                                                  *
CW     1+3*MULT                                                    *
C                                                                  *
CD     HNAME          HOLLERITH FILE NAME = NDXSRF = (A6)         *
CD     HUSE           HOLLERITH USER IDENTIFICATION (A6)          *
CD     IVERS          FILE VERSION NUMBER                         *
CD     MULT           DOUBLE PRECISION PARAMETER                  *
CD                        1= A6 WORD IS SINGLE WORD                *
CD                        2=A6 WORD IS DOUBLE PRECISION WORD       *
C                                                                  *
C*****************************************************************

C*****************************************************************
CR          SPECIFICATIONS                                         *
C                                                                  *
CL     NON,NSN,NNS,NAN,NZONE,NSZ                                   *
C                                                                  *
CW     6                                                           *
C                                                                  *
CD     NON                 NUMBER OF NUCLIDES IN CROSS SECTION DATA *
CD     NSN                 NUMBER OF NUCLIDE SETS IDENTIFIED      *
CD     NNS                 MAXIMUM NUMBER OF NUCLIDES IN ANY SET  *
CD     NAN                 NUMBER OF DIFFERENT NUCLIDES IN DATA   *
CD     NZONE               NUMBER OF ZONES                        *
CD     NSZ                 NUMBER OF SUBZONES (SUBASSEMBLIES)     *
C                                                                  *
C*****************************************************************

C*****************************************************************
C           NUCLIDE REFERENCING DATA                               *
C                                                                  *
CL       (HNNAME(N),N=1,NON),(HANAME(N),N=1,NON),(WPF(N),N=1,NON), *
CL     (ATWT(J),J=1,NAN),(NCLN(N),N=1,NON),((NDXS(K,L),K=1,4),L=1,NSN), *
CL     ((NOS(I,L),I=1,NNS),L=1,NSN),((NOR(N,L),N=1,NON),L=1,NSN)   *
C                                                                  *
CW   NAN+2*NON*(1+MULT)+NSN*(4+NNS+NON)                            *
C                                                                  *
CD     HNNAME              UNIQUE REFERENCE NUCLIDE NAME, IN LIBRARY ORDER *
CD                            (A6) ALPHANUMERIC                    *
CD     HANAME              ABSOLUTE NUCLIDE REFERENCE, IN LIBRARY ORDER *
CD                            (A6) ALPHANUMERIC                    *
CD     WPF                 RESERVED                               *
CD     ATWT                ATOMIC WEIGHT                          *
CD     NCLN                NUCLIDE CLASSIFICATION                 *
CD                            1= FISSILE                           *
CD                            2= FERTILE                           *
CD                            3= OTHER ACTINIDE                    *
CD                            4= FISSION PRODUCT                   *
CD                            5= STRUCTURAL                        *
CD                            6= COOLANT                           *
CD                            7= CONTROL ROD                       *
CD                            GREATER THAN 7, UNDEFINED            *
CD     NDXS(K,L)           REFERENCE DATA FOR SET L               *
CD                            K = 1, NUMBER OF NUCLIDES IN SET     *
CD                            K = 2, RESERVED                      *
CD                            K = 3, RESERVED                      *
CD                            K = 4, RESERVED                      *
CD     NOS(I,L)            ORDER NUMBER OF NUCLIDE IN CROSS SECTION DATA *
CD                            (IN HNNAME LIST) OF NUCLIDE ORDERED I IN *
CD                            SET L                                *
CD     NOR(N,L)            ORDER NUMBER OF NUCLIDE IN SET L GIVEN ORDER *
CD                            NUMBER N IN CROSS SECTION DATA       *
C                                                                  *
C*****************************************************************
```

```
C*****************************************************************
CR          NUCLIDE CONCENTRATION ASSIGNMENT DATA                *
C                                                                 *
CL    (VOLZ(N),N=1,NZONE),(VFPA(N),N=1,NZONE),(VLSA(M),M=1,NSZ),  *
CL    (NSPA(N),N=1,NZONE),(NSSA(M),M=1,NSZ),(NZSZ(M),M=1,NSZ)     *
C                                                                 *
CW    3*(NZONE+NSZ)                                               *
C                                                                 *
CD    VOLZ              VOLUMES OF ZONES, CC                      *
CD    VFPA              VOLUME FRACTIONS FOR PRIMARY ZONE ASSIGNMENTS *
CD    VLSA              VOLUMES OF SUBZONES                       *
CD    NSPA              NUCLIDE SET REFERENCE, PRIMARY ZONE ASSIGNMENT *
CD                         (MAY BE ZERO ONLY IF THERE ARE SUBZONES) *
CD    NSSA              NUCLIDE SET REFERENCE ASSIGNMENT TO SUBZONES *
CD    NZSZ              ZONE CONTAINING SUBZONE                   *
C                                                                 *
C     NOTE THAT TO CALCULATE MACROSCOPIC CROSS SECTIONS FOR A ZONE, *
C     IT IS NECESSARY TO CONSIDER THE CONCENTRATION OF EACH NUCLIDE *
C     IN THE PRIMARY SET ASSIGNMENT (UNLESS A ZERO IN NSPA INDICATES *
C     THERE ARE NONE) TIMES THE VOLUME FRACTION, AND THE CONCENTRATION *
C     OF EACH NUCLIDE IN EACH SUBZONE ASSIGNED TO THE ZONE TIMES THE *
C     RATIO OF THE SUBZONE VOLUME TO THE ZONE VOLUME.             *
C                                                                 *
C*****************************************************************

CEOF


C*****************************************************************
C                        REVISED 07/01/73                         *
C                                                                 *
CF          ZNATDN = III                                          *
C                                                                 *
CE          ZONE ATOMIC DENSITIES (OF NUCLIDES)                   *
C                                                                 *
C*****************************************************************


C*****************************************************************
CR          FILE IDENTIFICATION                                   *
C                                                                 *
CL    HNAME,(HUSE(I),I=1,2),IVERS                                 *
C                                                                 *
CW    1+3*MULT                                                    *
C                                                                 *
CD    HNAME             HOLLERITH FILE NAME = ZNATDN =(A6)        *
CD    HUSE              HOLLERITH USER IDENTIFICATION (A6)        *
CD    IVERS             FILE VERSION NUMBER                       *
CD    MULT              DOUBLE PRECISION PARAMETER                *
CD                         1= A6 WORD IS SINGLE WORD              *
CD                         2= A6 WORD IS DOUBLE PRECISION WORD    *
C                                                                 *
C*****************************************************************


C*****************************************************************
CR          SPECIFICATIONS                                        *
C                                                                 *
CL    TIME,NCY,NTZSZ,NNS,NBLKAD                                   *
C                                                                 *
CW    5                                                           *
C                                                                 *
CD    TIME              REFERENCE REAL TIME, DAYS                 *
CD    NCY               REFERENCE CYCLE NUMBER                    *
CD    NTZSZ             NUMBER OF ZONES PLUS NUMBER OF SUBZONES   *
CD    NNS               MAXIMUM NUMBER OF NUCLIDES IN ANY SET     *
CD    NBLKAD            NUMBER OF BLOCKS OF ATOM DENSITY DATA     *
C                                                                 *
C*****************************************************************
```

```
C*****************************************************************
CR          ZONE ATOMIC DENSITIES (OF NUCLIDES)                  *
C                                                                *
CL     ((ADEN(N,J),N=1,NNS),J=JL,JU)----SEE STRUCTURE BELOW*****  *
C                                                                *
CW     NNS*((NTZSZ+1)/NBLKAD+1)                                  *
C                                                                *
CC     DO 1 M=1,NBLKAD                                           *
CC   1 READ(N) *LIST AS ABOVE*                                   *
C                                                                *
CC         WITH M AS THE BLOCK INDEX, JL=(M-1)*((NTZSZ-1)/NBLKAD+1)+1  *
CC         AND JU=M*((NTZSZ-1)/NBLKAD+1)                         *
C                                                                *
CD     ADEN(N,J)           ATOMIC DENSITY OF NUCLIDE ORDERED N IN THE  *
CD                         ASSOCIATED SET GIVEN IN ORDER FOR EACH ZONE  *
CD                         FOLLOWED IN ORDER FOR EACH SUBZONE    *
C                                                                *
C*****************************************************************

CEOF
```

3. SEARCH - Criticality Search Data

This file provides specifications for neutronics problem searches including buckling, alpha, dimension, and concentration searches. All the records in SEARCH-III are modified to some extent with respect to those given in SEARCH-II.

Most of the parameters in the new FILE SPECIFICATIONS record are equivalent to the old specifications except specific names are assigned as in other files. Search type 2 and the associated 1/V DATA ASSIGNMENTS record are deleted in SEARCH-III because implementation of this type of search is now not contemplated. Dimension search modifiers are defined in terms of the coarse mesh as noted earlier in the discussion of GEODST. The lists in the two records containing concentration search specifications are rearranged for more convenient processing of the data.

```
C*****************************************************************
C                        REVISED 07/01/73                        *
C                                                                *
CF          SEARCH -III                                          *
C                                                                *
CE          CRITICALITY SEARCH FILE                              *
C                                                                *
C*****************************************************************


C*****************************************************************
CR          FILE IDENTIFICATION                                  *
C                                                                *
CL     HNAME,(HUSE(I),I=1,2),IVERS                               *
C                                                                *
CW     1+3*MULT                                                  *
C                                                                *
CD     HNAME               HOLLERITH FILE NAME - SEARCH - (A6)  *
CD     HUSE                HOLLERITH USER IDENTIFICATION (A6)   *
CD     IVERS               FILE VERSION NUMBER                  *
CD     MULT                DOUBLE PRECISION PARAMETER           *
CD                             1= A6 WORD IS SINGLE WORD         *
CD                             2= A6 WORD IS DOUBLE PRECISION WORD  *
C                                                                *
C*****************************************************************
```

```
C-----------------------------------------------------------------------
CR          INDIVIDUAL DATA SET IDENTIFIER                             -
C                                                                      -
CL    NSHID,NREC,(NSP(I),I=1,18)                                       -
C                                                                      -
CW    20                                                               -
C                                                                      -
CD    NSHID             POSITIVE INTEGER IDENTIFYING A SET OF SEARCH   -
CD                          DATA, THIS AND FOLLOWING RECORDS REPEATED  -
CD                          UNTIL NEGATIVE NSHID TERMINATES FILE       -
CD    NREC              NUMBER OF RECORDS TO SKIP TO POSITION ON NEXT  -
CD                          INDIVIDUAL DATA SET IDENTIFIER RECORD      -
CD    NSP               RESERVED                                       -
C                                                                      -
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
CR          FILE SPECIFICATIONS                                        -
C                                                                      -
CL    EFFK,DKEFF,EPSK,EPSEI,CMOD,(SRCH(I),I=1,5),ISRCH,ISZOP,NMAXNP,   -
CL    NCINTI,NCINTJ,NCINTK,NISOSR,NSETS,NEIRNG,ITEND,ICEND,            -
CL    (NRCH(I),I=1,19)                                                 -
C                                                                      -
CW    40                                                               -
C                                                                      -
CD    EFFK              DESIRED MULTIPLICATION FACTOR                  -
CD    DKEFF             MULTIPLICATION FACTOR SLOPE                    -
CD    EPSK              CONVERGENCE CRITERION TO BE MET BY EFFK         -
CD    EPSEI             CONVERGENCE CRITERION TO BE MET BY PRIMARY      -
CD                          VARIABLE                                   -
CD    CMOD              MODIFIER APPLIED TO NUCLIDE CONCENTRATIONS      -
CD                          VARIED SPECIALLY (ISRCH=7 BELOW),MAY BE    -
CD                          .LT.0                                      -
CD    SRCH              RESERVED                                       -
CD    ISRCH             TYPE OF SEARCH                                 -
CD                          0= NOT DEFINED                             -
CD                          1= BUCKLING SEARCH                         -
CD                          2= ALPHA SEARCH                            -
CD                          5= DIMENSION SEARCH                        -
CD                          7= NUCLIDE CONCENTRATION SEARCH BY         -
CD                             PROPORTIONAL ADJUSTMENTS OF SELECTED    -
CD                             INITIAL CONCENTRATIONS                  -
CD                          9= NUCLIDE CONCENTRATION SEARCH BY ADDING  -
CD                             WEIGHTED EIGENVALUE ADJUSTMENTS         -
CD                             TO SELECTED INITIAL CONCENTRATIONS      -
CD    ISZOP             SUBZONE OPTION FOR ISRCH = 7 OR 9              -
CD                          0= SEARCH DATA IS BY ZONE                  -
CD                          1= SEARCH DATA IS BY SUBZONE               -
CD    NMAXNP            MAXIMUM NUMBER OF NEUTRONICS PROBLEMS OR TRIAL -
CD                          EIGENVALUES ALLOWED IN A SEARCH, A ZERO    -
CD                          HERE SPECIFIES A DIRECT SEARCH,            -
CD    NCINTI            NUMBER OF FIRST DIMENSION COARSE MESH INTERVALS-
CD    NCINTJ            NUMBER OF SECOND DIMENSION COARSE MESH         -
CD                          INTERVALS                                  -
CD    NCINTK            NUMBER OF THIRD DIMENSION COARSE MESH INTERVALS-
CD    NISOSR            NUMBER OF ISOTOPES OR NUCLIDES INVOLVED IN     -
CD                          CONCENTRATION SEARCH (ISRCH = 7 OR 9)      -
CD    NSETS             NUMBER OF SPECIFICATION SETS IN CONCENTRATION  -
CD                          SEARCH (ISRCH = 7 OR 9)                    -
CD    NEIRNG            EIGENVALUE (EI) RANGE RESTRICTIONS, SEARCH     -
CD                          TERMINATED IF SPECIFIED RANGE IS VIOLATED, -
CD                          =1  EI.LT.0                                -
CD                           0= NO RESTRICTION ON EI                   -
CD                           1= EI.GT.0 AND .LT.1                      -
CD                           2= EI.GT.1                                -
CD    ITEND             TERMINATION OPTION ON ITERATIVE PROCESS, SEARCH-
CD                          IS LIMITED BY NMAXNP,NUMBER OF OUTER       -
CD                          ITERATIONS,OR OTHER PARAMETER,THEN         -
CD                          0= NO RESTRAINT                            -
CD                          1= TERMINATE IF CONVERGENCE CRITERIA ARE   -
CD                             NOT MET                                 -
```

```
CD                          2= IF CONVERGENCE CRITERIA ARE NOT MET,
CD                             TERMINATE ONLY IF PROBLEM IS NOT
CD                             CONVERGING.
CD     ICEND              TERMINATION OPTIONS ON NUCLIDE CONCENTRATIONS
CD                          0= TERMINATE IF ANY NUCLIDE CONCENTRATION
CD                             BECOMES NEGATIVE AT ANY STAGE OF THE
CD                             CALCULATION
CD                          1= TERMINATE IF ANY NUCLIDE CONCENTRATION
CD                             IS NEGATIVE AT THE END OF THE SEARCH
CD                          2= ALLOW NEGATIVE NUCLIDE CONCENTRATIONS
CD     NRCH               RESERVED
C
C*****************************************************************

C*****************************************************************
CR          COARSE MESH MODIFIERS FOR DIMENSION SEARCH
C
CC          PRESENT IF ISRCH.EQ.5
C
CL     (SRHDI(I),I=1,NCINTI),(SRHDJ(J),J=1,NCINTJ),(SRHDK(K),K=1,NCINTK)
C
CW     NCINTI+NCINTJ+NCINTK
C
CD     SRHDI              FIRST DIMENSION COARSE MESH MODIFIERS
CD     SRHDJ              SECOND DIMENSION COARSE MESH MODIFIERS
CD     SRHDK              THIRD DIMENSION COARSE MESH MODIFIERS
C
C*****************************************************************

C*****************************************************************
CR          NUCLIDES FOR PROPORTIONAL SEARCH AND SPECIAL SEARCH
C
CC          PRESENT IF ISRCH.EQ.7
C
CL     (NSHZ1(I),I=1,NSETS),(NSHZ2(I),I=1,NSETS),
CL     ((HNNAMS(N,I),N=1,NISOSR),I=1,NSETS),(HNSHN(J),J=1,10)
C
CW     2*NSETS+MULT*(NISOSR*NSETS+10)
C
CD     NSHZ1              FIRST NUMBER OF A CONSECUTIVE SET OF ZONES
CD                           IF ISZOP.EQ.0, OR OF A CONSECUTIVE SET OF
CD                           SUBZONES IF ISZOP.EQ.1
CD     NSHZ2              LAST NUMBER OF A SET OF ZONES OR SUBZONES
CD     HNNAMS             REFERENCE NAMES OF NUCLIDES WHOSE
CD                           CONCENTRATIONS ARE TO BE ADJUSTED
CD                           PROPORTIONATELY IN ABOVE ZONES (A6)
CD     HNSHN              SEARCH NUCLIDE REFERENCE USED AS NOTED BELOW
CD                           (A6)
C
CC                        HNNAMS CONCENTRATIONS ADJUSTED ACCORDING TO
CC                        C2 = C1*EI AND HNSHN CONCENTRATIONS ADJUSTED
CC                        ACCORDING TO C2 =C1 + C1*(1.0-EI)*CMOD WHERE
CC                           EI IS THE EIGENVALUE,
CC                           C1 IS THE INITIAL CONCENTRATION, AND
CC                           C2 IS THE FINAL OR INTERMEDIATE VALUE OF
CC                              THE CONCENTRATION
C
C*****************************************************************

C*****************************************************************
CR          NUCLIDES FOR SEARCH INVOLVING WEIGHTED EIGENVALUE
CR              ADJUSTMENTS TO INITIAL CONCENTRATIONS
C
CC          PRESENT IF ISRCH.EQ.9
C
CL     (NSHZ1(I),I=1,NSETS),(NSHZ2(I),I=1,NSETS),
CL     ((HNNAMS(N,I),N=1,NISOSR),I=1,NSETS),
CL     ((CHZDN(N,I),N=1,NISOSR),I=1,NSETS)
C
CW     NSETS*(2+NISOSR*(1+MULT))
C
CD     NSHZ1              FIRST NUMBER OF A CONSECUTIVE SET OF ZONES
```

```
CD                          IF ISZOP,EQ,0, OR OF A CONSECUTIVE SET OF
CD                          SUBZONES IF ISZOP,EQ,1
CD     NSHZ2              LAST NUMBER OF A SET OF ZONES OR SUBZONES
CD     HNNAMS             REFERENCE NAMES OF NUCLIDES WHOSE
CD                          CONCENTRATIONS ARE TO BE ADJUSTED
CD     CHZDN              CONCENTRATION MODIFIERS
C
CC                        CONCENTRATIONS ADJUSTED ACCORDING TO
CC                          C2 = C1+EI*CHZDN WHERE EI, C1, AND C2 ARE
CC                          AS DEFINED UNDER ISRCH ,EQ, 7
C
C-------------------------------------------------------------------------

CEOF
```

D. Particle and Power Distribution Files - Sn Constants, Sources, Fluxes, Currents, and Power Densities

1. SNCONS - Sn Constants

This file containing Sn Constants is the same as SNCONS-II except for the addition of the MULT parameter.

```
C*************************************************************************
C                          REVISED 07/01/73
C
CF          SNCONS=III
CE          SN CONSTANTS
C
C*************************************************************************

C-------------------------------------------------------------------------
CR          FILE IDENTIFICATION
C
CL     HNAME,(HUSE(I),I=1,2),IVERS
C
CW     1+3*MULT
C
CD     HNAME              HOLLERITH FILE NAME = SNCONS = (A6)
CD     HUSE               HOLLERITH USER IDENTIFICATION (A6)
CD     IVERS              FILE VERSION NUMBER
CD     MULT               DOUBLE PRECISION PARAMETER
CD                          1= A6 WORD IS SINGLE WORD
CD                          2= A6 WORD IS DOUBLE PRECISION WORD
C
C-------------------------------------------------------------------------

C-------------------------------------------------------------------------
CR          SPECIFICATIONS
C
CL     NDIM,NDIR,IDUM,IDUM
C
CW     4
C
CD     NDIM               NUMBER OF DIMENSIONS
CD     NDIR               NUMBER OF DIRECTIONS
CD     IDUM               UNDEFINED, USED TO OBTAIN FOUR WORD RECORD,
C
C-------------------------------------------------------------------------
```

```
C*****************************************************************
CR          ONE DIMENSIONAL SN CONSTANTS                          *
C                                                                 *
CC          PRESENT IF NDIM.EQ.1                                  *
C                                                                 *
CL    (DIRWGT(I),I=1,NDIR),(DIRMU(I),I=1,NDIR)                    *
C                                                                 *
CW    2*NDIR                                                      *
C                                                                 *
CD    DIRWGT            DIRECTION WEIGHT FOR EACH DIRECTION       *
CD    DIRMU             DIRECTION COSINE FOR EACH DIRECTION       *
C                                                                 *
C*****************************************************************

C*****************************************************************
CR          MULTI-DIMENSIONAL SN CONSTANTS                        *
C                                                                 *
CC          PRESENT IF NDIM.GE.2                                  *
C                                                                 *
CL    (DIRWGT(I),I=1,NDIR),(DIRMU(I),I=1,NDIR),(DIRETA(I),I=1,NDIR)*
C                                                                 *
CW    3*NDIR                                                      *
C                                                                 *
CD    DIRWGT            DIRECTION WEIGHT FOR EACH DIRECTION       *
CD    DIRMU             DIRECTION COSINES WITH RESPECT TO FIRST   *
CD                      DIMENSION.                                *
CD    DIRETA            DIRECTION COSINES WITH RESPECT TO SECOND  *
CD                      DIMENSION.                                *
C                                                                 *
C*****************************************************************

CEOF
```

2. FIXSRC - Fixed Sources

This file provides distributed and surface sources in one, two, or three dimensions for diffusion or Sn codes. FIXSRC-III is the same as FIXSRC-II except for the addition of the MULT paramater and the rearrangement of the ordering of some arrays. These changes in orderings are tabulated below:

	ORDERING	
RECORD	FIXSRC-II	FIXSRC-III
ONE-DIMENSIONAL DISTRIBUTED FIXED SOURCE	Interval, group, and component	Component, Interval, and group
MULTIDIMENSIONAL DISTRIBUTED FIXED SOURCE	Interval, group, and component	Interval, component, and group
SURFACE SOURCES (FIRST, SECOND, AND THIRD DIMENSIONS)	Boundary, group, and component	Boundary, component, and group

The new orderings, recommended by K. D. Lathrop, LASL, correspond to those used in existing codes.

```
C*****************************************************************
C                       REVISED 07/01/73                          *
C                                                                 *
CF          FIXSRC-III                                            *
CE          DISTRIBUTED AND SURFACE FIXED SOURCES                 *
C                                                                 *
C*****************************************************************
```

```
C*****************************************************************
CR          FILE IDENTIFICATION                                  *
C                                                                *
CL    HNAME,(HUSE(I),I=1,2),IVERS                                *
C                                                                *
CW    1+3*MULT                                                   *
C                                                                *
CD    HNAME              HOLLERITH FILE NAME = FIXSRC = (A6)     *
CD    HUSE               HOLLERITH USER IDENTIFICATION (A6)      *
CD    IVERS              FILE VERSION NUMBER                     *
CD    MULT               DOUBLE PRECISION PARAMETER              *
CD                           1= A6 WORD IS SINGLE WORD           *
CD                           2= A6 WORD IS DOUBLE PRECISION WORD *
C                                                                *
C*****************************************************************
C*****************************************************************
CR          SPECIFICATIONS                                       *
C                                                                *
CL    ITYPE,NDIM,NGROUP,NINTI,NINTJ,NINTK,IDISTS,NDCOMP,NSCOMP,NEDGI,*
CL    NEDGJ,NEDGK                                                *
C                                                                *
CW    12                                                         *
C                                                                *
CD    ITYPE              TYPE SOURCE, 0=DIFFUSION                *
CD                                    1=SN                       *
CD    NDIM               NUMBER OF  DIMENSIONS                   *
CD    NGROUP             NUMBER OF GROUPS                        *
CD    NINTI              NUMBER OF FIRST DIMENSION FINE MESH INTERVALS *
CD    NINTJ              NUMBER OF SECOND DIMENSION FINE MESH INTERVALS *
CD    NINTK              NUMBER OF THIRD DIMENSION FINE MESH INTERVALS *
CD    IDISTS             DISTRIBUTED SOURCE FLAG,                *
CD                           0= NO DISTRIBUTED SOURCE GIVEN,     *
CD                           1= DISTRIBUTED SOURCE IS GIVEN,     *
CD    NDCOMP             NUMBER OF DISTRIBUTED SOURCE COMPONENTS *
CD    NSCOMP             NUMBER OF SURFACE SOURCE COMPONENTS     *
CD    NEDGI              NUMBER OF FIRST DIMENSION BOUNDARY  SOURCES *
CD    NEDGJ              NUMBER OF SECOND DIMENSION  BOUNDARY SOURCES *
CD    NEDGK              NUMBER OF THIRD DIMENSION BOUNDARY SOURCES *
C                                                                *
C*****************************************************************
C*****************************************************************
CR          ONE-DIMENSIONAL DISTRIBUTED FIXED SOURCE             *
C                                                                *
CC          PRESENT IF NDIM.EQ.1 AND IDISTS.NE.0                 *
C                                                                *
CL    ((QDIST(L,I),L=1,NDCOMP),I=1,NINTI)---NOTE STRUCTURE BELOW---*
C                                                                *
CW    NDCOMP*NINTI                                               *
C                                                                *
C     DO 1 J=1,NGROUP                                            *
C   1 READ (N) *LIST AS ABOVE*                                   *
C                                                                *
CD    QDIST              DISTRIBUTED SOURCE BY COMPONENT, INTERVAL, *
CD                       AND GROUP                               *
C                                                                *
C*****************************************************************
C*****************************************************************
CR          MULTI-DIMENSIONAL DISTRIBUTED FIXED SOURCE           *
C                                                                *
CC          PRESENT IF NDIM.GE.2 AND IDISTS.NE.0                 *
C                                                                *
CL    ((QDIST(I,J),I=1,NINTI),J=1,NINTJ)---NOTE STRUCTURE BELOW---*
C                                                                *
CW    NINTI*NINTJ                                                *
C                                                                *
C     DO 1 N=1,NGROUP                                            *
C     DO 1 L=1,NDCOMP                                            *
C     DO 1 K=1,NINTK                                             *
```

```
C   1 READ (N) *LIST AS ABOVE*
C
CD    QDIST              AS DEFINED ABOVE.
C
C*****************************************************************

C*****************************************************************
CR          FIRST DIMENSION SURFACE SOURCE POINTERS
C
CC          PRESENT IF NEDGI.NE.0
C
CL    ((ISPTRI(I,J),I=1,NBDRYI),J=1,NINTJ)***NOTE STRUCTURE BELOW***
C
CW    NBDRYI*NINTJ
C
C     DO 1 K=1,NINTK
C   1 READ (N) *LIST AS ABOVE*
C
CD    ISPTRI             ISPTRI(I,J) DENOTES THE INTERCEPT OF CHANNEL
CD                       J,K WITH MESH BOUNDARY PLANE I.  IF ISPTRI(I,J)
CD                       =0, NO SURFACE SOURCE IS PRESENT AT THE
CD                       INTERCEPT.  IF ISPTRI(I,J)=M, THE MTH SURFACE
CD                       SOURCE SPECIFIED IN THE NEXT RECORD BELOW IS
CD                       PRESENT AT THE INTERCEPT.
CD    NBDRYI             =NINTI+1, NUMBER OF FIRST DIMENSION FINE MESH
CD                        BOUNDARIES
C
C*****************************************************************

C*****************************************************************
CR          FIRST DIMENSION SURFACE SOURCES
C
CC          PRESENT IF NEDGI.NE.0
C
CL    ((((QSURFI(M,L,N),M=1,NEDGI),L=1,NSCOMP),N=1,NGROUP)
C
CW    NEDGI*NGROUP*NSCOMP
C
CD    QSURFI             FIRST DIMENSION BOUNDARY SOURCES BY BOUNDARY,
CD                       COMPONENT, AND GROUP.
C
C*****************************************************************

C*****************************************************************
CR          SECOND DIMENSION SURFACE SOURCE POINTERS
C
C           PRESENT IF NDIM.GE.2 AND NEDGJ.NE.0
C
CL    ((ISPTRJ(I,J),I=1,NINTI),J=1,NBDRYJ)***NOTE STRUCTURE BELOW***
C
CW    NINTI*NBDRYJ
C
C     DO 1 K=1,NINTK
C   1 READ (N) *LIST AS ABOVE*
C
CD    ISPTRJ             ISPTRJ(I=J) DENOTES THE INTERCEPT OF CHANNEL
CD                       I,K WITH MESH BOUNDARY PLANE J.  IF ISPTRJ(I,J)
CD                       =0, NO SURFACE SOURCE IS PRESENT AT THE
CD                       INTERCEPT.  IF ISPTRJ(I,J)=M, THE MTH SURFACE
CD                       SOURCE SPECIFIED IN THE NEXT RECORD BELOW IS
CD                       PRESENT AT THE INTERCEPT.
CD    NBDRYJ             =NINTJ+1, NUMBER OF SECOND DIMENSION FINE MESH
CD                       BOUNDARIES
C
C*****************************************************************
```

```
C*****************************************************************
CR          SECOND DIMENSION SURFACE SOURCES                     *
C                                                                *
CC          PRESENT IF NDIM.GE.2 AND NEDGJ.NE.0                  *
C                                                                *
CL    (((QSURFJ(M,L,N),M=1,NEDGJ),L=1,NSCOMP),N=1,NGROUP)        *
C                                                                *
CW    NEDGJ*NGROUP*NSCOMP                                        *
C                                                                *
CD    QSURFJ            SECOND DIMENSION BOUNDARY SOURCES BY BOUNDARY *
CD                      COMPONENT, AND GROUP                     *
C                                                                *
C*****************************************************************
C*****************************************************************
CR          THIRD DIMENSION SURFACE SOURCE POINTERS              *
C                                                                *
CC          PRESENT IF NDIM.EQ.3 AND NEDGK.NE.0                  *
C                                                                *
CL    ((ISPTRK(I,J),I=1,NINTI),J=1,NINTK)***NOTE STRUCTURE BELOW*** *
C                                                                *
CW    NINTI*NINTJ                                                *
C                                                                *
C     DO 1 K=1,NBDRYK                                            *
C   1 READ (N) *LIST AS ABOVE*                                   *
C                                                                *
CD    ISPTRK            ISPTRK(I,J) DENOTES THE INTERCEPT OF CHANNEL *
CD                      I,J WITH MESH BOUNDARY PLANE K.  IF ISPTRK(I,J) *
CD                      =0, NO SURFACE SOURCE IS PRESENT AT THE  *
CD                      INTERCEPT.  IF ISPTRK(I,J)=M, THE MTH SURFACE *
CD                      SOURCE SPECIFIED IN THE NEXT RECORD BELOW IS *
CD                      PRESENT AT THE INTERCEPT.                *
CD    NBDRYK            =NINTK+1, NUMBER OF THIRD DIMENSION FINE MESH *
CD                       BOUNDARIES                              *
C                                                                *
C*****************************************************************
C*****************************************************************
CR          THIRD DIMENSION SURFACE SOURCES                      *
C                                                                *
CC          PRESENT IF NDIM.EQ.3 AND NEDGK.NE.0                  *
C                                                                *
CL    (((QSURFK(M,L,N),M=1,NEDGK),L=1,NSCOMP),N=1,NGROUP)        *
C                                                                *
CW    NEDGK*NGROUP*NSCOMP                                        *
C                                                                *
CD    QSURFK            THIRD DIMENSION BOUNDARY SOURCES BY BOUNDARY, *
CD                      COMPONENT, AND GROUP                     *
C                                                                *
C*****************************************************************

CEOF
```

3. RTFLUX, ATFLUX, RCURNT, ACURNT, RAFLUX, AAFLUX, RZFLUX, and PWDINT

The following list of files is unchanged from the Version II forms except for the introduction of the MULT parameter. Included are:

File	Data Type
RTFLUX	Regular Total Flux
ATFLUX	Adjoint Total Flux
RCURNT	Regular Currents
ACURNT	Adjoint Currents
RAFLUX	Regular Angular Flux
AAFLUX	Adjoint Angular Flux
RZFLUX	Regular Flux averaged over zones
PWDINT	Power Density

In addition to the usual application of the MULT parameter to Hollerith data in these files MULT is also used to provide double precision regular and adjoint total fluxes in files RTFLUX and ATFLUX on short word machines (MULT = 2).

```
C*******************************************************************************
C                          REVISED 07/01/73                                     *
C                                                                               *
CF          RTFLUX=III                                                          *
CE          REGULAR TOTAL FLUXES                                                *
C                                                                               *
C*******************************************************************************

CD                         ORDER OF GROUPS IS ACCORDING TO DECREASING
CD                         ENERGY, NOTE THAT DOUBLE PRECISION FLUXES ARE
CD                         GIVEN WHEN MULT.EQ.2.

C-------------------------------------------------------------------------------
CR          FILE IDENTIFICATION                                                 *
C                                                                               *
CL     HNAME,(HUSE(I),I=1,2),IVERS                                              *
C                                                                               *
CW     1+3*MULT                                                                 *
C                                                                               *
CD     HNAME               HOLLERITH FILE NAME = RTFLUX = (A6)                  *
CD     HUSE                HOLLERITH USER IDENTIFICATION (A6)                   *
CD     IVERS               FILE VERSION NUMBER                                  *
CD     MULT                DOUBLE PRECISION PARAMETER                           *
CD                             1= A6 WORD IS SINGLE WORD                       *
CD                             2= A6 WORD IS DOUBLE PRECISION WORD             *
C                                                                               *
C-------------------------------------------------------------------------------
C-------------------------------------------------------------------------------
CR          SPECIFICATIONS                                                      *
C                                                                               *
CL     NDIM,NGROUP,NINTI,NINTJ,NINTK,ITER,EFFK,POWER                            *
C                                                                               *
CW     8                                                                        *
C                                                                               *
CD     NDIM                NUMBER OF DIMENSIONS                                 *
CD     NGROUP              NUMBER OF ENERGY GROUPS                              *
CD     NINTI               NUMBER OF FIRST DIMENSION FINE MESH INTERVALS        *
CD     NINTJ               NUMBER OF SECOND DIMENSION FINE MESH INTERVALS       *
CD     NINTK               NUMBER OF THIRD DIMENSION FINE MESH INTERVALS,       *
CD                         NINTK.EQ.1 IF NDIM.LE.2                              *
CD     ITER                OUTER ITERATION NUMBER AT WHICH FLUX WAS             *
CD                         WRITTEN                                              *
CD     EFFK                EFFECTIVE MULTIPLICATION FACTOR                      *
CD     POWER               POWER IN WATTS TO WHICH FLUX IS NORMALIZED           *
C                                                                               *
C-------------------------------------------------------------------------------
C-------------------------------------------------------------------------------
CR          ONE DIMENSIONAL REGULAR TOTAL FLUX                                  *
C                                                                               *
CC          PRESENT IF NDIM.EQ.1                                                *
C                                                                               *
CL     ((FREG(I,J),I=1,NINTI),J=1,NGROUP)                                       *
C                                                                               *
CW     NINTI*NGROUP*MULT                                                        *
C                                                                               *
CD     FREG                ONE DIMENSIONAL REGULAR TOTAL FLUX BY INTERVAL       *
CD                         AND GROUP.                                           *
C                                                                               *
C-------------------------------------------------------------------------------
C-------------------------------------------------------------------------------
CR          MULTI-DIMENSIONAL REGULAR TOTAL FLUX                                *
C                                                                               *
CC          PRESENT IF NDIM.GE.2                                                *
C                                                                               *
CL     ((FREG(I,J),I=1,NINTI),J=1,NINTJ)-----NOTE STRUCTURE BELOW-----          *
C                                                                               *
CW     NINTI*NINTJ*MULT                                                         *
C                                                                               *
C      DO 1 L=1,NGROUP                                                          *
C      DO 1 K=1,NINTK                                                           *
C    1 READ(N)   *LIST AS ABOVE*                                                *
```

```
C                                                                       *
CD    FREG              MULTI-DIMENSIONAL REGULAR TOTAL FLUX            *
CD                      BY INTERVAL AND GROUP.                          *
C                                                                       *
C-----------------------------------------------------------------------*

CEOF
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```
C***********************************************************************
C                       REVISED 07/01/73                                *
C                                                                       *
CF          ATFLUX-III                                                  *
CE          ADJOINT TOTAL FLUXES                                        *
C                                                                       *
C***********************************************************************

CD                      ORDER OF GROUPS IS ACCORDING TO INCREASING
CD                      ENERGY.  NOTE THAT DOUBLE PRECISION
CD                      FLUXES ARE GIVEN WHEN MULT.EQ.2

C-----------------------------------------------------------------------*
CR          FILE IDENTIFICATION                                         *
C                                                                       *
CL    HNAME,(HUSE(I),I=1,2),IVERS                                       *
C                                                                       *
CW    1+3*MULT                                                          *
C                                                                       *
CD    HNAME             HOLLERITH FILE NAME - ATFLUX - (A6)             *
CD    HUSE              HOLLERITH USER IDENTIFICATION (A6)              *
CD    IVERS             FILE VERSION NUMBER                             *
CD    MULT              DOUBLE PRECISION PARAMETER                      *
CD                          1- A6 WORD IS SINGLE WORD                   *
CD                          2- A6 WORD IS DOUBLE PRECISION WORD         *
C                                                                       *
C-----------------------------------------------------------------------*


C-----------------------------------------------------------------------*
CR          SPECIFICATIONS                                              *
C                                                                       *
CL    NDIM,NGROUP,NINTI,NINTJ,NINTK,ITER,EFFK,ADUM                      *
C                                                                       *
CW    8                                                                 *
C                                                                       *
CD    NDIM              NUMBER OF DIMENSIONS                            *
CD    NGROUP            NUMBER OF ENERGY GROUPS                         *
CD    NINTI             NUMBER OF FIRST DIMENSION FINE MESH INTERVALS   *
CD    NINTJ             NUMBER OF SECOND DIMENSION FINE MESH INTERVALS  *
CD    NINTK             NUMBER OF THIRD DIMENSION FINE MESH INTERVALS.  *
CD                      NINTK.EQ.1 IF NDIM.LE.2                         *
CD    ITER              OUTER ITERATION NUMBER AT WHICH FLUX WAS        *
CD                      WRITTEN                                         *
CD    EFFK              EFFECTIVE MULTIPLICATION FACTOR                 *
CD    ADUM              RESERVED                                        *
C                                                                       *
C-----------------------------------------------------------------------*
```

```
C*****************************************************************
CR          ONE DIMENSIONAL ADJOINT TOTAL FLUX                    *
C                                                                 *
CC          PRESENT IF NDIM.EQ.1                                  *
C                                                                 *
CL    ((FADJ(I,J),I=1,NINTI),J=1,NGROUP)                          *
C                                                                 *
CW    NINTI*NGROUP*MULT                                           *
C                                                                 *
CD    FADJ              ONE DIMENSIONAL ADJOINT TOTAL FLUX BY INTERVAL *
CD                      AND GROUP.                                *
C                                                                 *
C*****************************************************************
C*****************************************************************
CR          MULTI-DIMENSIONAL ADJOINT TOTAL FLUX                  *
C                                                                 *
CC          PRESENT IF NDIM.GE.2                                  *
C                                                                 *
CL    ((FADJ(I,J),I=1,NINTI),J=1,NINTJ)-----NOTE STRUCTURE BELOW----- *
C                                                                 *
CW    NINTI*NINTJ*MULT                                            *
C                                                                 *
C     DO 1 L=1,NGROUP                                             *
C     DO 1 K=1,NINTK                                              *
C   1 READ(N)   *LIST AS ABOVE*                                   *
C                                                                 *
CD    FADJ              MULTI-DIMENSIONAL ADJOINT TOTAL FLUX      *
CD                      BY INTERVAL AND GROUP.                    *
C                                                                 *
C*****************************************************************

CEOF
```

```
C*****************************************************************************
C                       REVISED 07/01/73                                      *
C                                                                             *
CF          RCURNT=III                                                        *
CE          REGULAR CURRENTS                                                  *
C                                                                             *
C*****************************************************************************

CD                      ORDER OF GROUPS IS ACCORDING TO DECREASING
CD                      ENERGY.

C*****************************************************************
CR          FILE IDENTIFICATION                                   *
C                                                                 *
CL    HNAME,(HUSE(I),I=1,2),IVERS                                 *
C                                                                 *
CW    1+3*MULT                                                    *
C                                                                 *
CD    HNAME             HOLLERITH FILE NAME - RCURNT - (A6)       *
CD    HNAME             HOLLERITH FILE NAME -        -(A6)        *
CD    HUSE              HOLLERITH USER IDENTIFICATION (A6)        *
CD    IVERS             FILE VERSION NUMBER                       *
CD    MULT              DOUBLE PRECISION PARAMETER                *
CD                          1- A6 WORD IS SINGLE WORD             *
CD                          2- A6 WORD IS DOUBLE PRECISION WORD   *
C                                                                 *
C*****************************************************************
```

```
C*****************************************************************
CR          SPECIFICATIONS                                       *
C                                                                *
CL    NDIM,NGROUP,NINTI,NINTJ,NINTK                              *
C                                                                *
CW    5                                                          *
C                                                                *
CD    NDIM              NUMBER OF DIMENSIONS                     *
CD    NGROUP            NUMBER OF GROUPS                         *
CD    NINTI             NUMBER OF FIRST DIMENSION FINE MESH INTERVALS *
CD    NINTJ             NUMBER OF SECOND DIMENSION FINE MESH INTERVALS *
CD    NINTK             NUMBER OF THIRD DIMENSION FINE MESH INTERVALS, *
CD                      NINTK.EQ.1 IF NDIM.LE.2                  *
C                                                                *
C*****************************************************************

C*****************************************************************
CR          ONE DIMENSIONAL REGULAR CURRENT                      *
C                                                                *
CC          PRESENT IF NDIM.EQ.1                                 *
C                                                                *
CL    ((RCURI(I,J),I=1,NBDRYI),J=1,NGROUP)                       *
C                                                                *
CW    NBDRYI*NGROUP                                              *
C                                                                *
CD    RCURI             ONE DIMENSIONAL REGULAR CURRENT BY MESH POINT *
CD                      BOUNDARY AND GROUP                       *
CD    NBDRYI            =NINTI+1, NUMBER OF FIRST DIMENSION FINE MESH *
CD                      BOUNDARIES                               *
C                                                                *
C*****************************************************************

C*****************************************************************
CR          MULTI-DIMENSIONAL REGULAR CURRENTS AT FIRST DIMENSION *
CR          BOUNDARIES                                           *
C                                                                *
CC          PRESENT IF NDIM.GE.2                                 *
C                                                                *
CL    ((RCURI(I,J),I=1,NBDRYI),J=1,NINTJ)****NOTE STRUCTURE BELOW**** *
C                                                                *
CW    NBDRYI*NINTJ                                               *
C                                                                *
C     DO 1 L=1,NGROUP                                            *
C     DO 1 K=1,NINTK                                             *
C   1 READ(N) *LIST AS ABOVE*                                    *
C                                                                *
CD    RCURI             REGULAR FIRST DIMENSION BOUNDARY CURRENT *
C                                                                *
C*****************************************************************

C*****************************************************************
CR          MULTI-DIMENSIONAL REGULAR CURRENTS AT SECOND DIMENSION *
CR          BOUNDARIES                                           *
C                                                                *
CC          PRESENT IF NDIM.GE.2                                 *
C                                                                *
CL    ((RCURJ(I,J),I=1,NINTI),J=1,NBDRYJ)****NOTE STRUCTURE BELOW**** *
C                                                                *
CW    NINTI*NBDRYJ                                               *
C                                                                *
C     DO 1 L=1,NGROUP                                            *
C     DO 1 K=1,NINTK                                             *
C   1 READ(N) *LIST AS ABOVE*                                    *
C                                                                *
CD    RCURJ             REGULAR SECOND DIMENSION BOUNDARY CURRENT *
CD    NBDRYJ            =NINTJ+1, NUMBER OF SECOND DIMENSION FINE MESH *
CD                      BOUNDARIES                               *
C                                                                *
C*****************************************************************
```

```
C*****************************************************************
CR          MULTI-DIMENSIONAL REGULAR CURRENTS AT THIRD DIMENSION     *
CR          BOUNDARIES.                                               *
C                                                                     *
CC          PRESENT IF NDIM.EQ.3                                      *
C                                                                     *
CL    ((RCURK(I,J),I=1,NINTI),J=1,NINTJ)----NOTE STRUCTURE BELOW----  *
C                                                                     *
CW    NINTI*NINTJ                                                     *
C                                                                     *
C     DO 1 L=1,NGROUP                                                 *
C     DO 1 K=1,NBDRYK                                                 *
C   1 READ(N) *LIST AS ABOVE*                                         *
C                                                                     *
CD    RCURK             REGULAR THIRD DIMENSION BOUNDARY CURRENT      *
CD    NBDRYK            =NINTK+1, NUMBER OF THIRD DIMENSION FINE MESH *
CD                      BOUNDARIES                                    *
C                                                                     *
C*****************************************************************

CEOF
```

```
C*****************************************************************
C                       REVISED 07/01/75                            *
C                                                                   *
CF          ACURNT=III                                              *
CE          ADJOINT CURRENTS                                        *
C                                                                   *
C*****************************************************************

CD                      ORDER OF GROUPS IS ACCORDING TO INCREASING
CD                      ENERGY.

C*****************************************************************
CR          FILE IDENTIFICATION                                     *
C                                                                   *
CL    HNAME,(HUSE(I),I=1,2),IVERS                                   *
C                                                                   *
CW    1+3*MULT                                                      *
C                                                                   *
CD    HNAME             HOLLERITH FILE NAME - ACURNT - (A6)         *
CD    HUSE              HOLLERITH USER IDENTIFICATION (A6)          *
CD    IVERS             FILE VERSION NUMBER                         *
CD    MULT              DOUBLE PRECISION PARAMETER                  *
CD                          1= A6 WORD IS SINGLE WORD               *
CD                          2= A6 WORD IS DOUBLE PRECISION WORD     *
C                                                                   *
C*****************************************************************
```

```
C*****************************************************************
CR          SPECIFICATIONS                                       *
C                                                                *
CL    NDIM,NGROUP,NINTI,NINTJ,NINTK                              *
C                                                                *
CW    5                                                          *
C                                                                *
CD    NDIM              NUMBER OF DIMENSIONS                     *
CD    NGROUP            NUMBER OF GROUPS                         *
CD    NINTI             NUMBER OF FIRST DIMENSION FINE MESH INTERVALS *
CD    NINTJ             NUMBER OF SECOND DIMENSION FINE MESH INTERVALS *
CD    NINTK             NUMBER OF THIRD DIMENSION FINE MESH INTERVALS, *
CD                      NINTK.EQ.1 IF NDIM.LE.2                  *
C                                                                *
C*****************************************************************
C*****************************************************************
CR          ONE DIMENSIONAL ADJOINT CURRENT                      *
C                                                                *
CC          PRESENT IF NDIM.EQ.1                                 *
C                                                                *
CL    ((ACURI(I,J),I=1,NBDRYI),J=1,NGROUP)                       *
C                                                                *
CW    NBDRYI*NGROUP                                              *
C                                                                *
CD    ACURI             ONE DIMENSIONAL ADJOINT CURRENT BY MESH POINT *
CD                      BOUNDARY AND GROUP                       *
CD    NBDRYI            =NINTI+1, NUMBER OF FIRST DIMENSION FINE MESH *
CD                      BOUNDARIES                               *
C                                                                *
C*****************************************************************

C*****************************************************************
CR          MULTI-DIMENSIONAL ADJOINT CURRENTS AT FIRST DIMENSION *
CR          BOUNDARIES                                           *
C                                                                *
CC          PRESENT IF NDIM.GE.2                                 *
C                                                                *
CL    ((ACURI(I,J),I=1,NBDRYI),J=1,NINTJ)----NOTE STRUCTURE BELOW---- *
C                                                                *
CW    NBDRYI*NINTJ                                               *
C                                                                *
C     DO 1 L=1,NGROUP                                            *
C     DO 1 K=1,NINTK                                             *
C   1 READ(N) *LIST AS ABOVE*                                    *
C                                                                *
CD    ACURI             ADJOINT FIRST DIMENSION BOUNDARY CURRENT *
C                                                                *
C*****************************************************************

C*****************************************************************
CR          MULTI-DIMENSIONAL ADJOINT CURRENTS AT SECOND DIMENSION *
CR          BOUNDARIES                                           *
C                                                                *
CC          PRESENT IF NDIM.GE.2                                 *
C                                                                *
CL    ((ACURJ(I,J),I=1,NINTI),J=1,NBDRYJ)----NOTE STRUCTURE BELOW---- *
C                                                                *
CW    NINTI*NBDRYJ                                               *
C                                                                *
C     DO 1 L=1,NGROUP                                            *
C     DO 1 K=1,NINTK                                             *
C   1 READ(N) *LIST AS ABOVE*                                    *
C                                                                *
CD    ACURJ             ADJOINT SECOND DIMENSION BOUNDARY CURRENT *
CD    NBDRYJ            =NINTJ+1, NUMBER OF SECOND DIMENSION FINE MESH *
CD                      BOUNDARIES                               *
C                                                                *
C*****************************************************************
```

```
C*****************************************************************
CR          MULTI-DIMENSIONAL ADJOINT CURRENTS AT THIRD DIMENSION     *
CR          BOUNDARIES.                                               *
C                                                                     *
CC          PRESENT IF NDIM.EQ.3                                      *
C                                                                     *
CL    ((ACURK(I,J),I=1,NINTI),J=1,NINTJ)----NOTE STRUCTURE BELOW----  *
C                                                                     *
CW    NINTI*NINTJ                                                     *
C                                                                     *
C     DO 1 L=1,NGROUP                                                 *
C     DO 1 K=1,NBDRYK                                                 *
C   1 READ(N) *LIST AS ABOVE*                                         *
C                                                                     *
CD    ACURK               ADJOINT THIRD DIMENSION BOUNDARY CURRENT    *
CD    NBDRYK              *NINTK+1, NUMBER OF THIRD DIMENSION FINE MESH *
CD                        BOUNDARIES                                  *
C                                                                     *
C*****************************************************************

CEOF
```

```
C*********************************************************************
C                         REVISED 07/01/73                            *
C                                                                     *
CF          RAFLUX=III                                                *
CE          REGULAR ANGULAR FLUX                                      *
C                                                                     *
C*********************************************************************

CD                        ORDER OF GROUPS IS ACCORDING TO DECREASING
CD                        ENERGY.

C*****************************************************************
CR          FILE IDENTIFICATION                                       *
C                                                                     *
CL    HNAME,(HUSE(I),I=1,2),IVERS                                     *
C                                                                     *
CW    1+3*MULT                                                        *
C                                                                     *
CD    HNAME               HOLLERITH FILE NAME - RAFLUX - (A6)       *
CD    HNAME               HOLLERITH FILE NAME -        -(A6)        *
CD    HUSE                HOLLERITH USER IDENTIFICATION (A6)        *
CD    IVERS               FILE VERSION NUMBER                       *
CD    MULT                DOUBLE PRECISION PARAMETER                *
CD                            1- A6 WORD IS SINGLE WORD             *
CD                            2- A6 WORD IS DOUBLE PRECISION WORD   *
C                                                                     *
C*****************************************************************
```

```
C*****************************************************************
CR          SPECIFICATIONS                                      *
C                                                               *
CL    NDIM,NGROUP,NINTI,NINTJ,NINTK,NDIR,EFFK,POWER             *
C                                                               *
CW    8                                                         *
C                                                               *
CD    NDIM              NUMBER OF DIMENSIONS                    *
CD    NGROUP            NUMBER OF GROUPS                        *
CD    NINTI             NUMBER OF FIRST DIMENSION FINE MESH INTERVALS *
CD    NINTJ             NUMBER OF SECOND DIMENSION FINE MESH INTERVALS,*
CD                      NINTJ.EQ.1 IF NDIM.EQ.1                 *
CD    NINTK             NUMBER OF THIRD DIMENSION FINE MESH INTERVALS, *
CD                      NINTK.EQ.1 IF NDIM.LE.2                 *
CD    NDIR              NUMBER OF DIRECTIONS                    *
CD    EFFK              EFFECTIVE MULTIPLICATION FACTOR         *
CD    POWER             POWER IN WATTS TO WHICH FLUX IS NORMALIZED *
C                                                               *
C*****************************************************************

C*****************************************************************
CR          REGULAR ANGULAR FLUXES AT FIRST DIMENSION BOUNDARIES *
C                                                               *
CL    ((AFREGI(M,I),M=1,NDIR),I=1,NBDRYI)----NOTE STRUCTURE BELOW--- *
C                                                               *
CW    NDIR*NBDRYI                                               *
C                                                               *
C     DO 1 L=1,NGROUP                                           *
C     DO 1 K=1,NINTK                                            *
C     DO 1 J=1,NINTJ                                            *
C   1 READ (N) *LIST AS ABOVE*                                  *
C                                                               *
CD    AFREGI            REGULAR FIRST DIMENSION BOUNDARY ANGULAR FLUX *
CD    NBDRYI            =NINTI+1, NUMBER OF FIRST DIMENSION FINE MESH *
CD                      BOUNDARIES.                             *
C                                                               *
C*****************************************************************

C*****************************************************************
CR          REGULAR ANGULAR FLUXES AT SECOND DIMENSION BOUNDARIES *
C                                                               *
CC          PRESENT IF NDIM.GE.2                              *
C                                                               *
CL    ((AFREGJ(M,I),M=1,NDIR),I=1,NINTI)----NOTE STRUCTURE BELOW---- *
C                                                               *
CW    NDIR*NINTI                                                *
C                                                               *
C     DO 1 L=1,NGROUP                                           *
C     DO 1 K=1,NINTK                                            *
C     DO 1 J=1,NBDRYJ                                           *
C   1 READ (N) *LIST AS ABOVE*                                  *
C                                                               *
CD    AFREGJ            REGULAR SECOND DIMENSION BOUNDARY ANGULAR FLUX *
CD    NBDRYJ            =NINTJ+1, NUMBER OF SECOND DIMENSION FINE MESH *
CD                      BOUNDARIES.                             *
C                                                               *
C*****************************************************************

C*****************************************************************
CR          REGULAR ANGULAR FLUXES AT THIRD DIMENSION BOUNDARIES *
C                                                               *
CC          PRESENT IF NDIM.EQ.3                              *
C                                                               *
CL    ((AFREGK(M,I),M=1,NDIR),I=1,NINTI)----NOTE STRUCTURE BELOW---- *
C                                                               *
CW    NDIR*NINTI                                                *
C                                                               *
C     DO 1 L=1,NGROUP                                           *
C     DO 1 K=1,NBDRYK                                           *
C     DO 1 J=1,NINTJ                                            *
C   1 READ (N) *LIST AS ABOVE*                                  *
```

```
C                                                                       *
CD    AFREGK            REGULAR THIRD DIMENSION BOUNDARY ANGULAR FLUX  *
CD    NBDRYK            *NINTK+1, NUMBER OF THIRD DIMENSION FINE MESH  *
CD                      BOUNDARIES,                                    *
C                                                                       *
C***********************************************************************

CEOF
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```
C***********************************************************************
C                       REVISED 07/01/73                                *
C                                                                       *
CF          AAFLUX=III                                                  *
CE          ADJOINT ANGULAR FLUX                                        *
C                                                                       *
C***********************************************************************

CD                      ORDER OF GROUPS IS ACCORDING TO INCREASING
CD                      ENERGY.  THE DIRECTION NUMBERS M=1,NDIR DENOTE
CD                      DIRECTIONS WHICH ARE REFLECTED WITH RESPECT TO
CD                      THE DIRECTIONS GIVEN IN THE SNCONS FILE.

C***********************************************************************
CR          FILE IDENTIFICATION                                         *
C                                                                       *
CL    HNAME,(HUSE(I),I=1,2),IVERS                                       *
C                                                                       *
CW    1+3*MULT                                                          *
C                                                                       *
CD    HNAME             HOLLERITH FILE NAME - AAFLUX - (A6)           *
CD    HUSE              HOLLERITH USER IDENTIFICATION (A6)            *
CD    IVERS             FILE VERSION NUMBER                           *
CD    MULT              DOUBLE PRECISION PARAMETER                    *
CD                          1= A6 WORD IS SINGLE WORD                 *
CD                          2= A6 WORD IS DOUBLE PRECISION WORD       *
C                                                                       *
C***********************************************************************


C***********************************************************************
CR          SPECIFICATIONS                                              *
C                                                                       *
CL    NDIM,NGROUP,NINTI,NINTJ,NINTK,NDIR,EFFK,ADUM                      *
C                                                                       *
CW    8                                                                 *
C                                                                       *
CD    NDIM              NUMBER OF DIMENSIONS                          *
CD    NGROUP            NUMBER OF GROUPS                              *
CD    NINTI             NUMBER OF FIRST DIMENSION FINE MESH INTERVALS *
CD    NINTJ             NUMBER OF SECOND DIMENSION FINE MESH INTERVALS,*
CD                      NINTJ.EQ.1 IF NDIM.EQ.1                       *
CD    NINTK             NUMBER OF THIRD DIMENSION FINE MESH INTERVALS, *
CD                      NINTK.EQ.1 IF NDIM.LE.2                       *
CD    NDIR              NUMBER OF DIRECTIONS                          *
CD    EFFK              EFFECTIVE MULTIPLICATION FACTOR               *
CD    ADUM              RESERVED                                      *
C                                                                       *
C***********************************************************************
```

```
C*****************************************************************
CR          ADJOINT ANGULAR FLUXES AT FIRST DIMENSION BOUNDARIES     *
C                                                                    *
CL    ((AFADJI(M,I),M=1,NDIR),I=1,NBDRYI)----NOTE STRUCTURE BELOW----*
C                                                                    *
CW    NDIR*NBDRYI                                                    *
C                                                                    *
C     DO 1 L=1,NGROUP                                                *
C     DO 1 K=1,NINTK                                                 *
C     DO 1 J=1,NINTJ                                                 *
C   1 READ (N) *LIST AS ABOVE*                                       *
C                                                                    *
CD    AFADJI            ADJOINT FIRST DIMENSION BOUNDARY ANGULAR FLUX*
CD    NBDRYI            =NINTI+1, NUMBER OF FIRST DIMENSION FINE MESH*
CD                      BOUNDARIES.                                  *
C                                                                    *
C*****************************************************************

C*****************************************************************
CR          ADJOINT ANGULAR FLUXES AT SECOND DIMENSION BOUNDARIES    *
C                                                                    *
CC          PRESENT IF NDIM.GE.2                                     *
C                                                                    *
CL    ((AFADJJ(M,I),M=1,NDIR),I=1,NINTI)----NOTE STRUCTURE BELOW----*
C                                                                    *
CW    NDIR*NINTI                                                     *
C                                                                    *
C     DO 1 L=1,NGROUP                                                *
C     DO 1 K=1,NINTK                                                 *
C     DO 1 J=1,NBDRYJ                                                *
C   1 READ (N) *LIST AS ABOVE*                                       *
C                                                                    *
CD    AFADJJ            ADJOINT SECOND DIMENSION BOUNDARY ANGULAR FLUX*
CD    NBDRYJ            =NINTJ+1, NUMBER OF SECOND DIMENSION FINE MESH*
CD                      BOUNDARIES.                                  *
C                                                                    *
C*****************************************************************
C*****************************************************************
CR          ADJOINT ANGULAR FLUXES AT THIRD DIMENSION BOUNDARIES     *
C                                                                    *
CC          PRESENT IF NDIM.EQ.3                                     *
C                                                                    *
CL    ((AFADJK(M,I),M=1,NDIR),I=1,NINTI)----NOTE STRUCTURE BELOW----*
C                                                                    *
CW    NDIR*NINTI                                                     *
C                                                                    *
C     DO 1 L=1,NGROUP                                                *
C     DO 1 K=1,NBDRYK                                                *
C     DO 1 J=1,NINTJ                                                 *
C   1 READ (N) *LIST AS ABOVE*                                       *
C                                                                    *
CD    AFADJK            ADJOINT THIRD DIMENSION BOUNDARY ANGULAR FLUX*
CD    NBDRYK            =NINTK+1, NUMBER OF THIRD DIMENSION FINE MESH*
CD                      BOUNDARIES.                                  *
C                                                                    *
C*****************************************************************

CEOF
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C*******************************************************************************
C                          REVISED 07/01/73                                     *
C                                                                               *
CF          RZFLUX=III                                                          *
C                                                                               *
CE          REGULAR ZONE FLUX BY GROUP, AVERAGED OVER EACH ZONE                 *
C                                                                               *
C*******************************************************************************

C-------------------------------------------------------------------------------*
CR          FILE IDENTIFICATION                                                 *
C                                                                               *
CL    HNAME,(HUSE(I),I=1,2),IVERS                                               *
C                                                                               *
CW    1+3*MULT                                                                  *
C                                                                               *
CD    HNAME              HOLLERITH FILE NAME = RZFLUX = (A6)                    *
CD    HUSE               HOLLERITH USER IDENTIFICATION (A6)                     *
CD    IVERS              FILE VERSION NUMBER                                    *
CD    MULT               DOUBLE PRECISION PARAMETER                             *
CD                           1= A6 WORD IS SINGLE WORD                          *
CD                           2= A6 WORD IS DOUBLE PRECISION WORD                *
C                                                                               *
C-------------------------------------------------------------------------------*
C-------------------------------------------------------------------------------*
CR          SPECIFICATIONS                                                      *
C                                                                               *
CL    TIME,POWER,VOL,EFFK,EIVS,DKDS,TNL,TNA,TNSL,TNBL,TNBAL,TNCRA,              *
CL   1(X(I),I=1,4),ITRVS,NZONE,NGROUP,NCY                                       *
C                                                                               *
CW    20                                                                        *
C                                                                               *
CD    TIME               REFERENCE REAL TIME, DAYS                              *
CD    POWER              POWER LEVEL FOR ACTUAL NEUTRONICS PROBLEM,WATTS-       *
CD                           THERMAL                                            *
CD    VOL                VOLUME OVER WHICH POWER WAS DETERMINED, CC             *
CD    EFFK               MULTIPLICATION FACTOR                                  *
CD    EIVS               EIGENVALUE OF SEARCH OF SEARCH PROBLEM                 *
CD    DKDS               DERIVATIVE OF SEARCH PROBLEM                           *
CD    TNL                TOTAL NEUTRON LOSSES                                   *
CD    TNA                TOTAL NEUTRON ABSORPTIONS                              *
CD    TNSL               TOTAL NEUTRON SURFACE LEAKAGE                          *
CD    TNBL               TOTAL NEUTRON BUCKLING LOSS                            *
CD    TNBAL              TOTAL NEUTRON BLACK ABSORBER LOSS                      *
CD    TNCRA              TOTAL NEUTRON CONTROL ROD ABSORPTIONS                  *
CD    X(I),I=1,4         RESERVED                                               *
CD    ITPS               ITERATIVE PROCESS STATE                                *
CD                           =0, NO ITERATIONS DONE                             *
CD                           =1, CONVERGENCE SATISFIED                          *
CD                           =2, NOT CONVERGED, BUT CONVERGING                  *
CD                           =3, NOT CONVERGED, NOT CONVERGING                  *
CD    NZONE              NUMBER OF GEOMETRIC ZONES                              *
CD    NGROUP             NUMBER OF NEUTRON ENERGY GROUPS                        *
CD    NCY                REFERENCE COUNT (CYCLE NUMBER)                         *
C                                                                               *
C-------------------------------------------------------------------------------*
C-------------------------------------------------------------------------------*
CR          FLUX VALUES                                                         *
C                                                                               *
CL    ((ZGF(K,M),K=1,NGROUP),M=1,NZONE)                                         *
C                                                                               *
CW    NGROUP*NZONE                                                              *
C                                                                               *
CD    ZGF                REGULAR ZONE FLUX BY GROUP, AVERAGED OVER ZONE -       *
CD                       NEUTRONS/SEC-CM**2                                     *
C                                                                               *
C-------------------------------------------------------------------------------*

CEOF
```

```
C*****************************************************************************
C                        REVISED 07/01/73                                     *
C                                                                             *
CF          PWDINT=III                                                        *
C                                                                             *
CE          POWER DENSITY BY INTERVAL                                         *
C                                                                             *
C*****************************************************************************


C-----------------------------------------------------------------------------*
CR          FILE IDENTIFICATION                                               *
C                                                                             *
CL    HNAME,(HUSE(I),I=1,2),IVERS                                             *
C                                                                             *
CW    1+3*MULT                                                                *
C                                                                             *
CD    HNAME              HOLLERITH FILE NAME = PWDINT = (A6)                  *
CD    HUSE               HOLLERITH USER IDENTIFICATION (A6)                   *
CD    IVERS              FILE VERSION NUMBER                                  *
CD    MULT               DOUBLE PRECISION PARAMETER                           *
CD                           1= A6 WORD IS SINGLE WORD                        *
CD                           2= A6 WORD IS DOUBLE PRECISION WORD              *
C                                                                             *
C-----------------------------------------------------------------------------*


C-----------------------------------------------------------------------------*
CR          SPECIFICATIONS                                                    *
C                                                                             *
CL    TIME, POWER, VOL, IM, JM, KM, NCY                                       *
C                                                                             *
CW    7                                                                       *
C                                                                             *
CD    TIME               REFERENCE REAL TIME, DAYS                          *
CD    POWER              POWER LEVEL FOR ACTUAL NEUTRONICS PROBLEM,         *
CD                           WATTS THERMAL                                    *
CD    VOL                VOLUME OVER WHICH POWER WAS DETERMINED,CC          *
CD    IM                 NUMBER OF FIRST DIMENSION FINE INTERVALS           *
CD    JM                 NUMBER OF SECOND DIMENSION FINE INTERVALS          *
CD    KM                 NUMBER OF THIRD DIMENSION FINE INTERVALS           *
CD    NCY                REFERENCE COUNT (CYCLE NUMBER)                     *
C                                                                             *
C-----------------------------------------------------------------------------*


C-----------------------------------------------------------------------------*
CR                       POWER DENSITY VALUES                                 *
C                                                                             *
CL    ((PWR(I,J),I=1,IM),J=1,JM)-----NOTE STRUCTURE BELOW-----                *
C                                                                             *
CW    IM*JM                                                                   *
C                                                                             *
CS    DO 1 K=1,KM                                                             *
CS  1 READ(N) *LIST AS ABOVE*                                                 *
C                                                                             *
CD    PWR                POWER DENSITY BY INTERVAL, WATTS/CC                  *
C                                                                             *
C-----------------------------------------------------------------------------*


CEOF
```

V. STANDARD SUBROUTINES

A. General Description

A set of standard routines is defined in order to achieve compatible coding for the retrieval of data from peripheral storage and to standardize program timing tests. The call names, arguments, and usage of the subroutines is standardized, but the contents of the routines are left entirely to local choice and needs. The objective is to exchange calling programs without modification by localizing the essential adaptations to the interior of the specified routines. Consequently, communication to the routines should be confined to the argument list; i.e., communication through common, internal subroutine calls, or other means having nonstandard influences on the calling program is excluded.

The mandatory subroutines are SEEK, REED, RITE, and TIMER. With an exception noted below all transfers of data between central memory and other storage components should be managed under the control of SEEK, REED, and RITE. The SEEK routine localizes in one place a catalog of the data files and their current status. SEEK is an important facility for linking codes for it provides a means of passing file status information in a compatible manner between codes. Actual data transfers are effected by the REED and RITE routines. In each call to REED or RITE a block of data of a specified number of words is transferred. The flexibility of FORTRAN lists is sacrificed under this specification in favor of providing local installations complete freedom in allocating peripheral storage units or devices to any given program.

In the usage of REED and RITE the dimensions determining the size of a record cannot be embedded in the given record. Since ENDF/B nuclear data files do contain records with embedded dimensions, these files are exempted from REED and RITE specifications. However, the assignment of reference numbers or logical unit numbers to ENDF/B files should still be controlled by SEEK.

In Ref. 2, "Report and Recommendations of the Committee on Computer Code Coordination," two other standard subroutines RECSIZ and FILES were proposed. Both of these routines provided for the storage of file structure information on scratch files needed for coping with particular file storage problems. Because such routines have no impact on calling programs, and because the requirements for such routines vary depending upon the local environment no standardization in this area is being developed.

It is expected, however, that such file structure subroutines will be used freely to overcome local storage problems. Their use should be fully documented so that code recipients can readily convert the codes received to their own needs. Documentation on the structure of scratch files similar to the documentation in IV, STANDARD INTERFACE FILES, should be provided.

Specifications for the standard routines are given below.

B. Subroutine SEEK

1. SEEK Specifications

Form: SEEK (HNAME, IVERS, NREF, NOP)

HNAME — The Hollerith name (A6) of a class of files of similar structure.

IVERS — The version number (positive integer) defining uniquely a member file of the class HNAME.

NREF — The reference number (positive integer) of the file HNAME, IVERS.

When NOP=0,1, NREF=0 or NREF=-1 is returned to the calling program if the file HNAME, IVERS is not properly initialized as follows:

NREF=0: The SEEK catalog has not been initialized in accordance with local requirements. It may be required locally that the parameters HNAME, IVERS, and NREF for files, or a subset of these parameters, be loaded initially in the SEEK tables in the NOP=3 call.

NREF=-1: Catalog initialization requirements are met but the file HNAME, IVERS has not been initialized. A file is initialized by an NOP=1 call. File initialization will include completing of the catalog entries not required in the NOP=3 call.

For NOP=2, 3, or 4 NREF is not referenced by SEEK. For NOP=5, the value of NREF has the special meaning discussed below.

NOP — An input integer that specifies the response required from SEEK. Standard options are:

NOP=0: The use of this option is required prior to reading a file. If IVERS.GT.0 and the file HNAME, IVERS has been initialized, SEEK returns the reference number NREF assigned to the given file. If IVERS.EQ.0 and at least one version of HNAME has been initialized, SEEK returns the reference number NREF and version number IVERS of the last initialized version of HNAME.

NOP=1: Initializes a file prior to writing the file. If IVERS.GT.0 and the catalog initialization requirements are satisfied,

SEEK initializes the file HNAME, IVERS and returns the reference number NREF assigned to the file. If IVERS.EQ.0 and the catalog initialization requirements on the class of files HNAME are satisfied, SEEK assigns a version number IVERS to the file equal to the number of previously initialized versions of HNAME plus one, initializes the new version HNAME, IVERS, and returns the version number and reference number NREF assigned to the file.

NOP=2: The SEEK subroutine is finalized. This is the last call issued by a program to SEEK to perform any wrap-up functions on SEEK or its catalog required locally.

NOP=3: The SEEK subroutine is initialized. This is the first call issued by a program to SEEK to perform any installation-dependent initializations of the SEEK routine and its catalog that are required.

NOP=4: The SEEK tables are modified to delete the file initialization of file HNAME, IVERS. A subsequent call to SEEK for file HNAME,IVERS with NOP=0 would return NREF =-1 until a reinitialization is performed.

NOP=5: SEEK returns the file identifiers HNAME and IVERS associated with the reference number NREF.

Special Name: If HNAME in a call to SEEK contains a special name CHANGE, two reference numbers are input in the SEEK call in the NREF and NOP arguments. SEEK then interchanges these reference number assignments in the SEEK catalog with respect to the associated HNAME, IVERS assignments.

2. SEEK Usage

The principal purpose of the standard subroutine SEEK is to provide management of the reference numbers, NREF, of files. Whenever a file is to be read or written by a calling program, a call to SEEK is made with the file identifying parameters HNAME and IVERS specified. The Hollerith name HNAME in A6 format identifies a class of files of similar structure, and the version number IVERS is a positive integer that defines uniquely a member file of the class HNAME. In such calls to SEEK, the positive integer NOP is also specified which identifies the particular response desired from SEEK. In these principal calls to SEEK, the reference number NREF for the file HNAME, IVERS is returned to the calling program.

SEEK, therefore, maintains a catalog, or set of tables, that associates the current list of reference numbers NREF with the corresponding file names HNAME and version numbers IVERS. The calling program uses the NREF in standard subroutine REED or RITE calls to read or write, respectively, records on the file identified by NREF. In a local environment, NREF may identify a unique storage "unit", or it may identify one of a number of files that are stored on the same unit or bulk memory device. In this context it is noteworthy that the recipes used in SEEK to assign reference numbers are entirely at local option. Consequently, the reference number assignment recipe can be used locally to identify in REED or RITE the specific location of a file on a unit from its reference number.

Two types of initialization are used in the SEEK routine. One form of initialization is the overall initialization of the SEEK routine performed under an NOP=3 call at the beginning of a program. The SEEK initialization is entirely at local option. The SEEK initialization can be used to specify partially or completely the contents of the SEEK catalog initially. Or it could be used to establish file buffers, or for any other file initializations required by local practice. A partial initial specification of the SEEK catalog could be used to distinguish two general types of files such as interface files and scratch files. This might involve two different modes of storage, and, therefore, two different procedures in handling reference numbers.

The second type of initialization is the initialization of a file. Whenever a file is to be written, an NOP=1 SEEK call is required. The file is then said to be initialized. When a file is to be read an NOP=0 call is required. Such a call can be valid only if the requested file has been previously initialized. The actual file initialization procedure performed in SEEK in response to an NOP=1 call depends upon what initializations are performed in the SEEK initialization call(NOP=3). If the SEEK catalog is completely established in the NOP=3 call, then file initialization may entail only the setting of a flag to indicate that an initialization call has been performed. On the other hand, if no entries in the SEEK catalog are made in the NOP=3 call, then the HNAME, IVERS, and NREF parameters are entered in the catalog in response to NOP=1 calls. Such details do not affect the logic of the calling program; consequently, they need not be standardized.

The Error Return flags NREF=0 or NREF=-1 are primarily for debugging applications although they

can be used for other purposes. Consequently, it is not required that tests on NREF be performed after every SEEK call. Such tests would be very laborious and would produce unnecessary clutter in programs after the debugging phase is completed. Such temporary testing requires no standardization. Applications of error flags, however, that have a permanent effect on programming logic should conform to the standards.

In the applications of SEEK to a program, the initialization call, NOP=3, should be one of the first executable statements in a program, and the finalization call, NOP=2, should be among the last executable statements. The calls NOP=0 or NOP=1 should be made just prior to the commencement of reading or writing a file, respectively. This not only will make program flow more understandable, but it is an essential practice for those environments where NOP=0, 1 calls are used for opening file buffers. Similarly, the termination calls (IREC=0) to subroutines REED and RITE (discussed below) should immediately follow completion of reading or writing a file because these latter calls may be used for closing buffers. It follows also that after a REED or RITE termination call a new NOP=0 or NOP=1 call to SEEK should be made prior to a new reading or writing of a file, respectively.

C. Subroutines REED and RITE

1. REED and RITE Specifications

Form: REED (NREF, IREC, ARRAY(I), NWDS, MODE)
RITE (NREF, IREC, ARRAY(I), NWDS, MODE)

NREF — The reference number assigned by SEEK of the file being read or written.

IREC — IREC>0, the number of the record to be transferred.
IREC=0, this signifies termination of reading or writing of the file NREF.

ARRAY(I) — The starting address in central memory at which the transfer is to begin.

NWDS — The total number of words to be moved.

MODE — This provides for buffering or parallel processing.
MODE=0, the order is completed before the return from REED or RITE.
MODE=1, the order is not necessarily completed before the return.
MODE=2, this forces completion of a MODE =1 order issued in a previous call.

2. REED and RITE Usage

The objective in defining standard subroutines REED and RITE is to provide an efficient approach to the problem of adapting codes to local data storage facilities. Central memory facilities, although of varying capacity, are common to all computers. In addition standard FORTRAN read and write statements for transferring data between facilities are implemented universally. However, in some environments the handling of the data transfers by standard FORTRAN read and write statements is unacceptably inefficient. Consequently, the practice of executing all data transfers through REED and RITE calls has been adopted. The local installations may then design REED and RITE subroutines that optimally utilize local storage facilities.

To avoid conflicts under code exchange which might necessitate large scale calling program modifications, careful usage of REED and RITE is required. REED and RITE calls are programmed following a restricted "direct access" procedure. A REED call transfers NWDS words of record IREC in file NREF from peripheral storage to central memory location ARRAY(I). A RITE call performs the inverse operation. Records are numbered consecutively in files but they may be accessed in any order by REED calls. Thus, if the records must actually be accessed sequentially, REED internally performs the required unit positioning calls such as rewinds, back spaces, or dummy reads. This implies that REED must keep track of the current positions of all sequential access files.

Interspersing of REED calls with RITE calls on the same file is allowed. In the case of sequential access files, file positioning information must be common to both REED and RITE. ANL has achieved this capability without influencing the calling program by making RITE an entry point to the REED routine In addition to achieving other economies this technique makes file position data common to REED and RITE.

In programming RITE calls account should be taken of the possibility that records downstream of the record being written on a unit may be destroyed in some environments. In principle RITE could be coded for unrestricted record access by transferring records from one unit to another internally in RITE. However, this is an expensive procedure which has not been implemented in any existing RITE subroutine.

For maximum efficiency the rearrangement of data before or after it is transferred should be avoided where possible. If several arrays are to be transferred in one operation, the arrays should be

stored in the same order in core and on the peripheral device. However, some sorting of data may be desirable in retrofiting existing codes to the standards, and data sorting is likely to be required in transferring data common to both interface and scratch files.

The MODE parameter in the argument lists offers no problems to users adapting a code to an environment where parallel processing is not involved. In this case the MODE=0 and MODE=1 specifications are ignored and MODE=2 call results in a return from REED or RITE with no response taken otherwise. It is more difficult for a programmer in a nonbuffering environment to program for a buffering environment. This problem could benefit from additional ideas developed from future code exchange experience. It would seem likely that parallel processing would be most important in the application to scratch files.

The ordering of files and the number of records per file must be provided the REED and RITE subroutines if several files are to be stacked on the same sequential unit. This information is required for positioning the unit on the correct record IREC of the file NREF. In addition the number of words per record is required for calculating pointers for records stored in large or extended core memories. Such information can be retrieved by REED and RITE by calls to routines similar to RECSIZ or FILES discussed earlier (Sec.V.A.). Calls to these file structure routines are required early in the program after the dimension data are available which affect file structures. These calls have no impact on calling programs; consequently, they may be deleted or dummy returns may be used at installations not requiring the routines. Similarly, the calls may be readily inserted when needed if file structures are adequately documented.

D. Subroutine TIMER

1. TIMER Specifications

Form: TIMER(I,T)

I — is an integer variable indicating the response needed.
I = 0 initialize timing (Set T(I), T(3) to zero)
I < 0 return array T with all entries updated (does not reinitialize)
I > 0 return array T with only entry T (1) updated from previous call (does not reinitialize)

T(J) — is a 10 word vector (double precision if necessary for transmitting BCD information).
T(1) = elapsed central processor time in seconds or central and peripheral processor times if only the combination is available. (Given as time since last call to TIMER with I = 0).
T(2) = remaining "limiting" time in seconds (as might be used to trigger a restart dump).
T(3) = elapsed peripheral processor time in seconds (given as time since last call to TIMER with I = 0).
T(4) = current day in BCD as MMDDYY.
T(5) = user's identification (A6).
T(6) = user's charge number in BCD as JJJJJJ.
T(7) = user's case identification in BCD as JJJJJJ.
T(8) = wall clock time in BCD as HHMM.T (T is tenths of a minute).
T(9) = unspecified (user's option).
T(10) = unspecified (user's option).

2. TIMER Usage

To retain compatibility under code exchange, T(9) and T(10) should be used only for edit purposes; i.e., they should not be used to control program flow.

VI. CARD FORMAT SPECIFICATIONS

A. General

The specifications herein are essentially those recommended by the card format subcommittee of the Committee on Computer Code Coordination. This subcommittee consisted of M. D. Kelley, GE-BRD, T. Pitterle, WARD, and B. J. Toppel, ANL. The original recommendations have been only slightly altered in response to suggestions from LASL and W. W. Little, HEDL.

The general function of an input processor, as discussed in Sec.III.C. is to create interface files entirely from card input, or to create new interface files by using card input to selectively overlay the data in pre-existing files. The card format specifications are well-adapted to this function since all lists in the records of the files can be read directly from cards under the free-format rules specified without necessitating any data rearrangements. Interface file specifications then become input specifications.

The recommended card format specifications define generalized procedures or rules for entering data on cards. The card format is completely free format in the sense that data items may be entered freely on a card without regard to card columns. However, certain rules for ordering data into groups and entering data on cards are specified by card format.

The card format is oriented toward entering data into arrays rather than independent data items.

The card format has two distinct categories for entries on a data card. These are (a) the file and record control words and (b) the data field for the actual data items to be loaded into a given array. The rules governing usage of these entries are given below.

B. File and Record Control Cards

There are three types of control cards governing the input of data. They are:

1. File Control Cards - nV FILEID. The unsigned integer n immediately followed by the character V denotes that version n of the file named FILEID is to be overlaid by the data on the cards that follow the nV card. If n=0 the new file FILEID is to be created entirely from the cards that follow. Data or comments following nV FILEID on the file control card are ignored.

A file control card is the first card read by the processor. Processing of the named file continues until a new file control card or a STOP card (see below) is encountered. Any number of files may be processed in any order. Any number of versions of a given file may be created. Once a given version is created it becomes available for subsequent overlaying to create additional versions. Versions of sets of files may be used to establish any number of input "cases" for a given code.

2. Record Type Control Card - mD. An unsigned integer immediately followed by the alphabetic character "D" denoted a "Data" card. The definition of this card varies from the previous control card in that the mD may appear anywhere on the card and more than one identifier may appear on the same card. The data on this card may be integer, floating point, Hollerith, etc., with any mixture being possible. If a card is encountered without the first word being an identifier, then the last read identifier is assumed. The first nonignorable word on cards following a file control card must be an mD.

EXAMPLE:

2D 1.0E+2 E HELLO 3D ONE TWO

The mD are associated with the record types appearing in the interface file specifications. Each unique data list in the specifications is identified as a record type. The record types are numbered consecutively beginning with the first record following the file identification record. Data for the file identification record are supplied on the file identifier card. If the list for record type m is repeated in the file, mD must precede each repetition of the list. In overlay applications the defined ordering of records is followed except that records may be skipped as desired. Skipped records are copied unmodified from the reference file onto the new file.

3. STOP Card. Input processing is terminated when a card containing STOP as the first entry is encountered.

One other type of identifier, a title card identifier, was specified originally. Titles, however, are contained in some standard files, and may be defined in code-dependent files as desired for particular codes. Titles in the files are automatically retrievable. Thus, there is no need for a special title card. Facilities for reading strings of Hollerith words into files are provided instead.

C. Data Field

The data field contains words which may be data and/or various options. This section describes the allowable data forms, the structure of data entries and the various options available to simplify data entries.

1. Allowable Data Forms. The allowable data forms are integers, floating point numbers, and Hollerith words and any combination of these forms is allowed within the data field. Card input specifications determine the allowable combinations of data forms.

a. Numeric Words. Numeric entries are integers if they contain no decimal point or exponent. Otherwise, numerics are taken to be real (floating-point) numbers. An exponent is an expression containing an optionally signed integer preceded optionally by the letter E. The sign or the E may be absent but not both. An exponent in a numeric word must always be preceded by at least one digit. As seen below, forms En or E±n delimited by blanks or commas are taken to be Hollerith words. Examples of allowed forms are:

Numeric	Equivalent Value	Type
10	10	integer
-10	-10	"
1E1	10.	real
1+1	10.	"
-1.0E+01	-10.	"

b. Hollerith Words. Hollerith data are specified in three different ways:

(1) By enclosing the data in asterisks or apostrophes,

(2) By using the nH specification,

(3) or by beginning a single word entry, containing no more than six characters, with a letter.

In all cases, Hollerith data are stored at the rate of six characters per word. On short word machines each six-character word is stored in a double precision word. Input words of less than six characters are stored left justified with blank fill. Imbedded blanks in words are allowed only in options (1) and (2); in option (3) blanks delimit words.

Two types of Hollerith arrays are exemplified by the first two arrays found in the FILE DATA record of the ISOTXS file:

(HSETID(I),I=1,12),(HISONM(I),I=1,NISO)

The first array HSETID is a 12 word sentence describing the contents of the file. Input for this array might be

THIRTY GROUP CROSS SECTIONS FOR LMFBR APPLICATIONS FROM ENDF/B-III DATA

or

72HTHIRTY GROUP CROSS SECTIONS FOR LMFBR APPLICATIONS FROM ENDF/B-III DATA.

In either case characters and blanks must be counted to ensure 12 words of data. The words are stored:

Word	Contents (b=blank)
1	THIRTY
2	bGROUP
3	bCROSS
4	bSECTI
5	ONSbFO
6	RbLMFB
7	RbAPPL
8	ICATIO
9	NSbFRO
10	MbENDF
11	/B-III
12	bDATAb

The isotope label array HISONM might best be input as

U235A PU239B PU240 NA

although

U235A PU239BPU240 NA

or

5HU235A 6HPU239B 5HPU240 2HNA

are acceptable forms. In all three cases the data are stored:

Word	Contents
1	U235Ab
2	PU239B
3	PU240b
4	NAbbbb

2. Card Structure. The card field has no fixed structure except that data items must be separated by blanks or a comma, and a single data item may not be split between two cards. The data field on a card may be terminated by a slash(/) after which comments may be freely punched. Use of the slash saves processing time. The trailing comments, however, will appear in the output since all card images are printed.

Comments enclosed in dollar signs ($)

$ COMMENT $

may also be inserted freely between data entries. except for printing the card images such comments are ignored by the processor. The initial $ terminates an immediately preceding data entry.

Card fields for data entries are commonly limited to 72 or 80 columns. These or other options may be invoked locally by a simple change in the processor.

3. DATA Field Options. Options available in the data field are repeat, skip, interpolation, and Section repeat.

a. Repeat Option. The repeat option is an unsigned integer immediately followed by the letter "R". Use of this option permits repeating the previously entered data item an integer number of times. For example:

1 2R = 1 1 and

2.0 3R = 2.0 2.0 2.0

b. Skip Option. The skip option is an unsigned integer immediately followed by the letter "S". This means that the integer number of locations will be skipped when determining the index of a value to be loaded. The skip option is useful only in overlay applications.

For example:

```
1  10R  5S  10R = The integer 1 is stored into
                  ten consecutive locations.
                  Then 5 locations are skipped
                  and the integer 2 is stored
                  into the 16th through 25th
                  locations.
```

c. Interpolation Option. The interpolate (nI) specification provides for linear interpolation between two real constants. The previously processed word is the initial end-point, n is the number of equally spaced interpolates to be inserted between the initial and terminal end-points, and the terminal end-point follows the nI specification. For exapmle:

```
1.0  3I  5.0 = 1.0  2.0  3.0  4.0  5.0
```

d. Section Repeat Option. A section is a group of entries enclosed in parentheses. The entries may consist of numeric or Hollerith constants; repeat, interpolate, and skip specifications; or section repeats. The section is always used in conjunction with the repeat option in the form

(entries) nR .

The entries are expanded to a set of constants and repeated to obtain n identical sets.

The terminal end-point of an interpolation section entry must lie within the section. The initial end-point may immediately precede the section, although this is seldom useful. The skip option as a section entry must be used cautiously since items skipped are taken from the array being overlayed and the overlayed array is the entity repeated in the section repeat operation. Sections may be continued over more than one card, and section repeats may be nested within section repeats up to 10 levels of nesting. An example of nesting is:

```
(1  (5.0  2I  20.0)  2R  WORD1)  2R
```

which is equivalent to

```
(1  5.0  10.0  15.0  20.0  5.0  10.0  15.0
 20.0  WORD1)  2R.
```

D. Card Input Example.

An example of card input for the GEODST standard interface file is given below.

Card	Contents
1	0V GEODST
2	1D 2 3R 0 2 1 1 50 1 3R 0 16R/SPECIFICATIONS
3	2D 0.0 29.64 64.2 0.0 4R/COARSE MESH BOUNDARIES
4	3D 30 20 1 1/FINE MESH INTERVALS
5	4D$ VOLS$ 2.76+3 1.02+$ZONE CLS$ 1 2 $ZONE ASS$ 1 2/GEOMETRY DATA
6	5D 1 2 /REGIONS ASSIGNED TO COARSE MESH

The input describes the geometry for a one-dimensional cylinder containing two regions with 50 fine mesh intervals, reflected condition on left boundary, and zero condition on right boundary. The inner region of outer radius 29.64 has 1 coarse mesh interval containing 30 fine intervals, and the outer region of outer radius 64.2 has 1 coarse interval with 20 fine intervals.

If the file created is Version 1 of GEODST, a second version with the fine mesh doubled could be obtained from the input:

Card	Contents
7	1V GEODST
8	1D 7S 100 19S/FINE MESH TOTAL
9	3D 60 40 2S/FINE MESH INTERVALS
10	STOP

VII. REFERENCES

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APPENDIX A

ORGANIZATIONS

Alphabetic abbreviations for organization names used in the text are interpreted below:

Abbreviation	Organization
AI	Atomics International, North American Rockwell
ANL	Argonne National Laboratory, University of Chicago
DRRD	Division of Reactor Research and Development, United States Atomic Energy Commission
GE-BRD	General electric Company-Breeder Reactor Department
GGA	Gulf General Atomics, Gulf Oil Company
HEDL	Hanford Engineering Development Laboratory, Westinghouse Electric Corporation
LASL	Los Alamos Scientific Laboratory, University of California
ORNL	Oak Ridge National Laboratory, Union Carbide Corporation
WARD	Westinghouse Electric Corporation, Advanced Reactors Division

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