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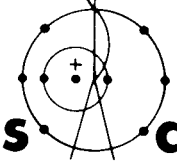
Standard Interface Files and Procedures for Reactor Physics Codes, Version IV

R. Douglas O'Dell



los alamos
scientific laboratory
of the University of California
LOS ALAMOS, NEW MEXICO 87545

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

R. Douglas O'Dell

ABSTRACT

Standards, procedures, and recommendations of the Committee on Computer Code Coordination for promoting the exchange of reactor physics codes are updated to Version IV status. Standards and procedures covering general programming, program structure, standard interface files, and file management and handling subroutines are included.

I. INTRODUCTION

A. Background

A major problem associated with the development of complex computer codes is their exportability or exchangeability. Due to the existing and ever-changing variety of computers and computing systems, codes developed at one facility are often incompatible with computers at other facilities. As a result, either major rewrites of a code at a receiving facility are necessary or there is a duplicate effort with two or more facilities developing similar codes. Both occurences are expensive and wasteful in manpower and money.

One way to minimize the problem of code exchange is to develop codes at designated facilities using standardized techniques and procedures that are generally compatible with large-scale computing environments. Such a standardization effort has been under way for the past several years for fast reactor physics codes being developed under the Physics Branch of ERDA's Division of Reactor Development and Demonstration (RDD). Work in this effort is being performed under procedures and guidelines established by the Committee on Computer Code Coordination (CCCC). This committee consisted of representatives of RDD-funded contractors assembled at the request of the Advisory Committee on Reactor Physics. The early efforts of the CCCC have been summarized by Hannum and Lewellen[1] and the original standards and procedures developed by the CCCC are described in three informal reports.[2,3,4] In July 1973, the standards and procedures (hereafter simply called standards) were frozen for extensive trial-use and applications-testing by RDD contractors. These standards were designated Version III and a complete, updated formal report[5] issued. During a three-year period of trial-use and testing of the Version III standards several omissions, deficiencies, and ambiguities in the standards were revealed. Through the CCCC the standards were revised to correct the majority of these weaknesses.

This report contains a description of the standards and procedures (designated Version IV) as evolved and revised under the CCCC to November 30, 1976. In an attempt to make this report complete and self-contained much of the material contained in the previously cited references is restated. Indeed, the majority of the standards and procedures contained in Version IV are unaltered from their Version III status. Those portions of the Version IV standards which differ significantly or substantively from Version III are generally noted.

B. Objective

The objective of the standards and procedures established by the CCCC is to facilitate the development of readily exchangeable reactor physics codes for meeting RDD reactor design goals. To achieve this objective, the standards and procedures

(i) define computer programming procedures which are generally compatible with large computer environments,

(ii) establish a program structure for the physical organization of a code to permit the code to be exchanged as a free-standing entity which is readily assimilable into a locally constructed linked code system where such a system is available,

(iii) define standard data interfaces between codes to facilitate linking the output of one code to the input of another code, and

(iv) define several standardized subroutines and specify their functions in order to eliminate the need for calling program modifications when adapting imported codes to local computing systems.

This report is sectioned according to the above four areas.

It is important to recognize that computer programs, by their nature, resist being measured by a common standard. Therefore, the procedures, guidelines, and recommendations given in this report cannot cover every case, but merely point the way to what is desired.

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, data management, 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, ANS Standard 3-1971, "Recommended Programming Practices to Facilitate the Interchange of Digital Computer Programs," will be followed. This standard recognizes FORTRAN as the de facto standard programming language. Standard FORTRAN is currently defined by the old ANSI standard, X3.9.[6] (A new and significantly revised FORTRAN standard is under development but has not yet been adopted.)

B. Structure

A standard structure for computer codes is adopted which separates, insofar as is practical, input and output functions from the main calculational section of the code. A detailed discussion of code structure is given in Sec. III.

C. Standard Interface Files

Computer codes are to be written to accept as input and to produce as output certain data in standardized form as binary sequential files. Standard interface files designed for this purpose are defined in Sec. IV. (Sequential interface files containing data whose form has not been standardized shall be called code-dependent interface files in this report).

D. Data Transfers

The management and transfer of data is to be performed in a standardized manner with implementation made through the use of standardized subroutines.

The standardized subroutines SEEK, REED, and RITE are used for data transfers involving sequential data files. These subroutines and their uses are unchanged from the Version III report and are presented in Sec. V.

In recognition of a need for standardizing multilevel data transfer techniques including the ability to transfer data using random (direct) access files, a new series of subroutines and their usage is presented for the first time in Sec. V. The multilevel data management strategy and the series of routines were jointly formulated by Ferguson (ANL), Bosler (LASL), Brinkley (LASL), and Rhoades (ORNL), were proposed to RDD by Bosler,[7] and approved by RDD as tentative standards for trial use.[8]

E. Central Memory Restrictions

Computer codes are to be designed to be operable within a-50 000 word central memory limitation. At the same time, however, codes are to be 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. The restriction and techniques presented above are unchanged from the Version III report.

F. Word Size

Codes are to be designed to minimize the word-size problems arising in exchanges between short- 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.

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. Such special statements which may be required on some computers but which are inadmissable on others can be programmed with the statements immediately preceded and followed by uniquely identifiable comment cards. For example,

```
CSW
      REAL*8 List
CSW
```

where the letter C of CSW occurs in column 1, could be statements inserted in a code for short-word computers recognizing the REAL*8 specification. The preferred method for deactivating the above specification for using the code on computers which do not recognize the statement is by inserting the letter C in column 1 of the REAL*8 statement. Although the use of comment card identifiers CSW and CLW (for short-word and long-word computer usage) has generally been accepted, they are not required. Code programmers are free to use any identifiers such as computer brand name, installation identification, etc., as they see fit. Documenting the identifiers, however, is essential.

The technique described above can be used to circumvent almost any code exchange difficulty. Simple preprocessing routines can be locally written to automate the activation or deactivation of special statements in an imported code.

An additional problem involving code exchange between short-word and long-word computers is that of word boundary compatibility. Special attention must be given by the code writer to ensure word boundary compatibility on pointers for arrays containing words which are required to be double precision on some computers but only single precision on other computers. Specifically, the number of integer variables preceding real variables in a common block must be even to ensure alignment if double precision is required.

G. Documentation

Complete documentation as set forth in "Guidelines for the Documentation of Digital Computer Program," ANSI standard N 413, is required. This includes both internal-to-the-code documentation, i.e., the liberal use of comment cards, as well as code manual documentation. 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 documenation should be of the same form as that used for standard interface files in Sec. IV.

It is also recommended that code users manuals should contain a single section on conditions/limitations regarding the code and the standard interface files. A single place within the manual where a user can look to find what files are required, accepted, or available as output, which geometry and boundary condition options are available, etc., is extremely helpful.

H. Programming Logic

A standard of good practice in programming logic is strongly endorsed. It is highly desirable that codes embody good, clean, easy-to-follow logic in programming. Although it is difficult to quantify what is meant by the preceding statement the following examples should be indicative of the nature of good programming logic applied to a code.

(a) The code should be a carefully structured collection of subprograms, each of which performs a clearly defined function.

(b) During execution, the flow through the code should be smooth, systematic, and easily identifiable.

(c) The coding logic should be such that existing algorithms can be easily changed and new code capabilities and options can be readily added without disrupting large portions of the code.

(d) There should be a high degree of consistency throughout the code, e.g., the names of primary variables and principal control words and dimension pointers should generally be the same throughout the code and there should be consistency in the manner in which control words and pointers are used.

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. Octal and hexadecimal constants should be avoided.
5. Both the use of an array name, or the use of the implicit DO notation are permitted in DATA statements. For example:

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

6. The use of the ENTRY statement must be treated as a machine-dependent feature and should generally be avoided. If ENTRY is used, however, it should be clearly identified and documented as discussed in Sec. II.G.
7. END OF FILE checks are forbidden since they are not needed when the standardized subroutines are used.
8. Use of statement numbers on RETURN statements as in

```
RETURN i
```

is forbidden.

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

J. Recommended Procedures

The following procedures are generally recommended by the CCCC. It is therefore suggested 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 W-ARD. Automated repacking of the container block when arrays are purged is one feature of this technique. ORNL, however, notes that arbitrary and indiscriminant use of such packages can lead to inefficient data handling.
2. Condensed Output. Codes should provide a condensed edit-output capability as well as a bulk-output capability. Bulk-output on microfiche should also be considered. History-of-calculation edit-output is also frequently useful, especially as a debugging aid.
3. Error Procedures. Error procedures and job termination should be localized in a single subroutine. Flexibility in the details of this routine is permitted.
4. DO Loop Termination. DO loops should terminate in a numbered CONTINUE statement.
5. Programming Items to be Avoided. It is recommended that the following programming items not be used in codes:

(a) Items in the Appendix of ANS Std. 3-1971

(b) LEVEL, PARAMETER, and INSERT statements

(c) Trailing or imbedded comments

(d) Delimiting quotes in DATA statements

(e) Subscripted variables as subscripts of variables

(f) Subscripted variables as control parameter of a computed GO TO statement

(g) More than 60 arguments in a subprogram or subprogram call.

(h) No more than 24 of the maximum of 60 arguments in a subprogram statement may be integer variables which set the dimensions of other arguments which are variably dimensioned arrays.

(i) More than 600 total arguments in all call statements in one routine

(j) Variables in COMMON for dimensions of variables

(k) Different implied lengths of the same data block as in call and subprogram statements and in common block specification statements

III. PROGRAM STRUCTURE

A basic program structure has been endorsed by the CCCC and is recommended for use. This structure was first formally presented in Ref. 5 and basically consists of a modular form with linkage between the modules, or sections, to be achieved through binary, sequential files, called interface files. The sections are described in accordance with their primary functions as follows:

(i) driver, or main control,

(ii) input,

(iii) calculations,

(iv) output, and, optionally

(v) file recovery.

The structure above is applicable both to li[illegible] code systems as well as to individual, free-stand[illegible] codes. Its usage facilitates the exchange of

free-standing codes and also, if desired, the incorporation of such a code into a linked-code system.

Although seemingly straightforward in nature there has been considerable discussion, apparent misunderstanding, and some confusion as to the specific application of the structure to codes. One reason for this is that in implementing the structure one needs to be aware of the distinction between applying the structure to a linked-code system and to a free-standing code. For example, the specific nature of an input processor in a linked-system is considerably different from that in a free-standing code. In an attempt to clarify the differences and to provide a better feel for the structuring rationale, the program structure will be discussed in two parts, first as it might be applied to a linked-code system, and second, as it can be applied to a free-standing code. It is also to be understood that the structure is much more of a general, structuring philosophy than it is a set of hard and fast rules.

A. Linked-Code System Structure

In a typical linked-code system the structure recommended by the CCCC might be represented in the form shown in Fig. 1 where each module is characterized by its function. The function of each of these modules is described below.

1. Driver

The function of the Driver is typically limited to that of calling the other modules in the appropriate sequence. The form of the Driver will depend almost entirely on the local environment and, as a result, is entirely exempt from the standards and procedures recommended by the CCCC with the exception that data linkages between the various modules of the linked system are to be solely by means of sequential data files, namely standard or code-dependent interface files.

2. File Recovery

The File Recovery module performs any activities required to retrieve and/or store sequential interface files between runs. Since these activities are local-installation-dependent, this module is exempt from any standards except for the limits on the data linkages to other sections or modules in the linked system.

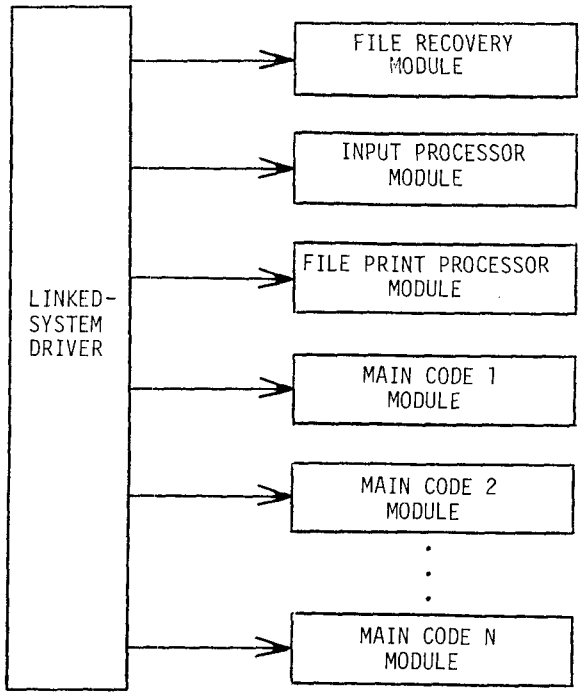

Fig. 1. Typical linked-code system structure.

The File Recovery module would, in the normal sequence, be called first to retrieve pertinent interface files from previous runs, if these are available. This retrieval task, for example, might involve the searching of a magnetic tape on which were previously written several interface files, extracting those interface files desired, and assigning them to individual logical units.

The File Recovery module might again be called at the end of the run to store pertinent interface files created during the run. This storage task, for example, might involve the writing of the desired interface files to a single magnetic tape.

3. Input Processor

The Input Processor typically uses card input, as supplied by the user, to construct the sequential interface files to be used as input to the desired main code (or codes) to be executed. New files may be created entirely from card input or existing files may be overlaid with card input data. The reference files for overlaying may be derived from previous runs or from the same run. In such a

manner, sets of interface files can be created which define any number of executable problem input cases. The interface files to be created may either be standard interface files as described in Sec. IV of this report or they may be code-dependent interface files.

For the creation of standard interface files, according to the Version III specifications of Ref. 5, Los Alamos Scientific Laboratory has developed an exportable code called LASIP-III,[9] available through the Argonne Code Center. This code actually consists of two separable parts -- an input processing part and a file print processing part. The input processing part can be used as a linked-system Input Processor, if desired. It is organized in a modular form with respect to the standard interface files in that each file is handled by a separate subroutine. This is done so that processing capabilities for new files can readily be added. Additionally, since LASIP-III was developed for export, the code follows coding standards and procedures recommended by the CCCC. The format of the card input for creating the standard files in LASIP-III is free-field format according to the specifications and conventions established by the CCCC for such an input processor. These specifications and conventions are fully described in both Refs. 5 and 9 and will not be reproduced in this report.

A generalized input processor such as found in LASIP-III for creating standard interface files from card input need not be the only form of a linked-system Input Processor. In addition to, or in lieu of, such a generalized processor, a local installation may elect to develop an Input Processor that creates standard interface files from card input which is more locally familiar to users due to traditional or historical custom. For example, at Los Alamos the linked-system input processor provides the capability of creating the reactor mixing data standard files NDXSRF and ZNATDN from cards input in the locally familiar LASL mixing specification format. Such input processing capabilities, if intended for local usage and not to be exported, are exempted from coding standards and procedures.

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.

4. File Print Processor

The File Print Processor is used to edit and print data from any of the existing sequential interface files. This processor should provide flexible control for printing of files and records within files. Although some printed output may be performed from within a Main Code module, such printed output is normally limited to monitoring the progress of the calculation. Bulk printing of data from interface files should be performed by the File Print Processor.

The LASIP-III code described in the preceding paragraphs contains a generalized file print processor for printing data from any of the Version III standard interface files. It is constructed in such a manner as to permit the easy addition of file-print capabilities for code-dependent interface files unique to particular main codes in a linked system.

In addition to providing for the bulk printing of sequential file data as described above, the file-print processing section of a local linked-code sysem may be used to provide edit-output prints. Such edit-output may include data from several interface files, e.g., reaction rate distribution, $\sigma\phi$. Whether such an edit-output capability is placed within the file-print processor or is included as a separate Main Code Module is arbitrary and is left to the local installation.

It is again noted that if a linked-system File-Print Processor is developed for local-installation use only and is not to be exported, the coding of the processor is exempt from CCCC standards and procedures.

5. Main Code Module

A typical linked-code system will contain numerous Main Code Modules. Each main code module operates between two sets of sequential interface files: an input set and an output set. Communication between a main code module and other modules or sections in the linked-code system is normally restricted to that provided by sequential interface files.

B. Free-Standing Code Structure

In a free-standing code developed for export the structure recommended by the CCCC might be represented in the form shown in Fig. 2. Each block or section of the code is characterized by its general function. In incorporating this structure into a code each block is typically comprised of a group of distinct, well-defined subroutines. If an overlay structure is to be used in the code, each block will normally be contained in one or more separate overlays. Insofar as is possible, the blocks of coding should be coupled through the use of sequential, binary, interface files rather than through COMMON blocks or through subroutine argument lists.

1. Driver

The function of the Driver should be limited to that of calling the other code blocks in the appropriate sequence. The driver routine is typically the main program routine.

2. Input Block

The Input Block in a free-standing code performs the necessary activities for processing all input data necessary for the execution of the Solver (calculational) Block and/or the Output Block. These activities include the reading of input data and the creation of binary interface files. This latter activity may require a certain degree of data processing. Each of these activities is discussed below.

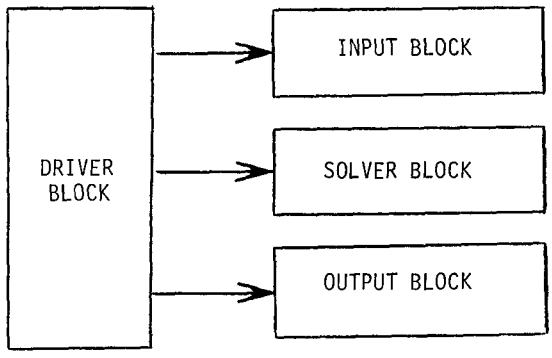

Fig. 2. Free-standing code structure.

In performing the reading-of-input data activity, the Input Block must be able to accept pertinent standard interface files in binary form. Additionally, the Input Block should be able to accept code-dependent data as card input. Code-dependent data provide information required by the code but which is not available from the standard interface files. The capability of reading standard interface files and card-input of required, code-dependent data is the minimum input-reading capability that the Input Block should provide. It is not intended that these be the only forms of input permitted. Most code developers and users prefer to permit additional, optional input forms and such capabilities are perfectly acceptable. Examples of additional, optional input commonly provided are input in forms characteristic of a local installation and familiar to the staff at that installation, streamlined and simplified starting flux guesses, and cross-section input in formats other than that of standard interface files.

The second activity of the Input Block is the creation of binary, sequential interface files containing the input data. Insofar as is practical and reasonable these interface files are the sole means of communication between the code blocks. In performing the file-creation activity, the Input Block will normally be required to perform some data processing tasks. The nature of these tasks will depend on the particular form of the input as well as on the desired forms of the interface files. Code-dependent input, as one example, may require restructuring or other type of data manipulation or processing in order to convert it from its input form (typically chosen for user convenience) to a form more readily usable by the Solver or Output Block. As a second example, if a particular standard interface file is to be used directly by the Solver or Output Block, the processing function of the Input Block may consist of little more than printing a message to the effect that the standard file was successfully read. Another form of input data processing that might be performed in the Input Block is that associated with additional, optional input forms. If, for example, a simplified starting

flux guess option from card input is provided, the Input Block could translate this input into an RTFLUX standard interface file format. In this manner, no matter how starting flux guesses are supplied as input to the Input Block, the output from the block will always be an RTFLUX file.

It is highly desirable that the Input Block be structured in a well-defined modular form. Separate subroutines should be used for each interface file and each subroutine should normally perform only a single task. Such a construction facilitates the insertion of additional capabilities or the removal of unneeded capabilities. It also makes easier the assimilation of the code into a linked code system. In such a system the input processing activities of the Input Block could be transferred to the Input Processor Module of the linked system and the Input Block eliminated from the code. Note that the linked system Input Processor Module would presumably already have a standard interface file input processing capability. The transfer of the code Input Block to the Input Processor Module would, therefore, actually only require that the code-dependent and code-optional input reading, processing, and sequential file creation subroutines be lifted from the Input Block and added to the Input Processor Module to give it the full capability of the original free-standing code Input Block.

3. Solver Block

The Solver, or Calculational, Block of a code has the function of effecting the solution to the desired problem by numerical methods. The Solver Block operates between two sets of interface files, an input set from the Input Block and an output set for use by the Output Block. Insofar as is practical, these sets of interface files provide the only means of communication between the blocks. All data and information necessary for the Solver Block to perform its task should be contained in the set of interface files input to the block.

The editing and printing of information in the Solver Block should be limited. Monitor prints which show the progress of the calculations in the Solver Block are nearly always required. Edit prints from the Solver Block are permitted, but these should be limited to information which is only available in or used by the Solver Block, i.e., "scratch" data, or to information which is of value to the user and which can be easily and readily generated from already-existing scratch data. In other words, edit prints should be restricted to information whose existence or formation is compatible with the calculations being performed in the Solver Block. Bulk printing of data contained on interface files should not be performed in the Solver Block. This function is reserved for the Output Block as described below.

4. Output Block

The function of the Output Block is to edit any of the existing interface files and to provide the "printed" output from these edits. Printed, in this context, refers to any of several forms of permanent display, e.g., paper listing, punched cards, microfiche, magnetic tape, etc. Included in the function of the Output Block is the bulk printing of data taken from any of the interface files. This bulk printing capability should be flexible to permit the selective printing of the files and of records within the files. In addition to printing data taken directly from interface files, the Output Block should normally provide for the generation and subsequent printing of edit-output. Edit-output refers to information which is obtained from data contained on one or more interface files but which requires manipulating or processing the data. An example of edit output is a reaction-rate distribution, $\sigma\phi$, where σ is a particular microscopic cross section for a particular nuclide and ϕ is the scalar flux. In this example data from both a cross-section interface file and a scalar flux file are required to be recovered, multiplied, and the product printed.

As with the other blocks in the code, the Output Block should be constructed in a modular form. Separate subroutines should be used to print each type of interface file passed to the Output Block. Each type of edit-output should be contained in one or more distinct subroutines. With such a structure, additional edit-options can be readily added to the Output Block or unneeded options can be removed. Also, the modular structure facilitates the assimilation of a free-standing code into a linked system in which the code's Output Block activities could be transferred to the linked system File Print Program Module in a manner similar to that described in the Input Block discussion.

C. Remarks on Program Structure

The recommended program structure applies both to linked-code systems as well as to individual free-standing codes. The structure consists of a modular, functionally sectioned, construction in which communication between modules, or sections, is achieved through binary, sequential interface files. Each section is in itself modularly constructed into distinct, functionally well-defined blocks and subroutines.

The use of this structure permits a high degree of flexibility and local-installation preference as to actual implementation. At the same time it minimizes the impact of variations in local-installation application on other installations when codes are exchanged.

IV. STANDARD INTERFACE FILES

A. General Comments

Interface files are binary, sequential files used to transmit data between codes, linked system modules, or code blocks. Standard interface files are interface files whose structure and data-content formats have been standardized.* Code-dependent interface files are interface files whose structure and data-content formats have not been standardized.

The complete set of standard interface files designated Version III and presented in Ref. 5 have been reviewed, revised as needed, and redesignated Version IV with a revision date of November 30, 1976. In addition, the (reactivity) WORTHS file appears for the first time in the Version IV specifications following. The WORTHS file, however, is presented only as a tentative for-trial-use, standard file and is not fully accepted as a standard.

Table I lists all Version IV standard interface files together with an indication of whether or not they are changed with respect to the Version III specifications. For each file whose specification is changed, a short narrative summarizing the change is provided immediately preceding the file specifications.

Before considering the specifications for the standard files individually there is one point, common to all standard files, that needs clarification. This point regards the meaning and usage of the word IVERS (the FILE VERSION NUMBER) on the File Identification Record of each standard file.

IVERS is intended to denote different data versions of files having the same generic name which may coexist during the execution of a code. For example, in a multigroup cross-section group-collapsing code, an ISOTXS file with IVERS=1 could denote the input library file while ISOTXS with IVERS=2 could denote the output, group-collapsed file. For free-standing codes the use of IVERS is seldom required. In a linked code environment, however, it is often necessary to use IVERS in order to distinguish between several files having the same generic name (but with different data contents). Note that IVERS is not intended to denote the version number of the standard interface file format specifications. The use of the term "Version III" file specifications or "Version IV" file specifications has nothing to do with the value of IVERS.

B. Nuclear Data Files

There are five standard interface data files which can be categorized as nuclear data files: ISOTXS, GRUPXS, BRKOXS, DLAYXS, and ISOGXS. The Verision IV specifications for each of these files follows.

1. ISOTXS - Nuclide (isotope)-ordered, Multigroup Neutron Cross Sections

The changes in ISOTXS-IV relative to ISOTXS-III are, in the main part, clarifications of ambiguities present in the latter. The changes reflected in Version IV are:

(a) If scattering bandwidth, JBAND(J,N), is zero, no scatter data are present in block N. (See 4D record.)

(b) The position of self- (or within-group-) scatter must lie within the scattering bandwidth unless the bandwidth is zero, i.e.,

$$1 \leq IJJ(J,N) \leq JBAND(J,N) \text{ if } JBAND(J,N) \neq 0.$$

(See 4D record.)

(c) The Legendre expansion coefficient factor (2L+1) is not included in the P_L weighted transport and total cross sections. (See 5D record.)

(d) the n,2n principal cross section (see 5D record) is clarified as the n,2n reaction cross section while the n,2n scatter matrix terms are clarified (see 4D record NOTE) as emission (production) based, i.e.,

$$\sigma_{n2n}(g) = 0.5 \sum_{g'} \sigma_{n2n}(g \to g').$$

*For interinstallation exchange purposes only, certain standard interface files may be written in binary-coded-decimal (BCD) formats.

TABLE I

LISTING OF VERSION IV STANDARD INTERFACE FILES

Name	General Description of Contents	Changed from Version III?
ISOTXS	Nuclide (isotope) - ordered, multigroup neutron cross-section data	Yes
GRUPXS	Group-ordered, isotopic, multigroup neutron cross-section data	Yes
BRKOXS	Bondarenko (Russian format) self-shielding data.	Yes
DLAYXS	Delayed neutron precursor data	No
ISOGXS	Nuclide (isotope)-ordered, multigroup gamma cross-section data	No
GEODST	Geometry description	Yes
NDXSRF	Nuclide density and cross-section referencing data	No
ZNATDN	Zone and subzone nuclide atomic densities	No
SEARCH	Criticality search data	No
SNCONS	S_N constants	No
FIXSRC	Distributed and surface fixed sources	Yes
RTFLUX	Regular total (scalar) neutron flux	Yes
ATFLUX	Adjoint total (scalar) neutron flux	Yes
RCURNT	Regular neutron current	Yes
ACURNT	Adjoint neutron current	Yes
RAFLUX	Regular angular neutron flux	No
AAFLUX	Adjoint angular neutron flux	No
RZFLUX	Regular, zone-averaged flux by neutron group	Yes
PWDINT	Power density by mesh interval	Yes
WORTHS	Reactivity per cc by mesh interval	New (for trial use)

In addition, the following is included to clarify the meaning of the vectors IDSCT(N) and LORD(N) contained in the ISOTOPE CONTROL AND GROUP INDEPENDENT DATA (4D) record and to remove an ambiguity in the subblocking of scattering data.

IDSCT(N) specifies the identity and ordering of scattering data blocks and LORD(N) specifies the number of Legendre orders contained in each block. Each block of scattering may be subblocked into NSBLOK records (subblocks) where NSBLOK is found on the FILE CONTROL (1D) record. With the single exception below, subblocking shall not be used (NSBLOK>1) if the individual blocks defined by IDSCT and LORD contain more than one Legendre order of scattering. The single exception is that subblocking may be used with more than one Legendre order per record (subblock) only if each record (subblock) contains data for a single "scattered-into" group.

Finally, the following information is reproduced from the Version III specifications for the sake of completeness.

The P_ℓ weighted transport and total cross sections can be defined* as

$$\sigma^g_{tr_\ell} \equiv \sigma^g_{t_\ell} - \sum_{g'} \sigma_{s_\ell}(g \to g') \qquad \ell = 1, \ldots, \text{LTRN}$$

and

$$\sigma^g_{t_\ell} \equiv \frac{\int_g \sigma_t \phi_\ell(E)\,dE}{\int_g \phi_\ell(E)\,dE} \qquad \ell = 0, 1, \ldots, \text{LTOT-}$$

The P_ℓ weighted scattering cross sections given in the scattering blocks are defined as

$$\sigma_{s_\ell}(g \to g') \equiv \frac{\int_g \int_{g'} \sigma_{s_\ell}(E \to E')\phi_\ell(E)\,dE'\,dE}{\int_g \phi_\ell(E)\,dE} .$$

*Other definitions of the P_ℓ weighted transport cross section are also possible.

```
C*****************************************************************************
C                        REVISED 11/30/76                                      -
C                                                                              -
CF          ISOTXS-IV                                                          -
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             FILE-WIDE 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=NUMBER OF WORDS                                                 -
C                                                                              -
CB    FORMAT(11H 0V ISOTXS ,   1H*,                                            -
CB   12A6,1H*,I6)                                                             -
C                                                                              -
CD    HNAME          HOLLERITH FILE NAME - ISOTXS - (A6)                       -
CD    HUSE(I)        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------------------------------------------------------------------------------
```

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C-----------------------------------------------------------------------
CR          FILE CONTROL   (1D RECORD)                                 -
C                                                                       -
CL    NGROUP,NISO,MAXUP,MAXDN,MAXORD,ICHIST,NSCMAX,NSBLOK               -
C                                                                       -
CW    8=NUMBER OF WORDS                                                 -
C                                                                       -
CB    FORMAT(4H 1D ,8I6)                                                -
C                                                                       -
CD    NGROUP         NUMBER OF ENERGY GROUPS IN FILE                    -
CD    NISO           NUMBER OF ISOTOPES IN FILE                         -
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         FILE-WIDE FISSION SPECTRUM FLAG                    -
CD                      ICHIST.EQ.0,      NO FILE-WIDE SPECTRUM         -
CD                      ICHIST.EQ.1,      FILE-WIDE CHI VECTOR          -
CD                      ICHIST.GT.1,      FILE-WIDE CHI MATRIX          -
CD    NSCMAX         MAXIMUM NUMBER OF BLOCKS OF SCATTERING DATA        -
CD    NSBLOK         SUBBLOCKING CONTROL FOR SCATTER MATRICES, THE      -
CD                      SCATTERING DATA ARE SUBBLOCKED INTO NSBLOK      -
CD                      RECORDS(SUBBLOCKS) PER SCATTERING BLOCK.        -
C                                                                       -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR          FILE DATA   (2D RECORD)                                     -
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)))=NUMBER OF WORDS                 -
C                                                                       -
CB    FORMAT(4H 2D ,1H*,11A6,1H*/       HSETID,HISONM                   -
CB   11H*,A6,1H*,9(1X,A6)/(10(1X,A6)))                                  -
CB    FORMAT(  6E12.5)                  CHI (PRESENT IF ICHIST.EQ.1)    -
CB    FORMAT(  6E12.5)                  VEL,EMAX,EMIN                   -
CB    FORMAT(12I6)                      LOCA                            -
C                                                                       -
CD    HSETID(I)      HOLLERITH IDENTIFICATION OF FILE (A6)              -
CD    HISONM(I)      HOLLERITH ISOTOPE LABEL FOR ISOTOPE I (A6)         -
CD    CHI(J)         FILE-WIDE 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          FILE-WIDE CHI DATA   (3D RECORD)                            -
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)=NUMBER OF WORDS                                 -
C                                                                       -
CB    FORMAT(4H 3D ,  5E12.5/(6E12.5)) CHI                              -
CB    FORMAT(12I6)                     ISSPEC                           -
C                                                                       -
CD    CHI(K,J)       FRACTION OF NEUTRONS EMITTED INTO 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        -
CD                      TO CALCULATE EMISSION SPECTRUM FROM FISSION     -
CD                      IN GROUP I                                      -
C                                                                       -
C-----------------------------------------------------------------------
```

```
C-----------------------------------------------------------------------
CR          ISOTOPE CONTROL AND GROUP INDEPENDENT DATA   (4D RECORD)    -
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)=NUMBER OF WORDS                      -
C                                                                        -
CB    FORMAT(4H 4D ,3(1X,A6)/  6E12.5/                                   -
CB   1(1216))                                                            -
C                                                                        -
CD    HABSID         HOLLERITH ABSOLUTE ISOTOPE LABEL - SAME FOR ALL     -
CD                         VERSIONS OF THE SAME ISOTOPE IN FILE (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 FILE-WIDE 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                          MATRIX TERMS).                               -
CD                              =100 + NN, ELASTIC SCATTERING            -
CD                              =200 + NN, INELASTIC SCATTERING          -
CD                              =300 + NN, (N,2N) SCATTERING,----SEE     -
CD                                NOTE BELOW----                         -
```

```
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)    NUMBER OF GROUPS THAT SCATTER INTO GROUP J,      -
CD                    INCLUDING SELF-SCATTER, IN SCATTERING BLOCK N,  -
CD                    IF JBAND(J,N)=0, NO SCATTER DATA IS PRESENT IN  -
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.  -
CD                    IF JBAND(J,N),NE.0 THEN IJJ(J,N) MUST SATISFY   -
CD                    THE RELATION 1.LE.IJJ(J,N),LE.JBAND(J,N)        -
C                                                                     -
CN                    NOTE- FOR N,2N SCATTER, THE MATRIX CONTAINS TERMS, -
CN                    SCAT(J TO G), WHICH ARE EMISSSION (PRODUCTION)- -
CN                    BASED, I.E., ARE DEFINED SUCH THAT MACROSCOPIC  -
CN                    SCAT(J TO G) TIMES THE FLUX IN GROUP J GIVES    -
CN                    THE RATE OF EMISSION (PRODUCTION) OF  NEUTRONS  -
CN                    INTO GROUP G.                                   -
C                                                                     -
C---------------------------------------------------------------------

C---------------------------------------------------------------------
CR          PRINCIPAL CROSS SECTIONS   (5D RECORD)                    -
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=NUMBER OF WORDS                      -
C                                                                     -
CB     FORMAT(4H 5D ,  5E12.5/(6E12.5)) LENGTH OF LIST AS ABOVE       -
C                                                                     -
CD     STRPL(J,L)    PL WEIGHTED TRANSPORT CROSS SECTION             -
CD                     THE FIRST ELEMENT OF ARRAY STRPL IS THE        -
CD                     CURRENT (P1) WEIGHTED TRANSPORT CROSS SECTION  -
CD                     THE LEGENDRE EXPANSION COEFFICIENT FACTOR (2L+1)-
CD                     IS NOT INCLUDED IN STRPL(J,L).                 -
CD     STOTPL(J,L)   PL WEIGHTED TOTAL CROSS SECTION                 -
CD                     THE FIRST ELEMENT OF ARRAY STOTPL IS THE       -
CD                     FLUX (P0) WEIGHTED TOTAL CROSS SECTION         -
CD                     THE LEGENDRE EXPANSION COEFFICIENT FACTOR (2L+1)-
CD                     IS NOT INCLUDED IN STOTPL(J,L).                -
CD     SNGAM(J)      (N,GAMMA)                                       -
CD     SFIS(J)       (N,F)          (PRESENT IF IFIS.GT.0)           -
CD     SNUTOT(J)     TOTAL NEUTRON YIELD/FISSION  (PRESENT IF IFIS.GT.0)-
CD     CHISO(J)      ISOTOPE CHI  (PRESENT IF ICHI.EQ.1)             -
CD     SNALF(J)      (N,ALPHA)     (PRESENT IF IALF.GT.0)            -
CD     SNP(J)        (N,P)         (PRESENT IF INP.GT.0)             -
CD     SN2N(J)       (N,2N)        (PRESENT IF IN2N.GT.0)  ----SEE   -
CD                     NOTE BELOW----                                 -
CD     SND(J)        (N,D)         (PRESENT IF IND.GT.0)             -
CD     SNT(J)        (N,T)         (PRESENT IF INT.GT.0)             -
CD     STRPD(J,I)    COORDINATE DIRECTION I TRANSPORT CROSS SECTION   -
CD                                  (PRESENT IF ISTRPD.GT.0)         -
C                                                                     -
CN                    NOTE - THE PRINCIPAL N,2N CROSS SECTION SN2N(J) -
CN                     IS DEFINED AS THE N,2N REACTION CROSS SECTION, -
CN                     I.E., SUCH THAT MACROSCOPIC SN2N(J) TIMES THE  -
CN                     FLUX IN GROUP J GIVES THE RATE AT WHICH N,2N   -
CN                     REACTIONS OCCUR IN GROUP J.  THUS, FOR N,2N    -
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CN                    SCATTERING, SN2N(J) = 0.5*(SUM OF SCAT(J TO G)  -
CN                    SUMMED OVER ALL G).                             -
C                                                                     -
C---------------------------------------------------------------------

C---------------------------------------------------------------------
CR          ISOTOPE CHI DATA   (6D RECORD)                            -
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)=NUMBER OF WORDS                                 -
C                                                                     -
CB    FORMAT(4H 6D    5E12.5/(6E12.5)) CHIISO                         -
CB    FORMAT(12I6)                     ISOPEC                         -
C                                                                     -
CD    CHIISO(K,J)   FRACTION OF NEUTRONS EMITTED INTO 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   (7D RECORD)                        -
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,N) 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=MIN0(NGROUP,JUP),     -
CC       WHERE JUP=M*((NGROUP-1)/NSBLOK +1).                          -
C                                                                     -
CC    LORDN=LORD(N)                                                   -
CC    N IS THE INDEX FOR THE LOOP OVER NSCMAX (SEE FILE STRUCTURE)    -
C                                                                     -
CW    KMAX*LORDN=NUMBER OF WORDS                                      -
C                                                                     -
CB    FORMAT(4H 7D ,  5E12.5/(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,N) VALUES FOR SCATTERING INTO  -
CD                     GROUP J ARE STORED AT LOCATIONS K=SUM FROM 1   -
CD                     TO (J-1) OF JBAND(J,N) PLUS 1 TO K=1+JBAND(J,N).-
CD                     THE SUM IS ZERO WHEN J=1.  J-TO-J SCATTER IS   -
CD                     THE IJJ(J,N)-TH ENTRY IN THE RANGE JBAND(J,N).  -
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,N)-1 AND JDN=JBAND(J,N)-IJJ(J,N)-
C                                                                     -
C---------------------------------------------------------------------

CEOF
```

2. GRUPXS - Group-Ordered, Isotopic, Multigroup Neutron Cross Sections

The changes to GRUPXS-IV relative to GRUPXS-III are as follows:

(a) The set fission spectrum, CHI(J), is always present in the File DATA (2D) Record and the word count is thus independent of the control word ICHIST.

(b) The LTRN(I) and LTOT(I) vectors have been removed from the Isotope Control (4D) Record and the word count is thus reduced to NISO*(3*MULT+9)+2*NSCMAX+7.

(c) The number of P_L weighted transport and total cross sections is now required to be MAXORD+1 for each isotope on the Principal Cross Sections (5D) Record. The word count algorithm is thus changed.

(d) The Legendre expansion coefficient factor (2L+1) is not included in the P_L weighted transport and total cross sections on the 5D record.

(e) The definition of $\sigma_{n,2n}(g)$ and $\sigma_{n,2n}(g \to g')$ have been made consistent with those on the ISOTXS-IV file.

```
C*****************************************************************************
C                          REVISED 11/30/76                                    -
C                                                                              -
CF          GRUPXS-IV                                                          -
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 NISO  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=NUMBER OF WORDS                                                -
C                                                                              -
CD     HNAME          HOLLERITH FILE NAME - GRUPXS - (A6)                      -
CD     HUSE(I)        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     (1D RECORD)                                -
C                                                                       -
CL    NGROUP,NISO,MAXUP,MAXDN,MAXORD,ICHIST,NPSCS,NSTRPD,NCHIN,NICHI,   -
CL    NSCMAX,NSBLOK,NRG,NRH                                             -
C                                                                       -
CW    14 = NUMBER OF WORDS                                              -
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     (2D RECORD)                                   -
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    3*NGROUP+MULT*(NISO+12)+1=NUMBER OF WORDS                         -
C                                                                       -
CD    HSETID(I)      HOLLERITH IDENTIFICATION OF SET (A6)               -
CD    HISONM(I)      HOLLERITH ISOTOPE LABEL FOR ISOTOPE I (A6)         -
CD    CHI(J)         SET FISSION SPECTRUM                               -
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     (3D RECORD)                                -
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)=NUMBER OF WORDS                                 -
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   (4D RECORD)
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),IALF,INP,IN2N,IND,INT,IX,IY
C
CW    NISO*(3*MULT+9)+2*NSCMAX+7=NUMBER OF WORDS
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 IN
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,----SEE
CD                               NOTE BELOW----
CD                       WHERE NN IS EXPANSION ORDER OF BLOCK N DATA,
CD                       DATA ORDERED BY INCREASING EXPANSION 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    IALF           (N,ALPHA) CROSS SECTION FLAG
CD                       IALF=1, (N,ALPHA) DATA IN THE FILE
CD                       IALF=0, NO (N,ALPHA) DATA IN THE FILE
CD    INP            (N,P) CROSS SECTION FLAG
CD                       SAME OPTIONS AS FOR IALF
CD    IN2N           (N,2N) CROSS SECTION FLAG
CD                       SAME OPTIONS AS FOR IALF
CD    IND            (N,D) CROSS SECTION FLAG
CD                       SAME OPTIONS AS FOR IALF
CD    INT            (N,T) CROSS SECTION FLAG
CD                       SAME OPTIONS AS FOR IALF
CD    IX             RESERVED
CD    IY             RESERVED
C
```

```
CN                  NOTE- FOR N,2N SCATTER, THE MATRIX CONTAINS TERMS,
CN                     SS(G TO J), WHICH ARE EMISSION (PRODUCTION)-
CN                     BASED, I.E., ARE DEFINED SUCH THAT MACROSCOPIC
CN                     SS(G TO J) TIMES THE FLUX IN GROUP G GIVES THE
CN                     RATE OF EMISSION (PRODUCTION) OF NEUTRONS IN
CN                     GROUP J.
C
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR          PRINCIPAL CROSS SECTIONS   (5D RECORD)
C
CL    ((STRPL(I,L),I=1,NISO),L=1,MAXT),
CL    ((STOTPL(I,L),I=1,NISO),L=1,MAXT),(SNGAM(I),I=1,NISO),
CL    (SFIS(I),I=1,NISO),(SNUTOT(I),I=1,NISO),
CL    (CHISO(I),I=1,NISO),(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=NISO*(2*MAXT+4+IALF+INP+IN2N+IND+INT+NSTRPD)=NUMBER
CW    OF WORDS
C
CD    STRPL(I,L)     PL WEIGHTED TRANSPORT CROSS SECTIONS
CD                      THE LEGENDRE EXPANSION COEFFICIENT FACTOR (2L+1)-
CD                      IS NOT INCLUDED IN STRPL(I,L).
CD    STOTPL(I,L)    PL WEIGHTED TOTAL CROSS SECTIONS
CD                      THE LEGENDRE EXPANSION COEFFICIENT FACTOR (2L+1)-
CD                      IS NOT INCLUDED IN STOTPL(I,L).
CD    SNGAM(I)       (N,GAMMA) CROSS SECTION
CD    SFIS(I)        (N,FISSION) CROSS SECTION
CD    SNUTOT(I)      TOTAL NEUTRON YIELD/FISSION
CD    CHISO(I)       ISOTOPE CHI VECTOR
CD    SNALF(I)       (N,ALPHA)          (PRESENT IF IALF,GT,0)
CD    SNP(I)         (N,P)              (PRESENT IF INP,GT,0)
CD    SN2N(I)        (N,2N)             (PRESENT IF IN2N,GT,0) ----SEE
CD                      NOTE BELOW----
CD    SND(I)         (N,D)              (PRESENT IF IND,GT,0)
CD    SNT(I)         (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    MAXT           MAXORD+1
C
CN                  NOTE - THE PRINCIPAL N,2N CROSS SECTION SN2N FOR
CN                     A GIVEN GROUP IS THE N,2N REACTION CROSS SECTION-
CN                     FOR THAT GROUP, I.E., SUCH THAT MACROSCOPIC
CN                     SN2N FOR A GIVEN GROUP TIMES THE GROUP FLUX
CN                     GIVES THE RATE AT WHICH N,2N REACTIONS OCCUR
CN                     IN THAT GROUP.
C
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR          ISOTOPE CHI DATA   (6D RECORD)
C
CC          PRESENT IF NCHIN,GT,0 AND ICHI(I),GT,1
C
CL    ((CHIST(K,J),K=1,ICHII,J=1,NGROUP),(ISOPEC(I),I=1,NGROUP)
C
CW    NGROUP*(ICHII + 1)=NUMBER OF WORDS
C
CD    ICHII          =ICHI(I)
CD    CHIST(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   (7D RECORD)                           -
C                                                                        -
CL    ((JBAND(I,N),I=1,NISO),N=1,NSCMAX)                                 -
CL    ((IJJ(I,N),I=1,NISO), N=1,NSCMAX)                                  -
C                                                                        -
CW    2*NISO*NSCMAX=NUMBER OF WORDS                                      -
C                                                                        -
CD    JBAND(I,N)     NUMBER OF GROUPS THAT SCATTER INTO THE GROUP,       -
CD                       INCLUDING SELF SCATTER, FOR ISOTOPE I, BLOCK N -
CD                       IF JBAND=0, NO SCATTER DATA IS PRESENT IN THAT -
CD                       BLOCK.                                         -
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-
CD                       IF JBAND(I,N).NE.0 THEN IJJ(I,N) MUST SATISFY  -
CD                       THE RELATION 1.LE.IJJ.LE.JBAND.                -
C                                                                        -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          SCATTERING SUB-BLOCK   (8D RECORD)                           -
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-ISOTOPE RANGE OF THIS   -
CC       SUB-BLOCK. IF M IS THE INDEX OF THE SUB-BLOCK, THE I-ISOTOPE    -
CC       RANGE CONTAINED WITHIN THIS SUB-BLOCK IS                        -
CC       IL=(M-1)*((NISO-1)/NSBLOK + 1)+1 TO IU=MIN0(NISO,IUP),          -
CC       WHERE IUP=M*((NISO-1)/NSBLOK + 1),                              -
C                                                                        -
CC    LORDN = LORD(N)                                                    -
CC    N IS THE INDEX FOR THE LOOP OVER NSCMAX (SEE FILE STRUCTURE)       -
C                                                                        -
CW    KMAX*LORDN=NUMBER OF WORDS                                         -
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. BRKOXS - Bondarenko (Russian Format) Self-shielding Data

BRKOXS-IV represents an extension-of-capability relative to BRKOXS-III. Two new words have been added to the File Control (1D) Record:

(a) NREACT - the number of reaction-types for which self-shielding factors are given. (In Version III, 5, and only 5, reaction-types were required).

(b) IBLK - a block-option flag for self-shielding factors to permit (IBLK=1) blocking the self-shielding factors by reaction-type.

Note that Version III is now a subset of Version IV, i.e., a Version III file is the same as a Version IV with NREACT=5, IBLK=0.

The blocking capability can alter the structure of the Self-Shielding Factors (3D) Record as indicated. Please note that the use of the four-dimensional array FFACT (N,K,J,M) is not intended to imply the actual programming of such arrays, but instead, is used to illustrate the file structure.

```
C*****************************************************************************
C                          REVISED 11/30/76
C
CF          BRKOXS-IV
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   *
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=NUMBER OF WORDS
C
CB     FORMAT(11H 0V BRKOXS ,1H*,2A6,1H*,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      (1D RECORD)                              -
C                                                                      -
CL    NGROUP,NISOSH,NSIGPT,NTEMPT,NREACT,IBLK                          -
C                                                                      -
CW    6 = NUMBER OF WORDS                                              -
C                                                                      -
CB    FORMAT(4H 1D ,6I6)                                               -
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)        -
CD    NREACT         NUMBER OF REACTION-TYPES FOR WHICH SELF-SHIELDING -
CD                      FACTORS ARE GIVEN (IN PREVIOUS VERSIONS OF THIS -
CD                      FILE NREACT HAS BEEN IMPLICITLY SET TO 5).     -
CD    IBLK           BLOCKING OPTION FLAG FOR SELF-SHIELDING FACTORS.  -
CD                      IBLK=0, FACTORS NOT BLOCKED BY REACTION-TYPE,  -
CD                      IBLK=1, FACTORS ARE BLOCKED BY REACTION-TYPE,  -
C                                                                      -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          FILE DATA         (2D RECORD)                              -
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=NUMBER OF WORDS           -
C                                                                      -
CB    FORMAT(4H 2D ,9(1X,A6)/          HISONM                        -
CB   1(10(1X,A6)))                                                     -
CB    FORMAT(  6E12.5)                 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(K)           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(K)          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(I)        LOWEST NUMBERED OR HIGHEST ENERGY GROUP FOR WHICH -
CD                      SELF-SHIELDING FACTORS ARE GIVEN               -
CD    JBFH(I)        HIGHEST NUMBERED OR LOWEST ENERGY GROUP FOR WHICH -
 CD                      SELF-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    (3D RECORD)                        -
C                                                                        -
CL    ((((FFACT(N,K,J,M),N=1,NBINT),K=1,NBTEM),J=JBFLI,JBFHI),M=ML,MU)   -
CL                    ------ SEE DESCRIPTION BELOW ------                -
C                                                                        -
CC    NBINT=NTABP(I)                                                     -
CC    NBTEM=NTABT(I)                                                     -
CC    JBFLI=JBFL(I)                                                      -
CC    JBFHI=JBFH(I)                                                      -
CC    FOR ML, MU SEE STRUCTURE BELOW                                     -
C                                                                        -
CW    NBINT*NBTEM*(JBFHI-JBFLI+1)*(MU-ML+1) = NUMBER OF WORDS            -
C                                                                        -
CB    FORMAT(4H 3D ,  5E12.5/(6E12.5))                                   -
C                                                                        -
CC    DO 1 L=1,NBLOK                                                     -
CC  1 READ(N) *LIST AS ABOVE*                                            -
C                                                                        -
CC          IF IBLK=0, NBLOK=1, ML=1, MU=NREACT                          -
CC          IF IBLK=1, NBLOK=NREACT, ML=MU=L, WHERE L IS THE BLOCK       -
CC              INDEX.                                                   -
C                                                                        -
CD    FFACT(N,K,J,M)     SELF-SHIELDING FACTOR EVALUATED AT X(N) AND     -
CD                           TB(K) FOR ENERGY GROUP J. THE M INDEX IS    -
CD                           A DUMMY INDEX TO DENOTE THE REACTION-TYPE.  -
CD                           THE FIRST FIVE REACTION-TYPES ARE, IN       -
CD                           ORDER, TOTAL, CAPTURE, FISSION, TRANSPORT,  -
CD                           AND ELASTIC.                                -
C                                                                        -
CN          NOTE THAT IF IBLK=1, EACH REACTION-TYPE WILL CONSTITUTE      -
CN             A SEPARATE DATA BLOCK.                                    -
C                                                                        -
C-----------------------------------------------------------------------

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

CEOF
```

4. DLAYXS - Delayed Neutron Processor Data

DLAYXS-IV is unchanged from DLAYXS-III.

```
C*************************************************************************
C                        REVISED 11/30/76                                -
CF          DLAYXS-IV                                                    -
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=NUMBER OF WORDS                                           -
C                                                                        -
CB    FORMAT(11H 0V DLAYXS  ,1H*,2A6,1H*,I6)                             -
C                                                                        -
CD    HNAME          HOLLERITH FILE NAME - DLAYXS -                      -
CD    HUSE(I)        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     (1D RECORD)                                 -
C                                                                        -
CL    NGROUP,NISOD,NFAM,IDUM                                             -
C                                                                        -
CW    4=NUMBER OF WORDS                                                  -
C                                                                        -
CB    FORMAT(4H 1D ,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                          (2D RECORD)                                  -
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)=NUMBER OF WORDS                -
C                                                                       -
CB    FORMAT(4H 2D ,9(1X,A6)/          HABSID                         -
CB   1(10(1X,A6)))                                                     -
CB    FORMAT(  6E12.5)                 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   (3D RECORD)          -
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=NUMBER OF WORDS                                 -
C                                                                       -
CB    FORMAT(4H 3D ,  5E12.5/(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-----------------------------------------------------------------------

CEOF
```

5. ISOGXS - Nuclide (isotope)-Ordered, Multigroup Gamma Cross Sections

ISOGXS-IV is unchanged from ISOGXS-III except for clarification of the size of the last block of neutron production cross-section data (6D record), gamma production cross sections (8D record), and gamma scattering cross sections (10D record).

```
C***********************************************************************
C                        REVISED 11/30/76                               *
C                                                                       *
CF          ISOGXS-IV                                                   *
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,Ø       -
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,Ø       -
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,Ø       -
CS    **************                                                  -
C                                                                      -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR          FILE IDENTIFICATION                                        -
C                                                                      -
CL    HNAME,(HUSE(I),I=1,2),IVERS                                      -
C                                                                      -
CW    1+3*MULT=NUMBER OF WORDS                                         -
C                                                                      -
CB    FORMAT(11H ØV ISOGXS ,1H*,2A6,1H*,I6)                            -
C                                                                      -
CD    HNAME          HOLLERITH FILE NAME -ISOGXS - (A6)                -
CD    HUSE(I)        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     (1D RECORD)                               -
C                                                                      -
CL    NGROUP,NGGRUP,NGIS,IDUM                                          -
C                                                                      -
CW    4=NUMBER OF WORDS                                                -
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        (2D RECORD)                               -
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=NUMBER OF WORDS                 -
C                                                                      -
```

```
CB     FORMAT(5H 2D *,11A6,1H*/          HSETID,HGISON                    -
CB    1(10(1X,A6)))                                                        -
CB     FORMAT(  6E12.5)                  VEL,EMAX,EMIN,EMAXG,EMING        -
C                                                                          -
CD     HSETID(I)      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        (3D RECORD)                                  -
C                                                                          -
CL     HABSID,LGTOT,LGTRN,IGN,ING,IGG                                      -
C                                                                          -
CW     MULT+5=NUMBER OF WORDS                                              -
C                                                                          -
CB     FORMAT(4H 3D ,A6,5I6)                                               -
C                                                                          -
CD     HABSID         HOLLERITH ABSOLUTE ISOTOPE LABEL - SAME FOR ALL      -
CD                       VERSIONS OF SAME ISOTOPE IN SET                   -
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   (4D RECORD)                       -
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=NUMBER OF WORDS                              -
C                                                                          -
CB     FORMAT(4H 4D ,  5E12.5/(6E12.5))                                    -
C                                                                          -
CD     GTRPL(K,L)     PL WEIGHTED TRANSPORT CROSS SECTION                  -
CD     GTOTPL(K,L)    PL WEIGHTED TOTAL CROSS SECTION                      -
CD     GABS(K)        TOTAL ABSORPTION CROSS SECTION                       -
CD     GEDEP(K)       ENERGY DEPOSITION-CROSS SECTION X ENERGY (EV)        -
CD                      DEPOSITED                                          -
CD     GDGR(K)        SOURCE FROM TOTAL DECAY (PHOTONS/DIS)                -
C                                                                          -
C-------------------------------------------------------------------------

C-------------------------------------------------------------------------
CR           NEUTRON PRODUCTION CONTROL   (5D RECORD)                     -
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)=NUMBER OF WORDS                                        -
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    (6D RECORD)
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)+1
CC    TO JU=MIN0(NGROUP,JUP) WHERE JUP=M*((NGROUP-1)/NBLKGN +1).
C
CW    LGNMAX=NUMBER OF WORDS
C
CB    FORMAT(4H 6D ,  5E12.5/(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    (7D RECORD)
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)=NUMBER OF WORDS
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    (8D RECORD)
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=NUMBER OF WORDS
C
CB    FORMAT(4H 8D ,  5E12.5/(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   (9D RECORD)                      -
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)=NUMBER OF WORDS                                      -
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    (10D RECORD)              -
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=NUMBER OF WORDS                                            -
C                                                                        -
CB     FORMAT(5H 10D ,  5E12.5/(6E12.5))                                 -
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
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C. Reactor Specification Files

There are four standard interface files which can be categorized as reactor specification files: GEODST, NDXSRF, ZNATDN, and SEARCH. The Version IV specifications for each of these files follows:

1. GEODST - Geometry Description

This file contains a geometric description of the region of solution for a problem. The differences between GEODST-III and GEODST-IV fall into two categories: changes in the text intended to tighten definitions, and additions intended to extend the capabilities of the file. The figures showing examples of triangular geometries have been redrawn and should now contribute more to the understanding of the text of the file definition. The substantive differences between GEODST-III and GEODST-IV are discussed below.

In the FILE SPECIFICATION (1D) record the first of the reserved integers, NGOP, has been replaced by a new sentinel, NTHPT. NTHPT is used for triangular mesh geometries within rectangular boundaries (IGOM=9 or 17, NTRIAG=2) to specify the orientation of the (1,1) mesh triangle. The length of the FILE SPECIFICATION record remains 27 words. In the same record the sentinels NBS (number of buckling specifications), NBCS (number of constants for external boundaries) and NIBCS (number of constants for internal boundaries) are now permitted to take on the value of zero. This option has an impact on the GEOMETRY DATA (5D) record; if NBS=0, the array BSQ (buckling values) is not present, if NBCS=0, the array BNDC (boundary constants) is not present, and if NIBCS=0, the array BNCI (internal black boundary constants) is not present. Finally, a new triangular geometry type, NTRIAG=5, has been added to define a rhombic region of solution in which the coordinate axes form an angle of 30° at the origin.

The specification of the coarse and fine mesh for uniform triangular and hexagonal geometries was not clear in GEODST-III. The mesh spacing in these geometries is characterized by a single number (e.g., the length of a side of a mesh triangle or the flat-to-flat distance across a mesh hexagon), and a very specific algorithm for extracting that characteristic distance from the data in the two-dimensional and three-dimensional records has been added. The specification of IFINTS, the number of fine-mesh intervals per coarse mesh interval in the first dimension, is clarified if the word "interval" is replaced with "triangle" for uniform triangular geometries.

Figures 3-11 are now an essential part of the file definition for uniform triangular and hexagonal geometries. Experience has shown that words alone cannot possibly make the definitions clear. Several of the geometry types are shown in two orientations; some users prefer to visualize the origin of a two-dimensional mesh at the lower left corner, and some place it at the upper left.

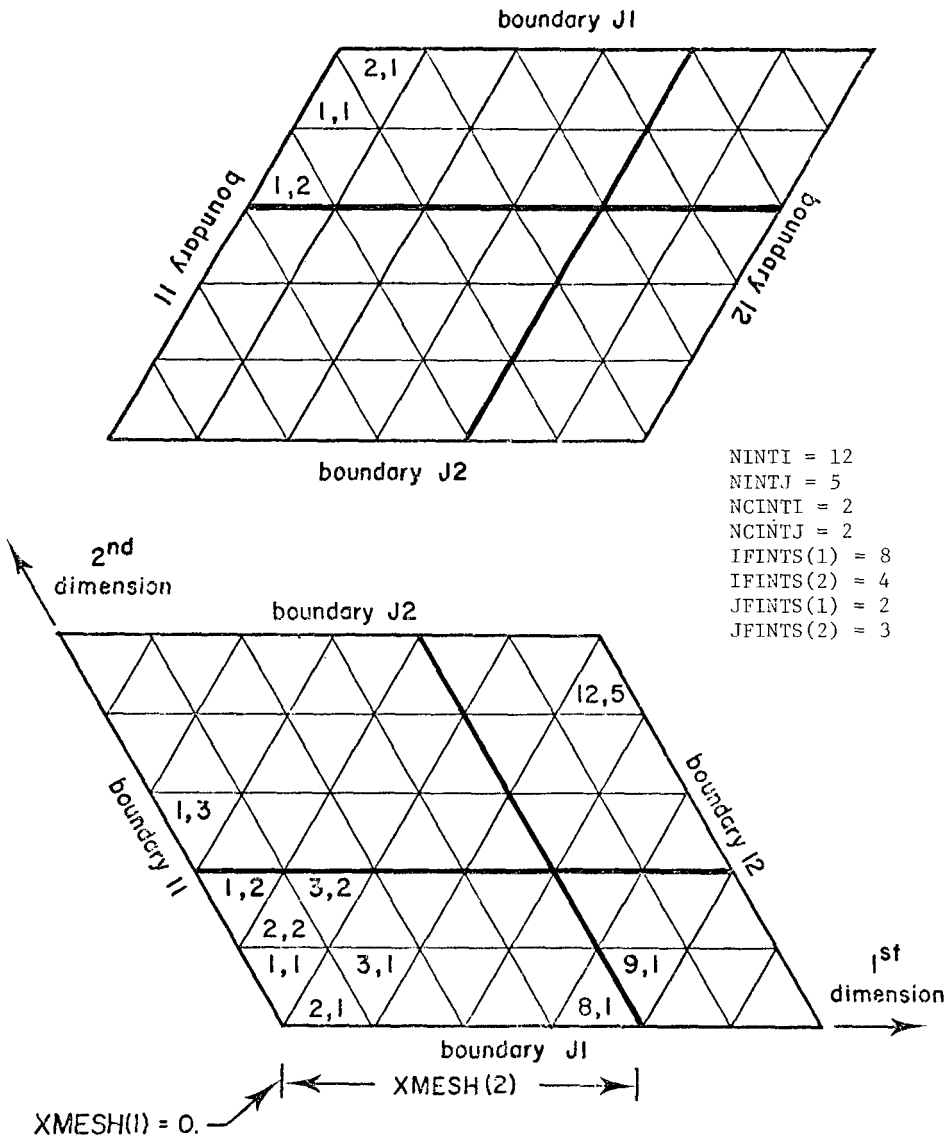

Fig. 3. Example of uniform triangular mesh geometry (IGM=9 or 17), rhombic region of solution with axes at 120° (NTRIAG=0). The mesh is shown in two possible orientations, one with the origin at the upper left corner and one with the origin at the lower left corner.

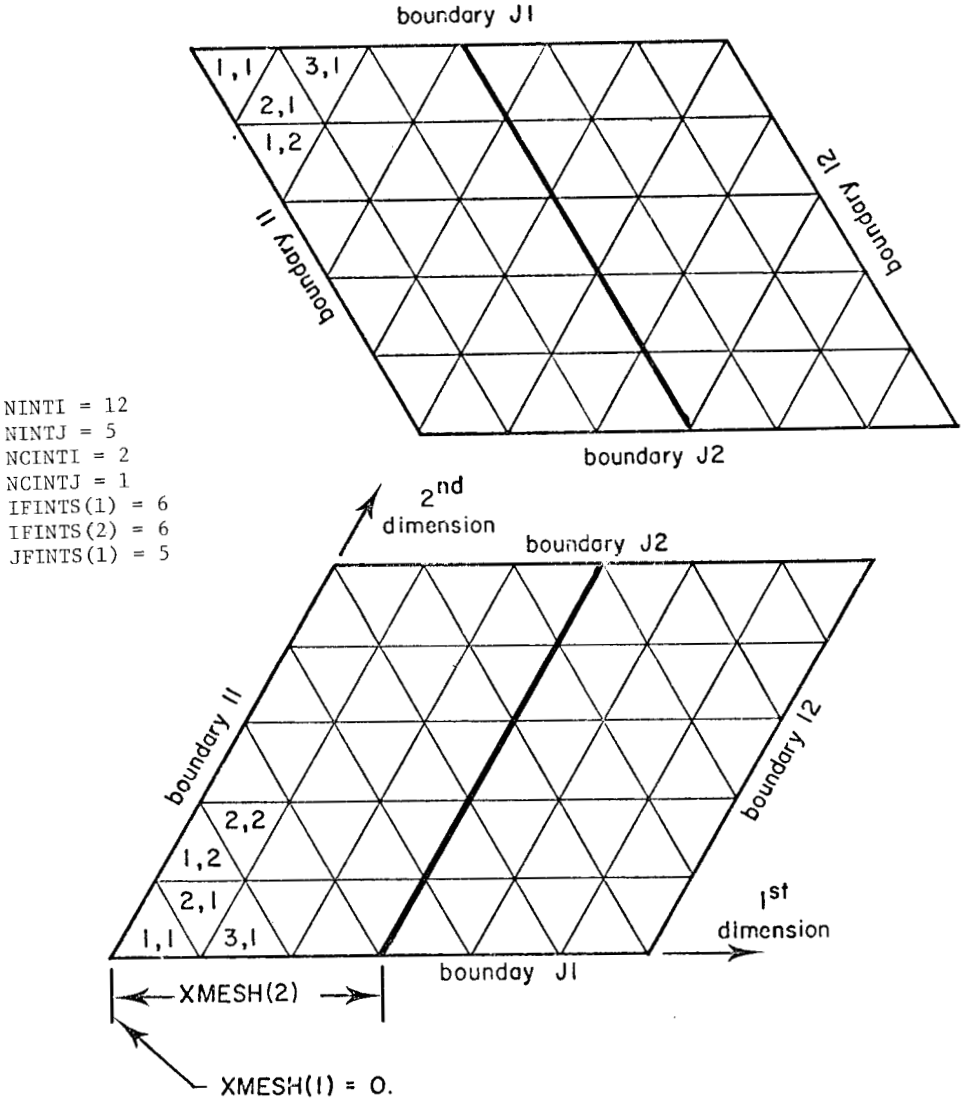

Fig. 4. Example of uniform triangular mesh geometry (IGOM=9 or 17), rhombic region of solution with axes at 60° (NTRIAG=1). The mesh is shown in two possible orientations, one with the origin at the upper left corner and one with the origin at the lower left corner.

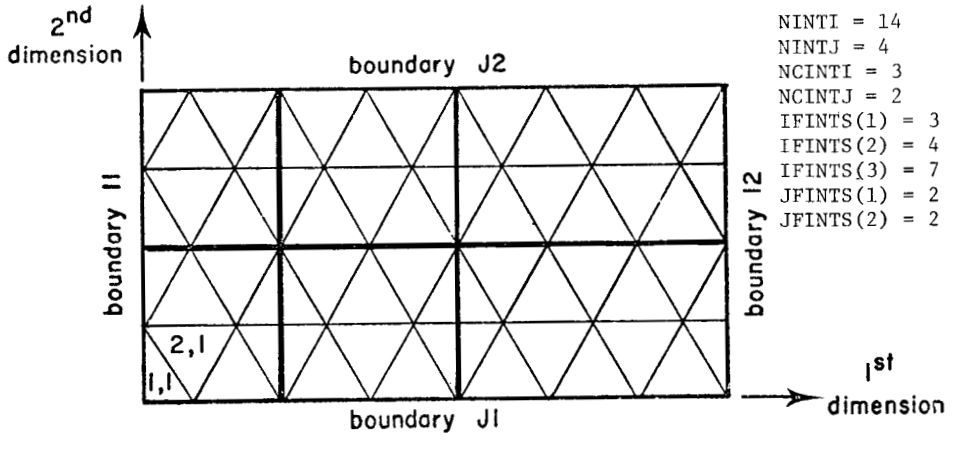

Fig. 5. Example of uniform triangular mesh geometry (IGOM=9 or 17), rectangular region of solution (NTRIAG=2), mesh triangle (1,1) points away from the first dimension axis (NTHPT=1). The mesh is shown in only one of its possible orientations. Note that the first dimension coarse-mesh boundaries split mesh triangles, and the mesh triangle split by the first boundary of a coarse-mesh interval is counted in that interval.

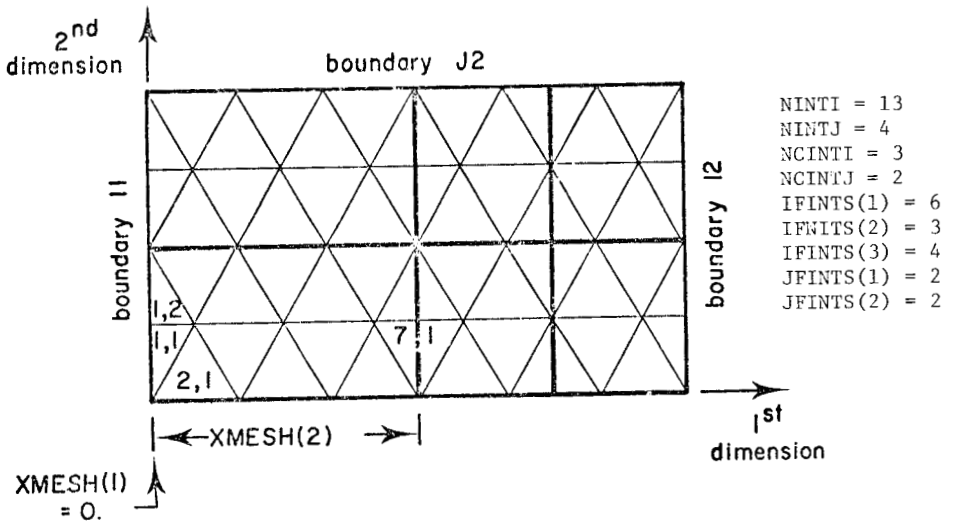

Fig. 6. Example of uniform triangular mesh geometry (IGOM=9 or 17), rectangular region of solution (NTRIAG=2), mesh triangle (1,1) points toward the first dimension axis (NTHPT=2). The mesh is shown in only one of its possible orientations. Note that first dimension coarse-mesh boundaries split mesh triangles, and the mesh triangle split by the first boundary of a coarse-mesh interval is counted in that interval.

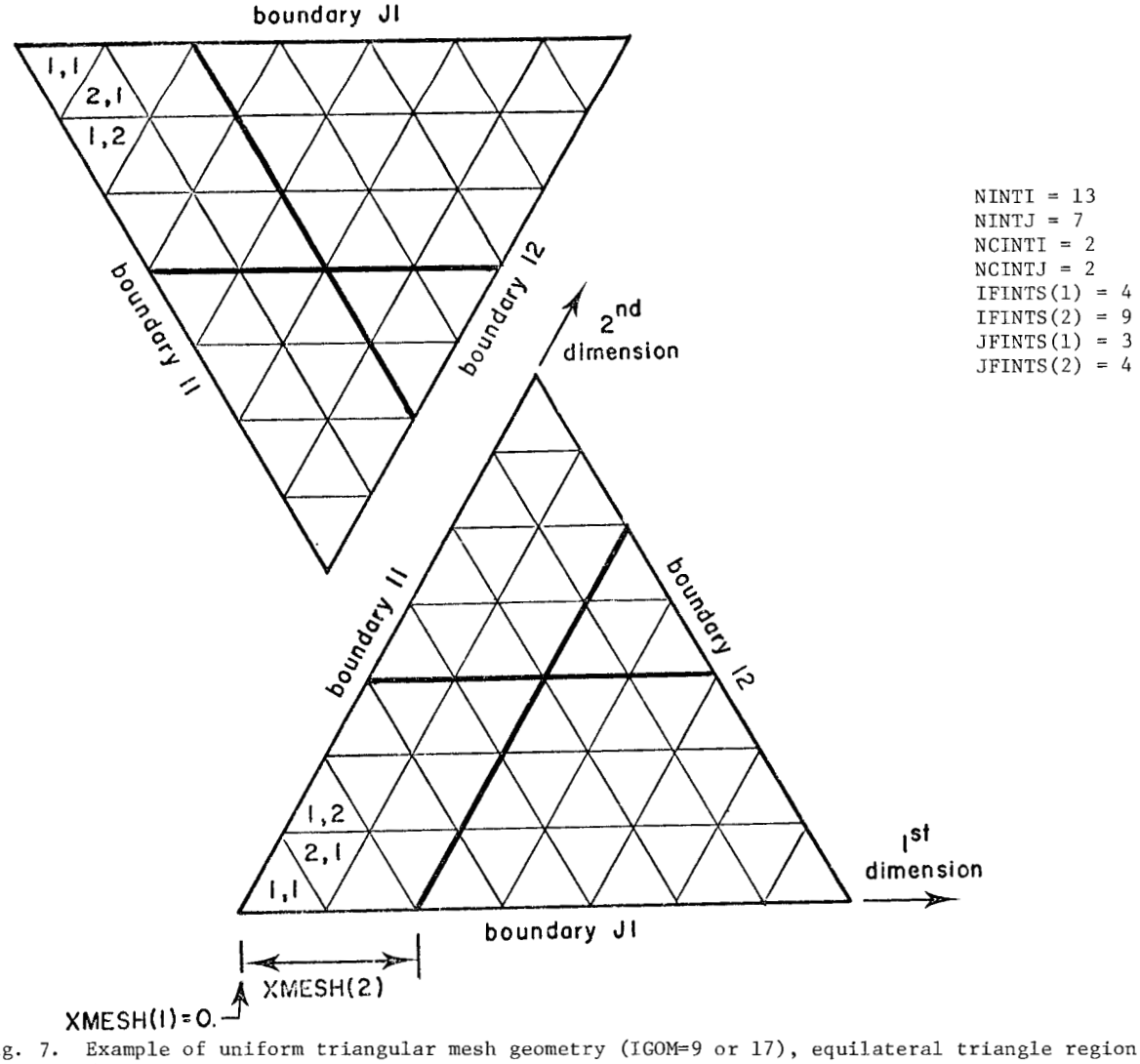

Fig. 7. Example of uniform triangular mesh geometry (IGOM=9 or 17), equilateral triangle region of solution (NTRIAG=3). The mesh is shown in two possible orientations.

NINTI = 17
NINTJ = 5
NCINTI = 2
NCINTJ = 2
IFINTS(1) = 12
IFINTS(2) = 5
JFINTS(1) = 2
JFINTS(2) = 3

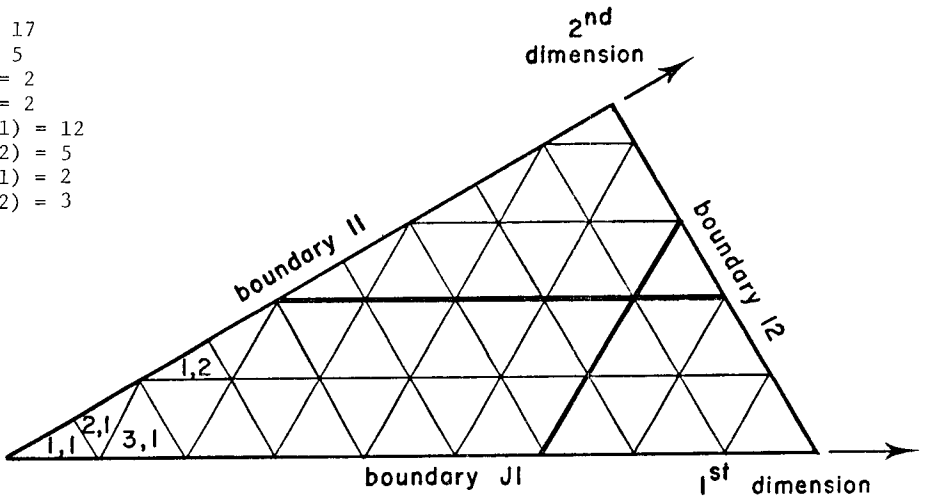

Fig. 8. Example of uniform triangular mesh geometry (IGOM=9 or 17), 30°-60° triangle region of solution (NTRIAG=4). The mesh is shown in only one of its possible orientations. Note that the first dimension coarse-mesh boundary lines are not parallel to boundary I1.

NINTI = 14
NINTJ = 3
NCINTI = 3
NCINTJ = 1
IFINTS(1) = 8
IFINTS(2) = 2
IFINTS(3) = 4
JFINTS(1) = 3

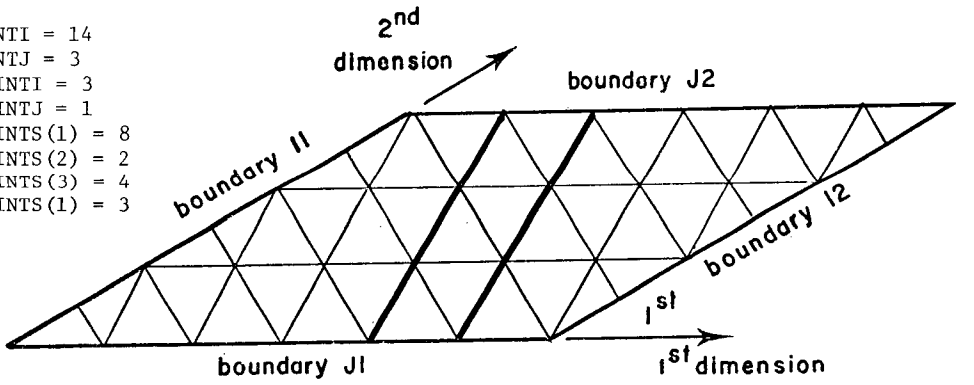

Fig. 9. Example of uniform triangular mesh geometry (IGOM=9 or 17), rhombic region of solution with axes at 30° (NTRIAG=5). The mesh is shown in only one of its possible orientations. Note that the first dimension coare-mesh boundary lines are not parallel to boundary I1. The number of first dimension, fine-mesh triangles (NINTI) must be even in order to avoid four-sided mesh cells along boundary J2.

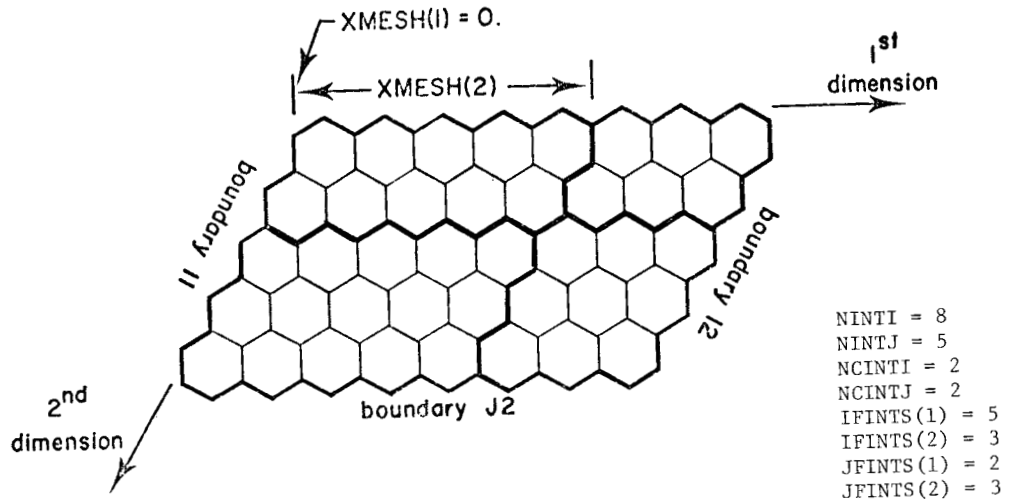

Fig. 10. Example of hexagonal mesh geometry (IGOM=10 or 18), rhombic region of solution with axes at 120° (NTRIAG=0). The mesh is shown in only one of its possible orientations.

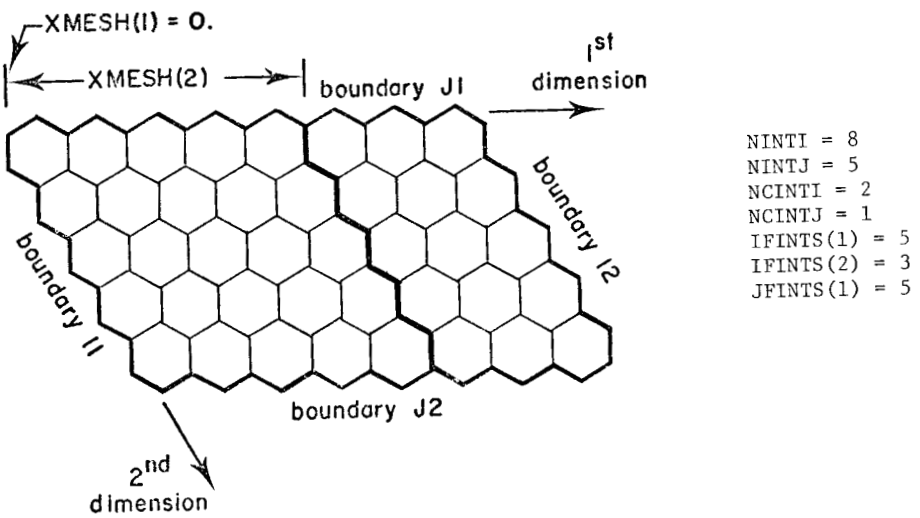

Fig. 11. Example of hexagonal mesh geometry (IGOM=10 or 18), rhombic region of solution with axes at 60° (NTRIAG=1). The mesh is shown in only one of its possible orientations.

```
C*******************************************************************************
C                          REVISED 11/30/76                                     -
C                                                                               -
CF          GEODST - IV                                                         -
C                                                                               -
CE          GEOMETRY DESCRIPTION                                                -
C                                                                               -
C*******************************************************************************


C-------------------------------------------------------------------------------
CR          FILE IDENTIFICATION (0V RECORD)                                     -
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 (1D RECORD)                                     -
C                                                                               -
CL     IGOM,NZONE,NREG,NZCL,NCINTI,NCINTJ,NCINTK,NINTI,NINTJ,NINTK,IMB1,-
CL     1MB2,JMB1,JMB2,KMB1,KMB2,NBS,NBCS,NIBCS,NZWBB,NTRIAG,NRASS,NTHPT,-
CL     (NGUP(I),I=1,4)                                                          -
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- UNIFORM TRIANGULAR                     -
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- UNIFORM TRIANGULAR-Z                  -
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 DIMENSIONAL         -
CD                           CASE.                                              -
CD     NCINTK             NUMBER OF THIRD DIMENSION COARSE MESH INTERVALS-
CD                           NCINTK.EQ.1 FOR ONE AND TWO DIMENSIONAL            -
CD                           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 DIMENSION CASES,-
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```
CD     IMB1                FIRST BOUNDARY ON FIRST DIMENSION                -
CD                             0 - ZERO FLUX (DIFFUSION)                    -
CD                             1 - REFLECTED                                -
CD                             2 - EXTRAPOLATED (DIFFUSION - DEL PHI/PHI    -
CD                                 = -C/D WHERE C IS GIVEN AS BNDC BELOW    -
CD                                 AND D IS THE GROUP DIFFUSION CONSTANT,   -
CD                                 TRANSPORT - NO RETURN).                  -
CD                             3 - REPEATING (PERIODIC) WITH OPPOSITE FACE- -
CD                             4 - REPEATING (PERIODIC) WITH NEXT ADJACENT- -
CD                                 FACE.                                    -
CD                             5 - INVERTED REPEATING ALONG THIS FACE.      -
CD                                 (180 DEGREE ROTATION)                    -
CD                             6 - ISOTROPIC RETURN (TRANSPORT)             -
C                                                                           -
CC          NOTE FOR REPEATING CONDITIONS (3,4,5) - LET I1 DENOTE FIRST-
CC          BOUNDARY ON FIRST DIMENSION, I2 THE SECOND BOUNDARY ON THE -
CC          FIRST DIMENSION, J1 THE FIRST BOUNDARY ON THE SECOND       -
CC          DIMENSION, ETC. THEN THESE REPEATING BOUNDARY CONDITIONS    -
CC          ONLY APPLY TO BOUNDARIES I1,I2,J1, AND J2. GOING IN ORDER  -
CC          OF I1,J1,I2,J2, THE FIRST BOUNDARY WHICH IS INVOLVED       -
CC          CARRIES THE DESIGNATOR DEFINING THE REPEATING CONDITION.   -
C                                                                           -
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                             0 - NONE                                     -
CD                             1 - SINGLE VALUE APPLIES EVERYWHERE          -
CD                             .EQ.NZONE- ZONE DEPENDENT                    -
CD                             M*NZONE - DATA IS GIVEN OVER ALL ZONES FOR   -
CD                                 THE FIRST ENERGY GROUP, THEN FOR THE     -
CD                                 NEXT GROUP, TO END OF LIST. IF           -
CD                                 M.LT.NGROUP THEN THE M-TH GROUP DATA     -
CD                                 APPLIES TO ALL ADDITIONAL GROUPS.        -
CD                                 (2.LE.M.LE.NGROUP)                       -
CD     NBCS                NUMBER OF CONSTANTS FOR EXTERNAL BOUNDARIES      -
CD                             0 - NONE                                     -
CD                             1 - SINGLE VALUE USED EVERYWHERE             -
CD                             6 - INDIVIDUAL VALUE GIVEN FOR EACH          -
CD                                 EXTERNAL BOUNDARY. THE ORDERING OF THE   -
CD                                 VALUES IS THE SAME AS THE ORDERING OF    -
CD                                 THE BOUNDARY CONDITIONS.                 -
CD                             6*M - SIX VALUES GIVEN FOR FIRST ENERGY      -
CD                                 GROUP (ORDERED AS DESCRIBED ABOVE),      -
CD                                 THEN 6 FOR THE NEXT GROUP, TO END OF     -
CD                                 LIST. (2.LE.M.LE.NGROUP).                -
CD                                 IF M.LT.NGROUP THEN THE M-TH GROUP DATA- -
CD                                 APPLIES TO ALL REMAINING GROUPS.         -
CD     NIBCS               NUMBER OF CONSTANTS FOR INTERNAL BOUNDARIES      -
CD                             0 - NONE                                     -
CD                             1 - SINGLE VALUE 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              TRIANGULAR/HEXAGONAL GEOMETRY OPTION             -
CD                             0 - REGION OF SOLUTION IS A RHOMBUS IN       -
CD                                 WHICH THE 1ST AND 2ND DIMENSION AXES     -
CD                                 INTERSECT AT AN ANGLE OF 120 DEGREES,    -
CD                             1 - REGION OF SOLUTION IS A RHOMBUS IN       -
CD                                 WHICH THE 1ST AND 2ND DIMENSION AXES     -
CD                                 INTERSECT AT AN ANGLE OF 60 DEGREES,     -
CD                             2 - REGION OF SOLUTION IS A RECTANGLE. THE-  -
CD                                 BOUNDARIES I1 AND I2 BISECT MESH         -
CD                                 TRIANGLES. SEE NTHPT BELOW.              -
CD                                 (IGOM=9,17 ONLY)                         -
CD                             3 - REGION OF SOLUTION IS AN EQUILATERAL,    -
CD                                 60 DEGREE TRIANGLE. (IGOM=9,17 ONLY)     -
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CD                          4 - REGION OF SOLUTION IS A 30-60 DEGREE   -
CD                              RIGHT TRIANGLE IN WHICH THE 1ST AND 2ND-
CD                              DIMENSION AXES INTERSECT AT THE 30     -
CD                              DEGREE ANGLE.  (IGOM=9,17 ONLY)        -
CD                          5 - REGION OF SOLUTION IS A RHOMBUS IN     -
CD                              WHICH THE 1ST AND 2ND DIMENSION AXES   -
CD                              INTERSECT AT AN ANGLE OF 30 DEGREES.   -
CD                              (IGOM=9,17 ONLY)                       -
CD    NRASS               REGION ASSIGNMENTS                          -
CD                            0- TO COARSE MESH                       -
CD                            1- TO FINE MESH                         -
CD    NTHPT               ORIENTATION OF FIRST FINE MESH INTERVAL IN  -
CD                            TRIANGULAR GEOMETRIES.  NTRIAG=2 ONLY,  -
CD                            1- TRIANGLE(1,1) POINTS AWAY FROM FIRST -
CD                               DIMENSION AXIS, I.E., NO INTERNAL MESH -
CD                               LINE INTERSECTS THE ORIGIN.           -
CD                            2- TRIANGLE(1,1) POINTS TOWARD THE FIRST -
CD                               DIMENSION AXIS, I.E., AN INTERNAL MESH -
CD                               LINE INTERSECTS THE ORIGIN.           -
CD    NGOP                RESERVED                                    -
C                                                                     -
C---------------------------------------------------------------------

C---------------------------------------------------------------------
CR          ONE DIMENSIONAL COARSE MESH INTERVAL BOUNDARIES AND FINE   -
CR          MESH INTERVALS (2D RECORD)                                 -
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 EQUALLY SPACED FINE MESH INTERVALS -
CD                            PER COARSE MESH 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 (3D RECORD)                                 -
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 EQUALLY SPACED FINE MESH INTERVALS -
CD                            PER COARSE MESH INTERVAL, SECOND DIMENSION,-
CD    NCBNDJ              NCINTJ+1, NUMBER OF SECOND DIMENSION COARSE -
CD                            MESH BOUNDARIES                          -
C                                                                      -
CC          FOR UNIFORM-TRIANGULAR-MESH GEOMETRY (IGOM = 9) THE        -
CC          LENGTH (L) OF THE SIDE OF A MESH TRIANGLE MUST BE GIVEN    -
CC          BY THE EXPRESSION                                          -
CC                          L = 2.*(XMESH(2)-XMESH(1))/IFINTS(1) ,     -
CC          FOR UNIFORM-HEXAGONAL-MESH GEOMETRY (IGOM = 10) THE        -
CC          FLAT-TO-FLAT DISTANCE (FTF) ACROSS A MESH HEXAGON MUST     -
CC          BE GIVEN BY THE EXPRESSION                                 -
CC                          FTF = (XMESH(2)-XMESH(1))/IFINTS(1)        -
C                                                                      -
C---------------------------------------------------------------------
```

```
C-----------------------------------------------------------------------
CR          THREE DIMENSIONAL COARSE MESH INTERVAL BOUNDARIES AND FINE -
CR          MESH INTERVALS (4D RECORD)                                 -
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 EQUALLY SPACED FINE MESH INTERVALS  -
CD                           PER COARSE MESH INTERVAL, THIRD DIMENSION. -
CD    NCBNDK             NCINTK+1, NUMBER OF THIRD DIMENSION COARSE MESH-
CD                           BOUNDARIES                                -
C                                                                      -
CC          FOR UNIFORM-TRIANGULAR-MESH GEOMETRY (IGOM = 17) THE       -
CC          LENGTH (L) OF THE SIDE OF A MESH TRIANGLE MUST BE GIVEN    -
CC          BY THE EXPRESSION                                          -
CC                        L = 2.*(XMESH(2)-XMESH(1))/IFINTS(1) .       -
CC          FOR UNIFORM-HEXAGONAL-MESH GEOMETRY (IGOM = 18) THE        -
CC          FLAT-TO-FLAT DISTANCE (FTF) ACROSS A MESH HEXAGON MUST     -
CC          BE GIVEN BY THE EXPRESSION                                 -
CC                        FTF = (XMESH(2)-XMESH(1))/IFINTS(1)          -
C                                                                      -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR          GEOMETRY DATA (5D RECORD)                                  -
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 (6D RECORD)     -
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 (7D RECORD)      -
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                                                      -
C                                                                      -
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 - Nuclide Density and Cross-Section Referencing Data

Although there are no changes in NDXSRF-IV relative to the Version III specifications one item warrants some explanation. On the Nuclide Referencing Data (2D) Record is included the ATWT vector, providing for nuclide atomic weights. Unfortunately, there is no provision in the file for relating these atomic weights to specific isotopes. Unless and until the NDXSRF specifications are changed to include the relationship, the only means available for using the atomic weights in a particular code is for the atomic weight-to-isotope relationship to be specified as code-dependent (nonstandardized) input.

```
C**********************************************************************
C                        REVISED 11/30/76                              -
C                                                                      -
CF          NDXSRF-IV                                                  -
C                                                                      -
CE          NUCLIDE DENSTIY, DATA, CROSS SECTION REFERENCING           -
C                                                                      -
C**********************************************************************


C-----------------------------------------------------------------------
CR          FILE IDENTIFICATION                                        -
C                                                                      -
CL    HNAME,(HUSE(I),I=1,2),IVERS                                      -
C                                                                      -
CW    1+3*MULT=NUMBER OF WORDS                                         -
C                                                                      -
CD    HNAME          HOLLERITH FILE NAME - NDXSRF - (A6)               -
CD    HUSE(I)        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          (1D RECORD)                        -
C                                                                      -
CL    NON,NSN,NNS,NAN,NZONE,NSZ                                        -
C                                                                      -
CW    6    =NUMBER OF WORDS                                            -
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       (2D RECORD)
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     ((NDS(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)=NUMBER OF WORDS
C
CD     HNNAME(N)           UNIQUE REFERENCE NUCLIDE NAME, IN LIBRARY ORDER
CD                             (A6) ALPHANUMERIC
CD     HANAME(N)           ABSOLUTE NUCLIDE REFERENCE, IN LIBRARY ORDER
CD                             (A6) ALPHANUMERIC
CD     WPF(N)              RESERVED
CD     ATWT(J)             ATOMIC WEIGHT
CD     NCLN(N)             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     NDS(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      (3D RECORD)
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)=NUMBER OF WORDS
C
CD     VOLZ(N)             VOLUMES OF ZONES, CC
CD     VFPA(N)             VOLUME FRACTIONS FOR PRIMARY ZONE ASSIGNMENTS
CD     VLSA(M)             VOLUMES OF SUBZONES
CD     NSPA(N)             NUCLIDE SET REFERENCE, PRIMARY ZONE ASSIGNMENT
CD                             (MAY BE ZERO ONLY IF THERE ARE SUBZONES)
CD     NSSA(M)             NUCLIDE SET REFERENCE ASSIGNMENT TO SUBZONES
CD     NZSZ(M)             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
```

3. ZNATDN - Zone and Subzone Nuclide Atomic Densities

ZNATDN-IV is unchanged relative to the Version III specifications except for a clarification of the size of the last block of atom densities (see 2D record).

```
C*******************************************************************************
C                          REVISED 11/30/76                                     -
C                                                                               -
CF          ZNATDN-IV                                                           -
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=NUMBER OF WORDS                                                  -
C                                                                               -
CD    HNAME             HOLLERITH FILE NAME = ZNATDN =(A6)                      -
CD    HUSE(I)           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          (1D RECORD)                                 -
C                                                                               -
CL    TIME,NCY,NTZSZ,NNS,NBLKAD                                                 -
C                                                                               -
CW    5=NUMBER OF WORDS                                                         -
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)      (2D RECORD)                -
C                                                                               -
CL    ((ADEN(N,J),N=1,NNS),J=JL,JU)----SEE STRUCTURE BELOW----                  -
C                                                                               -
CW    NNS*(JL - JU + 1) = NUMBER OF WORDS                                       -
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=MIN0(NTZSZ,JUP) WITH JUP=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
```

4. SEARCH - Criticality Search Data

There is no change in the SEARCH specifications of Version IV relative to Version III.

```
C*****************************************************************************
C                          REVISED 11/30/76                                    -
C                                                                              -
CF          SEARCH -IV                                                         -
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=NUMBER OF WORDS                                                 -
C                                                                              -
CD    HNAME             HOLLERITH FILE NAME - SEARCH - (A6)                    -
CD    HUSE(I)           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       (1D RECORD)                   -
C                                                                              -
CL    NSHID,NREC,(NSP(I),I=1,18)                                               -
C                                                                              -
CW    20=NUMBER OF WORDS                                                       -
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(I)            RESERVED                                               -
C                                                                              -
C------------------------------------------------------------------------------


C------------------------------------------------------------------------------
CR          FILE SPECIFICATIONS       (2D RECORD)                              -
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=NUMBER OF WORDS                                                       -
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(I)           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(I)          RESERVED                                          -
C                                                                        -
C-------------------------------------------------------------------------

C-------------------------------------------------------------------------
CR          COARSE MESH MODIFIERS FOR DIMENSION SEARCH                   -
CR                          (3D RECORD)                                  -
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=NUMBER OF WORDS                               -
C                                                                        -
CD    SRHDI(I)         FIRST DIMENSION COARSE MESH MODIFIERS             -
CD    SRHDJ(J)         SECOND DIMENSION COARSE MESH MODIFIERS            -
CD    SRHDK(K)         THIRD DIMENSION COARSE MESH MODIFIERS             -
C                                                                        -
C-------------------------------------------------------------------------
```

```
C----------------------------------------------------------------------
CR          NUCLIDES FOR PROPORTIONAL SEARCH AND SPECIAL SEARCH
CR                              (4D RECORD)
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)=NUMBER OF WORDS
C
CD     NSHZ1(I)          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(I)          LAST NUMBER OF A SET OF ZONES OR SUBZONES
CD     HNNAMS(N,I)       REFERENCE NAMES OF NUCLIDES WHOSE
CD                           CONCENTRATIONS ARE TO BE ADJUSTED
CD                           PROPORTIONATELY IN ABOVE ZONES (A6)
CD     HNSHN(J)          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
CR                              (5D RECORD)
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))=NUMBER OF WORDS
C
CD     NSHZ1(I)          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(I)          LAST NUMBER OF A SET OF ZONES OR SUBZONES
CD     HNNAMS(N,I)       REFERENCE NAMES OF NUCLIDES WHOSE
CD                           CONCENTRATIONS ARE TO BE ADJUSTED (A6)
CD     CHZDN(N,I)        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, Power, and Reactivity-Worth Distribution Files

There are eleven standard interface files which can be categorized as particle, power, and reactivity-worth distribution files: SNCONS, FIXSRC, RTFLUX, ATFLUX, RCURNT, ACURNT, RAFLUX, AAFLUX, RZFLUX, PWDINT, and WORTHS. The specification for each of these files follows. The WORTHS file is presented as a tentative, for-trial-use standard only and has not yet been fully adopted as a standard.

1. SNCONS - S_N Constants

The SNCONS, Version IV file specifications are unchanged from Version III.

```
C*************************************************************************
C                        REVISED 11/30/76                                -
C                                                                        -
CF          SNCONS-IV                                                    -
CE          SN CONSTANTS                                                 -
C                                                                        -
C*************************************************************************

C------------------------------------------------------------------------
CR          FILE IDENTIFICATION                                          -
C                                                                        -
CL    HNAME,(HUSE(I),I=1,2),IVERS                                        -
C                                                                        -
CW    1+3*MULT=NUMBER OF WORDS                                           -
C                                                                        -
CD    HNAME              HOLLERITH FILE NAME - SNCONS - (A6)             -
CD    HUSE(I)            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      (1D RECORD)                              -
C                                                                        -
CL    NDIM,NDIR,IDUM,IDUM                                                -
C                                                                        -
CW    4=NUMBER OF WORDS                                                  -
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    (2D RECORD)                  -
C                                                                        -
CC          PRESENT IF NDIM.EQ.1                                         -
C                                                                        -
CL    (DIRWGT(I),I=1,NDIR),(DIRMU(I),I=1,NDIR)                           -
C                                                                        -
CW    2*NDIR=NUMBER OF WORDS                                             -
C                                                                        -
CD    DIRWGT(I)          DIRECTION WEIGHT FOR EACH DIRECTION             -
CD    DIRMU              DIRECTION COSINE FOR EACH DIRECTION             -
C                                                                        -
C------------------------------------------------------------------------

C------------------------------------------------------------------------
CR          MULTI-DIMENSIONAL SN CONSTANTS     (3D RECORD)               -
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=NUMBER OF WORDS                                             -
C                                                                        -
CD    DIRWGT(I)          DIRECTION WEIGHT FOR EACH DIRECTION             -
CD    DIRMU(I)           DIRECTION COSINES WITH RESPECT TO FIRST         -
CD                       DIMENSION,                                      -
CD    DIRETA(I)          DIRECTION COSINES WITH RESPECT TO SECOND        -
CD                       DIMENSION,                                      -
C                                                                        -
C------------------------------------------------------------------------

CEOF
```

2. FIXSRC - Distributed and Surface Fixed Sources

FIXSRC-IV contains two changes from FIXSRC-III:

(a) A blocking factor NBLOK has been added to the end of the list of file control words on the Specifications (1D) record. The use of this factor permits the blocking of distributed fixed source data on the 3D record. (It should be noted that FIXSRC-III files are structured the same as FIXSRC-IV files with NBLOK=1).

(b) A long-standing error in the Third Dimension Surface Source Pointers (8D) record has been corrected. The list in Version III had been incorrectly given as

[(ISPTRK(I,J),I=1,NINTI),J=1,NINTK].

The NINTK should be NINTJ.

```
C*****************************************************************************
C                          REVISED 11/30/76                                    -
C                                                                              -
CF          FIXSRC-IV                                                          -
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=NUMBER OF WORDS                                                 -
C                                                                              -
CD    HNAME             HOLLERITH FILE NAME - FIXSRC - (A6)                    -
CD    HUSE(I)           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   (1D RECORD)                                       -
C                                                                              -
CL    ITYPE,NDIM,NGROUP,NINTI,NINTJ,NINTK,IDISTS,NDCOMP,NSCOMP,NEDGI,          -
CL    NEDGJ,NEDGK,NBLOK                                                        -
C                                                                              -
CW    13=NUMBER OF WORDS                                                       -
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             -
CD    NBLOK             DATA BLOCKING FACTOR FOR DISTRIBUTED FIXED             -
CD                         SOURCES IN MULTI-DIMENSIONS, (2ND DIMENSION         -
CD                         VARIABLE IS BLOCKED INTO NBLOK BLOCKS,              -
CD                         SEE 3D RECORD BELOW)                                -
C                                                                              -
C------------------------------------------------------------------------------
```

```
C-----------------------------------------------------------------------
CR          ONE-DIMENSIONAL DISTRIBUTED FIXED SOURCE  (2D RECORD)       -
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=NUMBER OF WORDS                                       -
C                                                                        -
C     DO 1 J=1,NGROUP                                                    -
C   1 READ (N) *LIST AS ABOVE*                                           -
C                                                                        -
CD    QDIST(L,I)          DISTRIBUTED SOURCE BY COMPONENT, INTERVAL,     -
CD                        AND GROUP                                      -
C                                                                        -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR          MULTI-DIMENSIONAL DISTRIBUTED FIXED SOURCE  (3D RECORD)      -
C                                                                        -
CC          PRESENT IF NDIM.GE.2 AND IDISTS.NE.0                         -
C                                                                        -
CL    ((QDIST(I,J),I=1,NINTI),J=JL,JU) -----SEE STRUCTURE BELOW-----     -
C                                                                        -
CW    NINTI*(JU - JL + 1) = NUMBER OF WORDS                              -
C                                                                        -
C     DO 1 N=1,NGROUP                                                    -
C     DO 1 L=1,NDCOMP                                                    -
C     DO 1 K=1,NINTK                                                     -
C     DO 1 M=1,NBLOK                                                     -
C   1 READ (N) *LIST AS ABOVE*                                           -
C                                                                        -
CC          WITH M AS THE BLOCK INDEX, JL=1+(M-1)*((NINTJ-1)/NBLOK +1)   -
CC          AND JU=MIN0(NINTJ,JUP) WHERE JUP=M*((NINTJ-1)/NBLOK +1)      -
C                                                                        -
CD    QDIST(I,J)          DISTRIBUTED SOURCE AS DEFINED ABOVE            -
C                                                                        -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR          FIRST DIMENSION SURFACE SOURCE POINTERS   (4D RECORD)        -
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=NUMBER OF WORDS                                       -
C                                                                        -
C     DO 1 K=1,NINTK                                                     -
C   1 READ (N) *LIST AS ABOVE*                                           -
C                                                                        -
CD    ISPTRI(I,J)         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-----------------------------------------------------------------------
CR          FIRST DIMENSION SURFACE SOURCES     (5D RECORD)              -
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=NUMBER OF WORDS                                -
C                                                                        -
CD    QSURFI(M,L,N)       FIRST DIMENSION BOUNDARY SOURCES BY BOUNDARY,  -
CD                        COMPONENT, AND GROUP.                          -
C                                                                        -
C-----------------------------------------------------------------------
```

```
C-----------------------------------------------------------------------
CR          SECOND DIMENSION SURFACE SOURCE POINTERS   (6D RECORD)      -
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=NUMBER OF WORDS                                       -
C                                                                        -
C     DO 1 K=1,NINTK                                                     -
C   1 READ (N) *LIST AS ABOVE*                                           -
C                                                                        -
CD    ISPTRJ(I,J)         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   (7D RECORD)               -
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=NUMBER OF WORDS                                -
C                                                                        -
CD    QSURFJ(M,L,N)       SECOND DIMENSION BOUNDARY SOURCES BY BOUNDARY  -
CD                        COMPONENT, AND GROUP                           -
C                                                                        -
C-----------------------------------------------------------------------
```

```
C-----------------------------------------------------------------------
CR          THIRD DIMENSION SURFACE SOURCE POINTERS   (8D RECORD)       -
C                                                                        -
CC          PRESENT IF NDIM.EQ.3 AND NEDGK.NE.0                          -
C                                                                        -
CL    ((ISPTRK(I,J),I=1,NINTI),J=1,NINTJ)---NOTE STRUCTURE BELOW---      -
C                                                                        -
CW    NINTI*NINTJ=NUMBER OF WORDS                                        -
C                                                                        -
C     DO 1 K=1,NBDRYK                                                    -
C   1 READ (N) *LIST AS ABOVE*                                           -
C                                                                        -
CD    ISPTRK(I,J)         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    (9D RECORD)              -
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=NUMBER OF WORDS                               -
C                                                                       -
CD    QSURFK(M,L,N)      THIRD DIMENSION BOUNDARY SOURCES BY BOUNDARY,  -
CD                       COMPONENT, AND GROUP                          -
C                                                                       -
C-----------------------------------------------------------------------

CEOF
```

3. RTFLUX (ATFLUX) - Regular (Adjoint) Total Fluxes, RCURNT (ACURNT) - Regular (Adjoint) Currents

The four files RTFLUX-IV, ATFLUX-IV, RCURNT-IV, and ACURNT-IV each differ from their Version III counterparts only in that the former have added a blocking factor NBLOK to the end of the list of file control words on the Specifications (1D) record. The use of the NBLOK factor permits the blocking of either:

(a) the group variable in one-dimensional problems (see 2D record),

or

(b) the second dimensional variable in two- or three-dimensional problems (see 3D record).

Note that the Version III files are constructed in the same way as Version IV with NBLOK=1.

```
C***********************************************************************
C                          REVISED 11/30/76                             -
C                                                                       -
CF          RTFLUX-IV                                                   -
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=2

C-----------------------------------------------------------------------
CR          FILE IDENTIFICATION                                         -
C                                                                       -
CL    HNAME,(HUSE(I),I=1,2),IVERS                                       -
C                                                                       -
CW    1+3*MULT=NUMBER OF WORDS                                          -
C                                                                       -
CD    HNAME              HOLLERITH FILE NAME - RTFLUX - (A6)            -
CD    HUSE(I)            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      (1D RECORD)                              -
C                                                                        -
CL    NDIM,NGROUP,NINTI,NINTJ,NINTK,ITER,EFFK,POWER,NBLOK                -
C                                                                        -
CW    9 =NUMBER OF WORDS                                                 -
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       -
CD    NBLOK             DATA BLOCKING FACTOR                             -
CD                        IF NDIM.EQ.1 THE GROUP VARIABLE IS BLOCKED     -
CD                          INTO NBLOK BLOCKS (SEE 2D RECORD BELOW)      -
CD                        IF NDIM.GE.2 THE 2ND DIMENSION VARIABLE IS     -
CD                          BLOCKED INTO NBLOK BLOCKS (SEE 3D RECORD)    -
C                                                                        -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR          ONE DIMENSIONAL REGULAR TOTAL FLUX   (2D RECORD)             -
C                                                                        -
CC          PRESENT IF NDIM.EQ.1                                         -
C                                                                        -
CL    ((FREG(I,J),I=1,NINTI),J=JL,JU)-----SEE STRUCTURE BELOW-----       -
C                                                                        -
CW    NINTI*(JU - JL + 1)*MULT = NUMBER OF WORDS                         -
C                                                                        -
C     DO 1 M=1,NBLOK                                                     -
C   1 READ(N)   *LIST AS ABOVE*                                          -
C                                                                        -
CC          WITH M AS THE BLOCK INDEX, JL=(M-1)*((NGROUP-1)/NBLOK+1)+1   -
CC          AND JU=MIN0(NGROUP,JUP) WHERE JUP=M*((NGROUP-1)/NBLOK +1)    -
C                                                                        -
CD    FREG(I,J)         ONE DIMENSIONAL REGULAR TOTAL FLUX BY INTERVAL   -
CD                      AND GROUP.                                       -
C                                                                        -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR          MULTI-DIMENSIONAL REGULAR TOTAL FLUX   (3D RECORD)           -
C                                                                        -
CC          PRESENT IF NDIM.GE.2                                         -
C                                                                        -
CL    ((FREG(I,J),I=1,NINTI),J=JL,JU)-----SEE STRUCTURE BELOW-----       -
C                                                                        -
CW    NINTI*(JU - JL + 1)*MULT = NUMBER OF WORDS                         -
C                                                                        -
C     DO 1 L=1,NGROUP                                                    -
C     DO 1 K=1,NINTK                                                     -
C     DO 1 M=1,NBLOK                                                     -
C   1 READ(N)   *LIST AS ABOVE*                                          -
C                                                                        -
CC          WITH M AS THE BLOCK INDEX, JL=(M-1)*((NINTJ-1)/NBLOK +1)+1   -
CC          AND JU=MIN0(NINTJ,JUP) WHERE JUP=M*((NINTJ-1)/NBLOK +1)      -
C                                                                        -
CD    FREG(I,J)         MULTI-DIMENSIONAL REGULAR TOTAL FLUX             -
CD                      BY INTERVAL AND GROUP.                           -
C                                                                        -
C-----------------------------------------------------------------------

CEOF
```

```
C*************************************************************************
C                          REVISED 11/30/76                              -
C                                                                        -
CF          ATFLUX-IV                                                    -
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=NUMBER OF WORDS                                           -
C                                                                        -
CD    HNAME               HOLLERITH FILE NAME - ATFLUX - (A6)            -
CD    HUSE(I)             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      (1D RECORD)                              -
C                                                                        -
CL    NDIM,NGROUP,NINTI,NINTJ,NINTK,ITER,EFFK,ADUM,NBLOK                 -
C                                                                        -
CW    9 =NUMBER OF WORDS                                                 -
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                                       -
CD    NBLOK               DATA BLOCKING FACTOR                           -
CD                           IF NDIM.EQ.1 THE GROUP VARIABLE IS BLOCKED  -
CD                              INTO NBLOK BLOCKS (SEE 2D RECORD BELOW)  -
CD                           IF NDIM.GE.2 THE 2ND DIMENSION VARIABLE IS  -
CD                              BLOCKED INTO NBLOK BLOCKS (SEE 3D RECORD)-
C                                                                        -
C------------------------------------------------------------------------


C------------------------------------------------------------------------
CR          ONE DIMENSIONAL ADJOINT TOTAL FLUX   (2D RECORD)             -
C                                                                        -
CC          PRESENT IF NDIM.EQ.1                                         -
C                                                                        -
CL    ((FADJ(I,J),I=1,NINTI),J=JL,JU)-----SEE STRUCTURE BELOW-----       -
C                                                                        -
CW    NINTI*(JU - JL + 1)*MULT = NUMBER OF WORDS                         -
C                                                                        -
C     DO 1 M=1,NBLOK                                                     -
C   1 READ(N)   *LIST AS ABOVE*                                          -
C                                                                        -
CC          WITH N AS THE BLOCK INDEX, JL=(M-1)*((NGROUP-1)/NBLOK+1)+1   -
CC          AND JU=MINO(NGROUP,JUP) WHERE JUP=M*((NGROUP-1)/NBLOK+1)     -
C                                                                        -
```

```
CD     FADJ(I,J)          ONE DIMENSIONAL ADJOINT TOTAL FLUX BY INTERVAL -
CD                        AND GROUP.                                     -
C                                                                        -
C                                                                        -
C-------------------------------------------------------------------------

C-------------------------------------------------------------------------
CR           MULTI-DIMENSIONAL ADJOINT TOTAL FLUX   (3D RECORD)          -
C                                                                        -
CC           PRESENT IF NDIM.GE.2                                        -
C                                                                        -
CL     ((FADJ(I,J),I=1,NINTI)J=JL,JU)-----SEE STRUCTURE BELOW-----       -
C                                                                        -
CW     NINTI*(JU - JL + 1)*MULT = NUMBER OF WORDS                        -
C                                                                        -
C      DO 1 L=1,NGROUP                                                   -
C      DO 1 K=1,NINTK                                                    -
C      DO 1 M=1,NBLOK                                                    -
C    1 READ(N)   *LIST AS ABOVE*                                         -
C                                                                        -
CC           WITH M AS THE BLOCK INDEX, JL=(M-1)*((NINTJ-1)/NBLOK +1)+1  -
CC           AND JU=MIN0(NINTJ,JUP) WHERE JUP=M*((NINTJ-1)/NBLOK +1)     -
C                                                                        -
CD     FADJ(I,J)          MULTI-DIMENSIONAL ADJOINT TOTAL FLUX           -
CD                        BY INTERVAL AND GROUP.                         -
C                                                                        -
C-------------------------------------------------------------------------

CEOF
```

```
C*************************************************************************
C                          REVISED 11/30/76                               -
C                                                                         -
CF           RCURNT=IV                                                    -
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=NUMBER OF WORDS                                          -
C                                                                        -
CD     HNAME               HOLLERITH FILE NAME - RCURNT - (A6)           -
CD     HNAME               HOLLERITH FILE NAME -        -(A6)            -
CD     HUSE(I)             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     (1D RECORD)                             -
C                                                                      -
CL    NDIM,NGROUP,NINTI,NINTJ,NINTK,NBLOK                              -
C                                                                      -
CW    6=NUMBER OF WORDS                                                -
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                        -
CD    NBLOK             DATA BLOCKING FACTOR                           -
CD                        IF NDIM.EQ.1 THE GROUP VARIABLE IS BLOCKED   -
CD                          INTO NBLOK BLOCKS (SEE 2D RECORD BELOW)    -
CD                        IF NDIM.GE.2 THE 2ND DIMENSION VARIABLE IS   -
CD                          BLOCKED INTO NBLOK BLOCKS (SEE 3D RECORD)  -
C                                                                      -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          ONE DIMENSIONAL REGULAR CURRENT    (2D RECORD)             -
C                                                                      -
CC          PRESENT IF NDIM.EQ.1                                       -
C                                                                      -
CL    ((RCURI(I,J),I=1,NBDRYI),J=JL,JU) -----SEE STRUCTURE BELOW-----  -
C                                                                      -
CW    NBDRYI*(JU-JL+1) = NUMBER OF WORDS                               -
C                                                                      -
C     DO 1 M=1,NBLOK                                                   -
C   1 READ(N)   *LIST AS ABOVE*                                        -
C                                                                      -
CC          WITH M AS THE BLOCK INDEX, JL=(M-1)*((NGROUP-1)/NBLOK+1)+1 -
CC          AND JU=MIN0(NGROUP,JUP) WHERE JUP=M*((NGROUP-1)/NBLOK +1)  -
C                                                                      -
CD    RCURI(I,J)        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       (3D RECORD)                               -
C                                                                      -
CC          PRESENT IF NDIM.GE.2                                       -
C                                                                      -
CL    ((RCURI(I,J),I=1,NBDRYI),J=JL,JU) -----SEE STRUCTURE BELOW-----  -
C                                                                      -
CW    NBDRYI*(JU-JL+1) = NUMBER OF WORDS                               -
C                                                                      -
C     DO 1 L=1,NGROUP                                                  -
C     DO 1 K=1,NINTK                                                   -
C     DO 1 M=1,NBLOK                                                   -
C   1 READ(N) *LIST AS ABOVE*                                          -
C                                                                      -
CC          WITH M AS THE BLOCK INDEX, JL=(M-1)*((NINTJ-1)/NBLOK +1)+1 -
CC          AND JU=MIN0(NINTJ,JUP) WHERE JUP=M*((NINTJ-1)/NBLOK +1)    -
C                                                                      -
CD    RCURI(I,J)        REGULAR FIRST DIMENSION BOUNDARY CURRENT       -
C                                                                      -
C-----------------------------------------------------------------------
```

```
C-----------------------------------------------------------------------
CR          MULTI-DIMENSIONAL REGULAR CURRENTS AT SECOND DIMENSION
CR          BOUNDARIES        (4D RECORD)
C
CC          PRESENT IF NDIM.GE.2
C
CL    ((RCURJ(I,J),I=1,NINTI),J=JL,JU) -----SEE STRUCTURE BELOW-----
C
Cw    NINTI*(JU - JL + 1) = NUMBER OF WORDS
C
C     DO 1 L=1,NGROUP
C     DO 1 K=1,NINTK
C     DO 1 M=1,NBLOK
C   1 READ(N) *LIST AS ABOVE*
C
CC          WITH M AS THE BLOCK INDEX, JL=(M-1)*((NBDRYJ-1)/NBLOK+1)+1
CC          AND JU=MIN0(NBDRYJ,JUP) WHERE JUP=M*((NBDRYJ-1)/NBLOK+1)
C
CD    RCURJ(I,J)          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,       (5D RECORD)
C
CC          PRESENT IF NDIM.EQ.3
C
CL    ((RCURK(I,J),I=1,NINTI),J=JL,JU) -----SEE STRUCTURE BELOW-----
C
Cw    NINTI*(JU - JL + 1) = NUMBER OF WORDS
C
C     DO 1 L=1,NGROUP
C     DO 1 K=1,NBDRYK
C     DO 1 M=1,NBLOK
C   1 READ(N) *LIST AS ABOVE*
C
CC          WITH M AS THE BLOCK INDEX, JL=(M-1)*((NINTJ-1)/NBLOK +1)+1
CC          AND JU=MIN0(NINTJ,JUP) WHERE JUP=M*((NINTJ-1)/NBLOK +1)
C
CD    RCURK(I,J)          REGULAR THIRD DIMENSION BOUNDARY CURRENT
CD    NBDRYK              =NINTK+1, NUMBER OF THIRD DIMENSION FINE MESH
CD                        BOUNDARIES
C
C-----------------------------------------------------------------------

CEOF
```

```
C***********************************************************************
C                         REVISED 11/30/76
C
CF          ACURNT-IV
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=NUMBER OF WORDS                                         -
C                                                                      -
CD    HNAME              HOLLERITH FILE NAME - ACURNT - (A6)           -
CD    HUSE(I)            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     (1D RECORD)                             -
C                                                                      -
CL    NDIM,NGROUP,NINTI,NINTJ,NINTK,NBLOK                              -
C                                                                      -
CW    6=NUMBER OF WORDS                                                -
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                       -
CD    NBLOK              DATA BLOCKING FACTOR                          -
CD                          IF NDIM.EQ.1 THE GROUP VARIABLE IS BLOCKED -
CD                             INTO NBLOK BLOCKS (SEE 2D RECORD BELOW) -
CD                          IF NDIM.GE.2 THE 2ND DIMENSION VARIABLE IS -
CD                             BLOCKED INTO NBLOK BLOCKS (SEE 3D RECORD)-
C                                                                      -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          ONE DIMENSIONAL ADJOINT CURRENT    (2D RECORD)             -
C                                                                      -
CC          PRESENT IF NDIM.EQ.1                                       -
C                                                                      -
CL    ((ACURI(I,J),I=1,NBDRYI),J=JL,JU) -----SEE STRUCTURE BELOW-----  -
C                                                                      -
CW    NBDRYI*(JU-JL+1) = NUMBER OF WORDS                               -
C                                                                      -
C     DO 1 M=1,NBLOK                                                   -
C   1 READ(N)   *LIST AS ABOVE*                                        -
C                                                                      -
CC          WITH M AS THE BLOCK INDEX, JL=(M-1)*((NGROUP-1)/NBLOK+1)+1 -
CC          AND JU=MIN0(NGROUP,JUP) WHERE JUP=M*((NGROUP-1)/NBLOK +1)  -
C                                                                      -
CD    ACURI(I,J)         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       (3D RECORD)                               -
C                                                                      -
CC          PRESENT IF NDIM.GE.2                                       -
C                                                                      -
CL    ((ACURI(I,J),I=1,NBDRYI),J=JL,JU) -----SEE STRUCTURE BELOW-----  -
C                                                                      -
CW    NBDRYI*(JU-JL+1) = NUMBER OF WORDS                               -
```

```
C
C      DO 1 L=1,NGROUP
C      DO 1 K=1,NINTK
C      DO 1 M=1,NBLOK
C    1 READ(N) *LIST AS ABOVE*
C
CC           WITH M AS THE BLOCK INDEX, JL=(M-1)*((NINTJ-1)/NBLOK +1)+1
CC           AND JU=MIN0(NINTJ,JUP) WHERE JUP=M*((NINTJ-1)/NBLOK +1)
C
CD     ACURT(I,J)          ADJOINT FIRST DIMENSION BOUNDARY CURRENT
C
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR           MULTI-DIMENSIONAL ADJOINT CURRENTS AT SECOND DIMENSION
CR           BOUNDARIES        (4D RECORD)
C
CC           PRESENT IF NDIM.GE.2
C
CL     ((ACURJ(I,J),I=1,NINTI),J=JL,JU) -----SEE STRUCTURE BELOW-----
C
CW     NINTI*(JU - JL + 1) = NUMBER OF WORDS
C
C      DO 1 L=1,NGROUP
C      DO 1 K=1,NINTK
C      DO 1 M=1,NBLOK
C    1 READ(N) *LIST AS ABOVE*
C
CC           WITH M AS THE BLOCK INDEX, JL=(M-1)*((NBDRYJ-1)/NBLOK+1)+1
CC           AND JU=MIN0(NBDRYJ,JUP) WHERE JUP=M*((NBDRYJ-1)/NBLOK+1)
C
CD     ACURJ(I,J)          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,       (5D RECORD)
C
CC           PRESENT IF NDIM.EQ.3
C
CL     ((ACURK(I,J),I=1,NINTI),J=JL,JU) -----SEE STRUCTURE BELOW-----
C
CW     NINTI*(JU - JL + 1) = NUMBER OF WORDS
C
C      DO 1 L=1,NGROUP
C      DO 1 K=1,NBDRYK
C      DO 1 M=1,NBLOK
C    1 READ(N) *LIST AS ABOVE*
C
CC           WITH M AS THE BLOCK INDEX, JL=(M-1)*((NINTJ-1)/NBLOK +1)+1
CC           AND JU=MIN0(NINTJ,JUP) WHERE JUP=M*((NINTJ-1)/NBLOK +1)
C
CD     ACURK               ADJOINT THIRD DIMENSION BOUNDARY CURRENT
CD     NBDRYK              =NINTK+1, NUMBER OF THIRD DIMENSION FINE MESH
CD                         BOUNDARIES
C
C-----------------------------------------------------------------------

CEOF
```

4. RAFLUX (AAFLUX) - Regular (Adjoint) Angular Fluxes

The two files RAFLUX and AAFLUX remain unchanged from their Version III specifications.

```
C*****************************************************************************
C                          REVISED 11/30/76                                    -
C                                                                              -
CF           RAFLUX=1V                                                         -
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=NUMBER OF WORDS                                                -
C                                                                              -
CD     HNAME               HOLLERITH FILE NAME - RAFLUX - (A6)                 -
CD     HNAME               HOLLERITH FILE NAME -        -(A6)                  -
CD     HUSE(I)             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      (1D RECORD)                                   -
C                                                                              -
CL     NDIM,NGROUP,NINTI,NINTJ,NINTK,NDIR,EFFK,POWER                           -
C                                                                              -
CW     8=NUMBER OF WORDS                                                       -
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                              (2D RECORD)                                     -
C                                                                              -
CL     ((AFREGI(M,I),M=1,NDIR),I=1,NBDRYI)----NOTE STRUCTURE BELOW---          -
C                                                                              -
CW     NDIR*NBDRYI=NUMBER OF WORDS                                             -
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(M,I)        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      -
                          (3D RECORD)                                  -
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=NUMBER OF WORDS                                       -
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(M,I)        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                          (4D RECORD)                                 -
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=NUMBER OF WORDS                                       -
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(M,I)        REGULAR THIRD DIMENSION BOUNDARY ANGULAR FLUX -
CD    NBDRYK             =NINTK+1, NUMBER OF THIRD DIMENSION FINE MESH -
CD                       BOUNDARIES.                                   -
C                                                                      -
C----------------------------------------------------------------------

CEOF
```

```
C**********************************************************************
C                        REVISED 11/30/76                              -
C                                                                      -
CF          AAFLUX-IV                                                  -
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=NUMBER OF WORDS                                         -
C                                                                      -
CD    HNAME              HOLLERITH FILE NAME - AAFLUX - (A6)           -
CD    HUSE(I)            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     (1D RECORD)                             -
C                                                                      -
CL    NDIM,NGROUP,NINTI,NINTJ,NINTK,NDIR,EFFK,ADUM                     -
C                                                                      -
CW    8=NUMBER OF WORDS                                                -
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       -
CR                          (2D RECORD)                                -
C                                                                      -
CL    ((AFADJI(M,I),M=1,NDIR),I=1,NBDRYI)----NOTE STRUCTURE BELOW----  -
C                                                                      -
CW    NDIR*NBDRYI=NUMBER OF WORDS                                      -
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(M,I)        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      -
CR                          (3D RECORD)                                -
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=NUMBER OF WORDS                                       -
C                                                                      -
C     DO 1 L=1,NGROUP                                                  -
C     DO 1 K=1,NINTK                                                   -
C     DO 1 J=1,NRDRYJ                                                  -
C   1 READ (N) *LIST AS ABOVE*                                         -
```

```
C                                                                       -
CD     AFADJJ(M,I)          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       -
CR                              (4D RECORD)                             -
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=NUMBER OF WORDS                                       -
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(M,I)          ADJOINT THIRD DIMENSION BOUNDARY ANGULAR FLUX -
CD     NBDRYK               =NINTK+1, NUMBER OF THIRD DIMENSION FINE MESH -
CD                          BOUNDARIES.                                -
C                                                                       -
C-----------------------------------------------------------------------

CEOF
```

5. RZFLUX- Regular Zone-Averaged Group Fluxes

The Version IV RZFLUX file differs from Version III only in that the former has replaced one of the reserved variables, X(I), with a blocking factor, NBLOK, in the control words on the Specification (1D) record. Thus, the total number of words on the 1D record remains unchanged from Version III. The NBLOK parameter permits the blocking of the geometries zone variables in problems having a large number of zones (see 2D record).

Note that Version III RZFLUX files are merely Version IV files with NBLOK=1.

```
C***********************************************************************
C                          REVISED 11/30/76                             -
C                                                                       -
CF           RZFLUX-IV                                                  -
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=NUMBER OF WORDS                                         -
C                                                                       -
CD     HNAME                HOLLERITH FILE NAME - RZFLUX - (A6)         -
CD     HUSE(I)              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      (1D RECORD)
C
CL     TIME,POWER,VOL,EFFK,EIVS,DKDS,TNL,TNA,TNSL,TNBL,TNBAL,TNCRA,
CL    1(X(I),I=1,3),NBLOK,ITPS,NZONE,NGROUP,NCY
C
CW     20=NUMBER OF WORDS
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=1,3           RESERVED
CD     NBLOK                DATA BLOCKING FACTOR,  THE GEOMETRIC ZONE
CD                             VARIABLE IS BLOCKED INTO NBLOK BLOCKS,
CD
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      (2D RECORD)
C
CL     ((ZGF(K,J),K=1,NGROUP),J=JL,JU) -----SEE STRUCTURE BELOW-----
C
CW     NGROUP*(JU-JL+1) = NUMBER OF WORDS
C
C      DO 1 M=1,NBLOK
C    1 READ(N)   *LIST AS ABOVE*
C
CC          WITH M AS THE BLOCK INDEX, JL=(M-1)*((NZONE-1)/NBLOK +1)+1
CC          AND JU=MIN0(NZONE,JUP) WHERE JUP=M*((NZONE-1)/NBLOK +1)
C
CD     ZGF(K,J)            REGULAR ZONE FLUX BY GROUP, AVERAGED OVER ZONE
CD                         NEUTRONS/SEC-CM**2
C
C-----------------------------------------------------------------------

CEOF
```

6. PWDINT - Power Densities by Interval

Version IV of the PWDINT specification differs from Version III only by the addition of a word, NBLOK, to the list of file control words on the specifications (1D) record. NBLOK is used to denote the data blocking factor to be applied to the second dimension variable on the 2D record.

Note that Version III PWDINT files are a subset of Version IV, i.e., are Version IV files with NBLOK=1.

```
C*******************************************************************************
C                          REVISED 11/30/76                                     -
C                                                                               -
CF          PWDINT-IV                                                           -
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=NUMBER OF WORDS                                                  -
C                                                                               -
CD    HNAME              HOLLERITH FILE NAME - PWDINT - (A6)                    -
CD    HUSE(I)            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     (1D RECORD)                                      -
C                                                                               -
CL    TIME, POWER, VOL, NINTI,NINTJ,NINTK,NCY,NBLOK                             -
C                                                                               -
CW    8=NUMBER OF WORDS                                                         -
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    NINTI              NUMBER OF FIRST DIMENSION FINE INTERVALS               -
CD    NINTJ              NUMBER OF SECOND DIMENSION FINE INTERVALS              -
CD    NINTK              NUMBER OF THIRD DIMENSION FINE INTERVALS               -
CD    NCY                REFERENCE COUNT (CYCLE NUMBER)                         -
CD    NBLOK              DATA BLOCKING FACTOR. THE SECOND DIMENSION             -
CD                          VARIABLE IS BLOCKED INTO NBLOK BLOCKS.              -
C                                                                               -
C-------------------------------------------------------------------------------


C-------------------------------------------------------------------------------
CR                       POWER DENSITY VALUES   (2D RECORD)                     -
C                                                                               -
CL    ((PWR(I,J), I=1,NINTI),J=JL,JU)-----SEE STRUCTURE BELOW-----              -
C                                                                               -
CW    NINTI*(JU - JL + 1) = NUMBER OF WORDS                                     -
C                                                                               -
CS    DO 1 K=1,KM                                                               -
CS    DO 1 M=1,NBLOK                                                            -
CS  1 READ(N) *LIST AS ABOVE*                                                   -
C                                                                               -
CC          WITH M AS THE BLOCK INDEX, JL=(M-1)*((NINTJ-1)/NBLOK +1)+1          -
CC          AND JU=MIN0(NINTJ,JUP) WHERE JUP=M*((NINTJ-1)/NBLOK +1)             -
C                                                                               -
CD    PWR(I,J)           POWER DENSITY BY INTERVAL, WATTS/CC                    -
C                                                                               -
C-------------------------------------------------------------------------------

CEOF
```

7. WORTHS - Reactivity per cc by Fine-Mesh Interval

Version IV of the WORTHS file actually represents only the second version of the file as proposed in October 1973, and is, in fact, the first version to be made public. In order to be consistent with other files described herein, it is designated Version IV. This file is not fully adopted as a standard file, but is presented only as a tentative, for-trial-use standard.

```
C*****************************************************************************
C                          REVISED 11/30/76                                    -
C                                                                              -
CF          WORTHS-IV                                                          -
CE          REACTIVITY PER CC BY FINE MESH INTERVAL                            -
C                                                                              -
C*****************************************************************************

C------------------------------------------------------------------------------
CS          FILE STRUCTURE                                                     -
CS                                                                             -
CS            RECORD TYPE                              PRESENT IF              -
CS            ================================         ===============         -
CS            IDENTIFICATION                           ALWAYS                  -
CS            SPECIFICATIONS                           ALWAYS                  -
CS            DELAYED NEUTRON DATA                     ALWAYS                  -
CS                                                                             -
CS        ********(REPEAT FOR ALL REACTIVITY SETS)                             -
CS        *     REACTIVITY SET DATA                    ALWAYS                  -
CS        *     ONE DIMENSIONAL REACTIVITIES           NDIM,EQ,1               -
CS        *     MULTI-DIMENSIONAL REACTIVITIES         NDIM,GE,2               -
CS        ********                                                             -
C                                                                              -
C------------------------------------------------------------------------------

C------------------------------------------------------------------------------
CR          IDENTIFICATION                                                     -
C                                                                              -
CL    HNAME,(HUSE(I),I=1,2),IVERS                                              -
C                                                                              -
CW    1+3*MULT=NUMBER OF WORDS                                                 -
C                                                                              -
CD    HNAME             HOLLERITH FILE NAME - WORTHS =(A6)                     -
CD    HUSE(I)           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   (1D RECORD)                                       -
C                                                                              -
CL    GTIME,BETAEF,NDIM,NINTI,NINTJ,NINTK,NFI,NISOD,NFAM,NSETS,NBLOK           -
C                                                                              -
CW    10 = NUMBER OF WORDS                                                     -
C                                                                              -
CD    GTIME             PROMPT NEUTRON GENERATION TIME (SECONDS)               -
CD    BETAEF            TOTAL DELAYED NEUTRON FRACTION                         -
CD    NDIM              NUMBER OF DIMENSIONS                                   -
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    NISOD             NUMBER OF FISSIONABLE ISOTOPES OR MATERIALS            -
CD    NFAM              NUMBER OF DELAYED NEUTRON FAMILIES                     -
CD    NSETS             NUMBER OF REACTIVITY SETS                              -
CD    NBLOK             DATA BLOCKING FACTOR, THE SECOND DIMENSION             -
CD                        VARIABLE IS BLOCKED INTO NBLOK BLOCKS,               -
CD                        ----SEE 5D RECORD BELOW----                          -
C                                                                              -
C------------------------------------------------------------------------------
```

```
C-----------------------------------------------------------------------
CR          DELAYED NEUTRON DATA      (2D RECORD)                        -
C                                                                        -
CL    (NFISO(NF),NF=1,NISOD),((FBETA(I,NF),I=1,NFAM),NF=1,NISOD)         -
C                                                                        -
CW    NISOD*(NFAM+1) = NUMBER OF WORDS                                   -
C                                                                        -
CD    NFISO(NF)          ORDER NUMBER OF FISSIONABLE ISOTOPE             -
CD                           OR MATERIAL NF IN CROSS SECTION FILE        -
CD    FBETA(I,NF)        DELAYED NEUTRON FRACTION FOR ISOTOPE OR         -
CD                           MATERIAL NF AND DELAYED NEUTRON FAMILY I    -
C                                                                        -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          REACTIVITY SET DATA     (3D RECORD)                          -
C                                                                        -
CL    (HPERTD(I),I=1,12),HSETID,RHO,TEMP1,TEMP2                          -
C                                                                        -
CW    13*MULT+3=NUMBER OF WORDS                                          -
C                                                                        -
CD    HPERTD(I)          PERTURBATION DESCRIPTION (12A6)                 -
CD    HSETID             HOLLERITH REFERENCE NAME OF REACTIVITY SET (A6)-
CD    RHO                TOTAL REACTIVITY IN SET (INTEGRATED OVER MESH) -
CD    TEMP1              AVERAGE REFERENCE FUEL TEMPERATURE - KELVIN -   -
CD    TEMP2              AVERAGE PERTURBED FUEL TEMPERATURE - KELVIN -   -
C                                                                        -
CC        TEMP1 AND TEMP2 UNDEFINED EXCEPT WHEN THE SET WORTHS ARE DUE   -
CC    TO A TEMPERATURE PERTURBATION OF CROSS SECTIONS                     -
C                                                                        -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          ONE-DIMENSIONAL REACTIVITIES     (4D RECORD)                 -
C                                                                        -
CC          PRESENT IF NDIM.EQ.1                                         -
C                                                                        -
CL    (WORTHS(I),I=1,NINTI)                                              -
C                                                                        -
CW    NINTI=NUMBER OF WORDS                                              -
C                                                                        -
CD    WORTHS(I)          REACTIVITY PER CC BY FINE MESH INTERVAL         -
C                                                                        -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          MULTI-DIMENSIONAL REACTIVITIES   (5D RECORD)                 -
C                                                                        -
CC          PRESENT IF NDIM.GE.2                                         -
C                                                                        -
CL    ((WORTHS(I,J),I=1,NINTI),J=JL,JU) ----NOTE STRUCTURE BELOW----     -
C                                                                        -
CW    NINTI*(JU-JL+1) = NUMBER OF WORDS                                  -
C                                                                        -
C     DO 1 K=1,NINTK                                                     -
C     DO 1 M=1,NBLOK                                                     -
C   1 READ(N) *LIST AS ABOVE*                                            -
C                                                                        -
CC          WITH M AS THE BLOCK INDEX, JL=(M-1)*((NINTJ-1)/NBLOK +1)+1   -
CC          AND JU=MIN0(NINTJ,JUP) WHERE JUP=M*((NINTJ-1)/NBLOK +1)      -
C                                                                        -
CD    WORTHS(I,J)        REACTIVITY PER CC BY FINE MESH INTERVAL         -
C                                                                        -
C-----------------------------------------------------------------------

CEOF
```

V. STANDARDIZED SUBROUTINES

A. General Description

A set of standardized routines has been defined by the CCCC in order to standardize program timing tests and to achieve compatible coding both for the retrieval of sequential file data from peripheral storage and for multilevel data management and the retrieval of data from random access files. (The multilevel data management schemes and random access data retrieval routines are presented as tentative, for-trial-use standards.) The call names, arguments, and usage of the subroutines are standardized, but the contents of the routines are left entirely to local choice and needs. The objective is to permit the exchange of calling programs between installations without the need for modification by localizing the essential adaptations to each computing environment to the interior of the standardized subroutines.

B. Program Timing - Subroutine TIMER

1. TIMER Specifications

FORM: TIMER(I,T)

I — is an integer variable indicating the response needed.
I = 0 initialize timing (Set T(1), 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(I) 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 floating-point word.
T(10) = unspecified Hollerith (A6) word.

2. TIMER Usage

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

C. Sequential File Handling Routines

All transfer of sequential file data between central memory and peripheral storage are managed under the control of the standardized subroutines SEEK, REED, and RITE.

The SEEK routine localizes in one place a catalog of the sequential data files and their current status. SEEK is an important facility for linking codes for it provides a means of passing sequential 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.

1. Subroutine SEEK

a. SEEK Specifications

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

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

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

NREF — A positive integer denoting the logical unit reference number of the sequential file HNAME, IVERS.

When NOP=0 or 1, a value of 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 special meaning.

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 sequential file. If IVERS.GT.0 and the the file specified by 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 sequential 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 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 to SEEK by a program 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 sequential 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 sequential file identifiers HNAME and IVERS associated with the reference number NREF.

Special Name: If HNAME in a call to SEEK is given the special name CHANGE, two logical unit reference numbers are concurrently input to SEEK in the NREF and NOP positions in the argument list. SEEK then interchanges these unit reference number assignments with respect to their HNAME,IVERS assignments in the SEEK catalog.

b. SEEK Usage

The principal purpose of the standard subroutine SEEK is to provide management of the logical unit reference numbers NREF, and the sequential files to which they are assigned. Whenever a sequential 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 logical unit reference number NREF for the sequential file HNAME, IVERS is returned to the calling program.

SEEK, therefore, maintains a catalog, or set of tables, that associates the current list of logical unit reference numbers NREF with the corresponding sequential 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 sequential 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 a 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 redundant and would produce unnecessary clutter in programs after the debugging phase is completed. Such temporary testing requires no standardization. Applications of error flags that have a permanent effect on programming logic, however, should conform to the standards.

2. Subroutines REED and RITE

a. REED and RITE Specifications

FORM:	REED (NREF, IREC, ARRAY(I), NWDS, MODE)
	RITE (NREF, IREC, ARRAY(I), NWDS, MODE)
NREF	The logical unit reference number assigned by SEEK for the sequential file being read or written.
IREC	IREC>0, the number of the record to be transferred. IREC=0 signifies termination of reading or writing of the sequential file NREF.
ARRAY(I)	The starting address in central memory at which the transfer is to begin.
NWDS	The total number of single-precision 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.

b. 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 sequential file data between facilities are implemented universally. However, in some environments the handling of sequential file data transfers by standard FORTRAN read and write statements is unacceptably inefficient. Consequently, the practice of executing all sequential file 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. A REED call transfers NWDS words of record IREC in the sequential file on logical unit NREF from peripheral storage to central memory location ARRAY(I). A RITE call performs the inverse operation. Records are numbered consecutively in sequential files but they may be accessed in any order by REED calls. Thus, if the records must actually be accessed randomly, REED internally performs the required unit positioning calls such as rewinds, backspaces, or dummy reads. This implies that REED must keep track of the current positions of all sequential access 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 physical unit. The information is required for positioning the physical unit on the correct record IREC of the file on logical unit NREF.

The termination calls (IREC=0) to REED and RITE should immediately follow completion of reading or writing a file.

D. Multilevel Data Management and Random Access File Handling

As mentioned in Sec. II.D of this report, a set of standardized routines for multilevel data management and random access file handling has been given tentative approval as standard-for-trial-use. The routines described below establish a standardized approach to multilevel data management which, if implemented in a code, should permit highly elegant and flexible data storage and transfer strategies with minimum effect on code exchangeability.

1. Terminology

In the context of the ensuing discussion, the following terminology will be used:

Extended Core: That portion of a computing system containing storage locations which serve as buffer for random access data. Extended core may be physically separate from central memory as a peripheral large core memory (LCM) on two-hierarchy memory computers or it may be a portion of central memory which has been designated as extended core on single-hierarchy memory computers.

Fast Core: That portion of a computing system which contains storage for both data and instructions, which is directly coupled to the computations portion of the system, and which is directly coupled to extended core. Fast core may be the entire central memory, i.e., small core memory (SCM) on two-hierarchy memory machines, or it may be that portion of central memory remaining after an extended core portion is designated on single-hierarchy memory machines.

Random Access Data: Data which can be transferred between fast core and extended core in out-of-sequence strings.

Random Access File: (Also called Direct Access File). A name collection of data which is stored on a peripheral storage device. The file data are arranged in blocks which can be transferred between extended core and peripheral storage randomly, i.e., out of sequence.

Logical File: A random access file. The identity of a logical file in a code is established by an integer variable, the (logical) file reference number.

Block: A subportion of a random access file. The block size is determined by the amount of extended core storage that can be allocated to the random access file. Data transfers between the peripheral device and extended core are block transfers.

String: A subportion of a random access file block. Data transfers between fast core and extended core are string transfers.

Disk: A generic name for peripheral storage device used for storing random access files.

Physical Unit: An identifiable subpart of a disk. One or more physical units comprise a disk.

File-Group: A collection of one or more random access files. The file-group collection is assigned to a single physical unit.

2. Multilevel Data Management Scheme

The standardized method of multilevel data management using random access data is shown in Fig. 12. Each random access file is composed of blocks and resides on disk, or more correctly, on a physical unit. When needed, the blocks of data are transferred between extended core and the physical unit on disk and then strings of data are transferred between extended core and fast core.

3. Subroutine DOPC

The first tentatively standardized subroutine, DOPC, provides for opening and closing the physical (disk) units to be used for storing the random access files. Information about maximum block size and the number of blocks required by a random access file is determined in the main code routines and passed to DOPC. Physical unit identifiers, disk locations, and other specifics on storage are local-installation-dependent which must be established by DOPC and suitably stored, e.g., in named COMMON, for subsequent by the subroutines DRED and DRIT. The actual programming

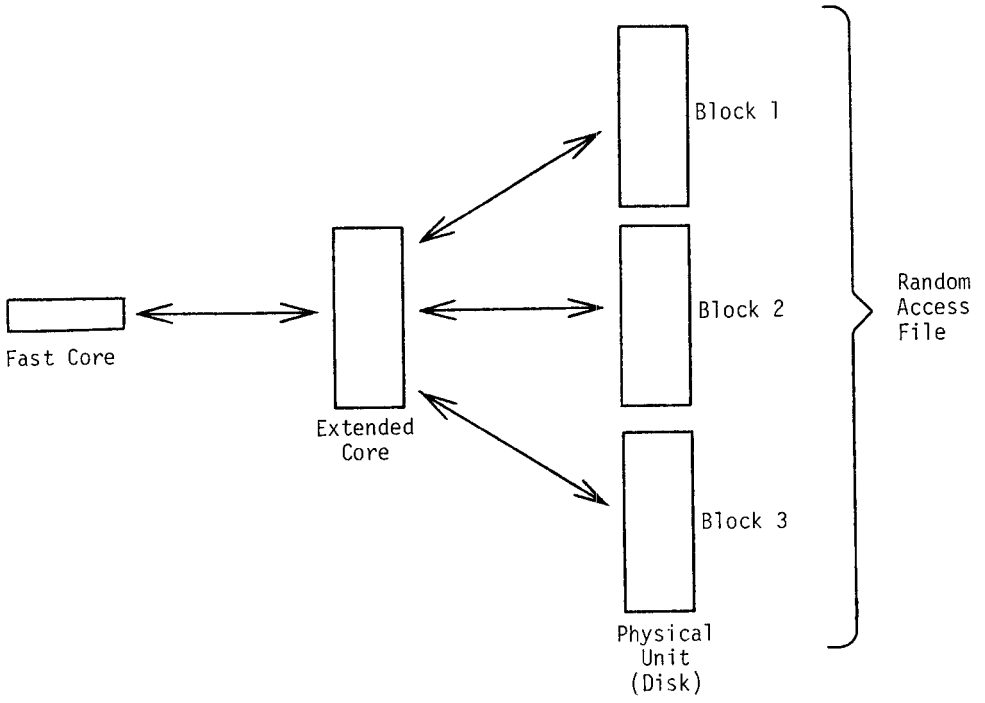

Fig. 12. Scheme for multilevel, random access data transfers.

of subroutine DOPC is left entirely to the local installation.

a. DOPC Specifications

FORM: DOPC (IOP, NREF, NGREF, IERRCS, ARRAY(K), MXLEN, MXBLOK, LENFIL)

FUNCTION: Define (open) and release (close) the physical units for the random access files. Also for initializing parameters which are needed for reserving space on disk, identifying the units, etc.

ROLE OF ARGUMENTS:

IOP
- 0 - Initialize the routine (called once in a program module before all other DOPC calls).
- 1 - Define the logical file identified by parameter NREF (NREF is passed to DOPC).
- 2 - Signal to DOPC that all logical files assigned to this file-group have been defined, i.e., all files defined with IOP=1 calls since either the last IOP=2 call or the original IOP=0 call. A unique file-group identifier, NGREF, is passed to DOPC.
- 3 - All logical files assigned to the file-group with identifying reference number NGREF will be deleted.
- 4 - Finalization option (called once at the conclusion of program module).

NREF — If IOP=1, NREF is the file reference number of the logical file being defined in the call to DOPC. The numerical value for NREF is passed to DOPC from the calling routine.
If IOP≠1, NREF is not used.

NGREF — If IOP=2 or 3, NGREF is the file-group reference number of the file-group being defined or deleted in the call to DOPC. Numerical value of NGREF is passed to DOPC from the calling routine.
If IOP=0, 1, or 4, NGREF is not used.

IERRCS — Error parameter (IERRCS<0 indicates an error condition has been detected in DOPC).

ARRAY(K) — If IOP=0 and computer is single-hierarchy memory, ARRAY(K) is the starting address of extended core in central memory.
If IOP≠0 or computer is two-hierarchy memory, ARRAY(K) is not used. NOTE: Even though not used on two-hierarchy memory machines, it is recommended that the entry ARRAY(K) in the DOPC call with IOP=0 be entered in a form, say, A(KMAXP), where KMAXP = KMAX+1, and KMAX is equal to the last storage location required in fast core. Such a practice will simplify the conversion of the code to operation on a single-hierarchy memory machine.

MXLEN — If IOP=1, MXLEN is the maximum length (in single-precision words) of blocks in the logical file with reference number NREF.
If IOP≠1, MXLEN is not used.

MXBLOK — If IOP=1, MXBLOK is the total number of blocks in the logical file with reference number NREF. If IOP≠1, MXBLOK is not used.

LENFIL — If LENFIL>0, LENFIL is the total file length (in single-precision words) of the logical file NREF. If LENFIL=0, the total file length of logical file NREF is assumed to be MXBLOK*MXLEN. (This option is provided to permit more efficient utilization of disk space when a logical file contains some blocks that are shorter than MXLEN).

b. DOPC Usage

The concept of file-groups has been introduced in order to minimize the number of physical units which need to be utilized during the execution of a program module. At installations where the number of physical units is restricted, all the logical files in a file-group are assigned to the same physical unit. Two or more logical files which are simultaneously highly active in a code should not be assigned to the same file-group. At installations where there is no restriction on the number of physical units, file-grouping may be ignored, i.e., each logical-file is assigned to its own, unique file-group, so that each logical file is assigned to a separate physical unit.

The following guidelines apply to the application of DOPC:

(i) All random access files assigned to a file-group must each be defined (with IOP=1) and then the file-group defined (with IOP=2) before any of the files in this file-group are used.

(ii) Several file-groups can be used by a given program module. A particular file-group can be defined and subsequently deleted independently of the times of definition and deletion of other file-groups used by the module.

(iii) All random access files in a file-group are deleted simultaneously with an IOP=3 call. Files cannot be deleted independently from the file-group. File reference numbers can be reassigned after the files have been deleted.

If the LENFIL parameter is used, all bookkeeping for variable block sizes must be kept in the installation-dependent versions of subroutines DRED and DRIT. Such use of variable block sizes can then be duplicated at other installations or the MXLEN value could be assumed for all records if the installation preferred to ignore the variable block size feature. In the latter case, all blocks would be assumed to be MXLEN-words long, MXBLOK*MXLEN words would be reserved on a physical unit, and the LENFIL parameter would be ignored.

4. Subroutines DRED and DRIT

The pair of subroutines DRED (pronounced DEE-READ) and DRIT (pronounced DEE-WRITE) provide for block transfers between disk and extended core. DRED is used for reading blocks of data into extended core from disk, i.e., disk-to-extended core transfers, while DRIT is used to "write" blocks of data onto disk from extended core, i.e., extended core-to-disk transfers. These subroutines move data blocks to and from locations (not addresses) in extended core. For these transfers all or part of the requested block may be transferred. All transfers, however, must begin with the first word of the block.

a. DRED Specifications

FORM: DRED (NREF, NBLOK, LCM, NBWDS, MODE)

FUNCTION: Transfer blocks of data from disk to extended core

ROLE OF ARGUMENTS:

NREF — File reference number of the logical (random access) file.

NBLOK — Number of the block in file NREF from which data will be transferred.

LCM — Location in extended core into which the first word of data from the block will be transferred.

NBWDS — Number of words (single precision) of data from the block will be transferred.

MODE — Transfer operation mode (provides for parallel processing)

0 - Complete the command before returning control to the calling program.

1 - Command is not necessarily completed before control is returned to the calling program.

2 - Forces completion of a MODE=1 command issued in a previous call.

b. DRIT Specifications

FORM: DRIT (NREF, NBLOK, LCM, NBWDS, MODE)

FUNCTION: Transfer data blocks from extended core to disk.

ROLE OF ARGUMENTS:

NREF — File reference number of the logical (random access) file.

NBLOK — Number of the block in file NREF i which data will be transferred.

LCM	Location in extended core from where first word of data will be transferred.
NBWDS	Number of words (single precision) of data to be transferred.
MODE	Transfer operation mode (provides for parallel processing).
	0 - Complete the command before returning control to the calling program.
	1 - Command is not necessarily completed before control is returned to the calling program.
	2 - Forces completion of a MODE=1 command issued in a previous call.

c. DRED/DRIT Usage

Blocks may be read from or written to disk randomly. Given the NREF and NBLOK parameters DRED and DRIT must be able to determine the correct disk (physical unit) positions by using the local-installation-dependent tables or arrays established by subroutine DOPC. Data are always transferred beginning with the first word of the block, but the entire block need not be transferred. The LCM parameter is an integer variable whose value is referenced relative to the first word in extended, e.g., LCM=1 is the first location in extended core into or from which data can be transferred.

5. Subroutines CRED and CRIT

The pair of subroutines CRED (pronounced SEE-READ) and CRIT (pronounced SEE-WRITE) provide for transferring strings of data between fast core and extended core. CRED is used for reading strings of data into fast core from extended core while CRIT is used for writing strings of data into extended core from fast core. The strings of data may be transferred randomly.

a. CRED Specifications

FORM:	CRED (ARRAY(I), LCM, NSWDS, IERR)
FUNCTION:	Transfer random strings of data from extended core into fast core.
ROLE OF ARGUMENTS:	
ARRAY(I)	Starting address in fast core where string will reside.
LCM	Location in extended core where first word of string resides.
NSWDS	Number of words (single precision) to be transferred.
IERR	Error flag.

b. CRIT Specifications

FORM:	CRIT (ARRAY(I), LCM, NSWDS, IERR)
FUNCTION:	Transfer random strings of data from fast core to extended core.
ROLE OF ARGUMENTS:	
ARRAY(I)	Starting address of the string in fast core.
LCM	Starting location in extended core to which the string will be transferred.
NSWDS	Number of words (single precision) to be transferred.
IERR	Error flag.

c. CRED/CRIT Usage

Data strings are transferred between fast core and extended core in any order. The strings in extended core are subparts of a larger data block residing in extended core. The LCM parameter is an integer variable whose value is referenced relative to the first word in extended core, e.g., LCM=1 is the first location in extended core into or from which data can be transferred.

E. Multilevel Data Management - Special Routines

Included in the set of routines which have been given tentative, standardized-for-trial-use status as mentioned in Sec. II.D. are three routines, ECMV, LRED, and LRIT. These three routines are quite special-purpose in nature and, although they provide a standardized means of effecting certain data-management operations, they should only be used with the greatest of care.

1. Subroutine ECMV

a. ECMV Specifications

FORM:	ECMV (LCMT, LCMF, NWDS)
FUNCTION:	Transfer of data blocks from one location in extended core to another location in extended core.
ROLE OF ARGUMENTS:	
LCMT	Location in extended core of first word to which data block will be moved.
LCMF	Location in extended core of first word of data block which is to be moved.
NWDS	Number of single-precision words to be transferred.

b. ECMV Usage

This routine should be used with extreme care. On some computers the transfer must be buffered through fast core in a very limited amount of

storage space. As a result, the transfer of large amounts of data can be quite time consuming.

The LCMT and LCMF parameters are integer variables whose values are referenced relative to the first word in extended core. For example LCMT=1 is the first location in extended core into which data can be transferred.

2. Subroutine LRED and LRIT

The two subroutines LRED (pronounced EL-READ) and LRIT (pronounced EL-WRITE) are provided for transferring data between extended core and sequential disk files.

a. LRED Specifications

FORM:	LRED (NREF, IREC, ARRAY(I), NWDS, MODE)
FUNCTION:	Transfer data records from a sequential file to extended core.
ROLE OF ARGUMENTS:	
NREF	Logical unit (reference) number of sequential file.
IREC	IREC>0, the number of the record to be transferred. IREC=0, signifies termination of reading of file NREF.
ARRAY(I)	Starting address in extended core into where data will be transferred
NWDS	Total number of single-precision words to be transferred.
MODE	MODE=0, the transfer is completed before returning to calling routine. MODE=1, the transfer is not necessarily completed before returning to calling routine. MODE=2, forces completion of a MODE=1 order issued in a previous call to LRED.

b. LRIT Specifications

FORM:	LRIT (NREF, IREC, ARRAY(I), NWDS, MODE)
FUNCTION:	Transfer data records from extended core to a sequential file.
ROLE OF ARGUMENTS:	
NREF	Logical unit (reference) number of sequential file.
IREC	IREC>0, the number of the record to be transferred. IREC=0, signifies termination of writing of the sequential file NREF.
ARRAY(I)	Starting address in extended core from where data will be transferred.
NWDS	Total number of single-precision words to be transferred.
MODE	MODE=0, the transfer is completed before returning to the calling routine. MODE=1, the transfer is not necessarily completed before returning to the calling routine. MODE=2, forces completion of a MODE=1 order issued in a previous call.

c. LRED/LRIT Usage

The two routines LRED and LRIT are, in a functional sense, quite similar to the REED/RITE routines described in Sec. V.C except that LRED/LRIT utilize extended core while REED/RITE use fast core. Both sets of routines use subroutine SEEK for defining the sequential file. Although it may appear that REED and RITE could be used for extended core/sequential file transfers such dual usage was not deemed advisable. The addresses for the argument ARRAY(I) differ among CDC computers depending on whether ARRAY(I) refers to word-addressable fast core (small core memory), in which case 18 bit addresses are used, or whether ARRAY(1) refers to word-addressable extended core (large core memory), in which case 19 bit or more addresses are used. Some CDC compilers will not support subroutines whose arguments have 18-bit addresses in some parts of a code and 19 or more bits in other parts. It was therefore deemed advisable to clearly delineate between the two cases with LRED/LRIT to be used when the argument ARRAY(I) uses the 19-bit or greater addresses of extended core and REED/RITE to be used only in conjunction with fast core.

Even though the routines LRED/LRIT are now established as standardized routines they are not intended to be widely used. Their formulation was intended primarily to permit a reasonable degree of standardization to a class of codes already in the late stages of development. The use of these routines in new code development is discouraged and, in no sense, should their existence be interpreted as a sanction for general use of word-addressable extended core.

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