LA-6287-MS
Informal Report

C.3

UC-34c and UC-80
Reporting Date: March 1976
Issued: April 1976

CINX: Collapsed Interpretation of Nuclear X Sections

by

R. B. Kidman
R. E. MacFarlane

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

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
CONTRACT W-7405-ENG. 36

This work was supported by the Division of Reactor Development and Demonstration, US Energy Research and Development Administration.

Printed in the United States of America. Available from
National Technical Information Service
U S Department of Commerce
5285 Port Royal Road
Springfield, VA 22151
Price: Printed Copy $4.00 Microfiche $2.25

CONTENTS

CINX:

COLLAPSED INTERPRETATION OF NUCLEAR X SECTIONS

by

R. B. Kidman and R. E. MacFarlane

ABSTRACT

CINX is a computer code designed to collapse multigroup cross sections in CCCC format to a subset of the original group structure and to write the results in the original CCCC format (ISOTXS, BRKOXS, and DLAYXS files only) or in the much used 1DX and PERT-V formats. CINX was designed as a collapse utility code for use with the MINX/SPHINX cross-section processing system, but it can be used to collapse CCCC cross-section sets from any source. If the weighting function specified is the same as the one used to generate the original multigroup cross sections, then the resulting collapsed cross sections will be exactly the same as those which would be obtained by generating the coarse-group cross sections directly.

I. INTRODUCTION

The Committee for Computer Code Coordination (CCCC)[1] interface files were designed to facilitate the communication of nuclear data between the codes and installations involved in the national fast reactor development program. The CCCC interface system allows for the production of cross sections using the Self-Shielding Factor Method.[2,3] CINX was designed as a collapsing code for the MINX/SPHINX implementation of this method, but it can be used with ISOTXS, BRKOXS, or DLAYXS files in CCCC Version III[4] format from any source.

Figure 1 outlines the MINX/SPHINX procedure for producing space and energy self-shielded macroscopic cross sections for use in reactor design codes. The MINX code (a Los Alamos Scientific Laboratory report in preparation) is used to generate fine-group cross sections and Legendre components of the group-to-group scattering matrices from the ENDF/B-IV nuclear data files.[5] These isotope cross sections are output in ISOTXS format. MINX also produces resonance self-shielding factors for a set of temperatures (T) and background cross sections (σ_0). These f-factors and other Bondarenko constants[2] are written in BRKOXS format. The DLAYXS file of delayed neutron yields and spectra is produced from ENDF/B-IV using NJOY.[6]

The LINX and BINX codes[7] are used to combine isotope cross sections from MINX into multi-isotope CCCC libraries, to list the binary libraries, and to convert files to BCD mode and back for transmission between installations.

The final code, SPHINX,[8] interpolates for the correct T and σ_0 dependent self-shielding factors for each isotope of the desired mixture, using equivalence principles to account for some geometry effects. The fine-group macroscopic cross sections are formed and used in a one-dimensional diffusion calculation (1DX)[9] or one-dimensional discrete ordinates calculation (ANISN).[10] The resulting flux is used to collapse to the final coarse-group macroscopic space and energy self-shielded cross sections; the results are written in ISOTXS format.

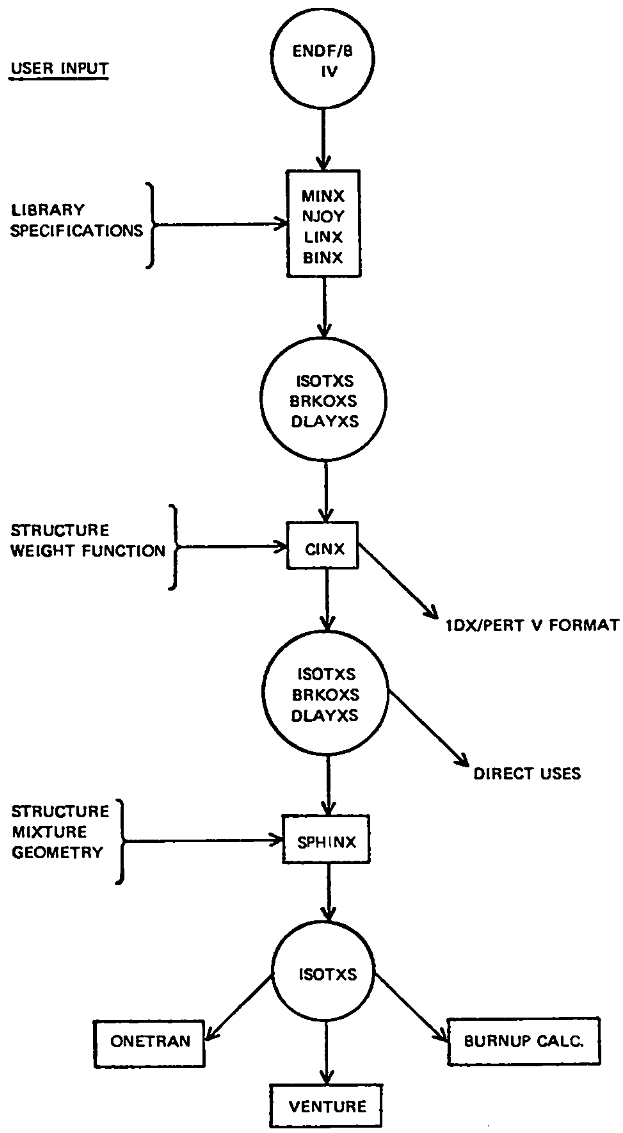

Fig. 1. Outline of the CCCC interface system for generating multigroup constants for fast reactor design.

This system has advantages of economy. It allows the detailed physics effects to be included in a seldom-run MINX code and saved on a pseudo-composition-independent library. Problem-dependent features can then be added using the frequently run SPHINX code.

The role of CINX in this system can now be made clear. For some difficult problems, very fine-group structures may be required (e.g., in the region of the iron 27-keV resonance). In addition, different energy ranges may be important to different users. The 14-MeV region so important in fusion applications is of little consequence in a fast reactor calculation. The concept of a "super-group library" has evolved to solve these two problems. The 239-group structure[11] contains features for fast reactors, CTR, weapons, and shielding applications which will not be needed by all users. The CINX code can be used to collapse such a super-group library into a new job-dependent library with a group structure and weighting function appropriate to a particular application. This library will be much cheaper to use with SPHINX.

The CINX code and the MINX multigroup libraries are also useful without SPHINX. Some problems do not require detailed self-shielding; in these cases, CINX can be used directly to provide group cross sections to such CCCC interfaced codes as ONETRAN.[12] In order to make MINX cross-section libraries useful for one widely used set[13,14,15] of fast reactor design codes, CINX has been provided with optional output in the 1DX[9] and PERT-V[16] formats.

The algorithms used in CINX, examples, sample problems, and operating instructions are discussed in the following sections.

II. COLLAPSING ALGORITHMS

If an element is present in a medium in low concentration, the element's particular resonance structure does not affect the neutron spectrum. In this case, cross-section processing codes (ETOX,[17] MINX, etc.) use an arbitrary smooth weighting function C(E) in the group-averaging process. A typical choice for C(E) is a thermal spectrum at low energies followed by a 1/E spectrum in the mid-range and a fission spectrum at high energies. The "infinitely dilute" isotope cross section for group g and reaction x is given by

$$\sigma_{xg} \equiv \frac{\int_g \sigma_x(E)C(E)dE}{\int_g C(E)dE} \quad . \qquad (1)$$

If the infinitely dilute fine-group cross sections σ_{xg} and a weighting flux $\phi_0(E)$ are passed on to CINX, CINX can preserve reaction rates and collapse to coarse group G as follows

$$\sigma_{xG} = \frac{\sum_{g\epsilon G} \sigma_{xg}\phi_{0g}}{\phi_{0G}} , \qquad (2)$$

where

$$\phi_{0g} = \int_g \phi_0(E)\,dE \qquad (3)$$

and

$$\phi_{0G} = \sum_{g\epsilon G} \phi_{0g} . \qquad (4)$$

If the weighting flux $\phi_0(E)$ is the same as the weighting function C(E) used in the original averaging, the collapsed cross section will have exactly the same value which would have been obtained by running the averaging in the coarse-group structure directly. Table I shows the CCCC ISOTXS, BRKOXS, and DLAYXS quantities that are collapsed according to Eq. (2).

Several quantities must be averaged with appropriate reaction rates in order to obtain proper group-averaged numbers. Neutron and delayed neutron precursor yields/fission must be weighted with the fission rate. The average cosine of the elastic scattering angle $\bar{\mu}$ and the average elastic scattering logarithmic energy decrement ξ must be weighted with the elastic scattering rate. Let Q_x represent the quantity to be reaction-rate averaged and σ_x the appropriate cross section, and let the processing code provide

$$Q_{xg} = \frac{\int_g Q_x(E)\sigma_x(E)C(E)\,dE}{\int_g \sigma_x(E)C(E)\,dE} , \qquad (5)$$

TABLE I

COLLAPSING AND NOTATION GUIDE

Quantity	CCCC Notation	Collapsing Algorithm
Transport X Sec	STRPL	12
Total X Sec	STOTPL	2
(n,γ) X Sec	SNGAM	2
Fission X Sec	SFIS	2
Neutron Yield/Fission	SNUTOT	6
Fission Spectrum	CHISO	7
(n,α) X Sec	SNALF	2
(n,p) X Sec	SNP	2
(n,2n) X Sec	SN2N	2
(n,D) X Sec	SND	2
(n,T) X Sec	SNT	2
Fission Matrix	CHIISO	9
Scattering Matrices	SCAT	10
Total Self-Shielding Factor	FTOT	22
Capture Self-Shielding Factor	FCAP	19
Fission Self-Shielding Factor	FFIS	19
Transport Self-Shielding Factor	FTR	23
Elastic Self-Shielding Factor	FEL	19
Potential Scattering X Sec	XSPO	2
Inelastic X Sec	XSIN	2
Elastic X Sec	XSE	2
$\bar{\mu}$	XSMU	6
Elastic Removal X Sec	XSED	11
ξ	XSXI	6
Delayed Neutron Spectra	CHID	7
Precursor Yield/Fission	SNUDEL	6

then exact collapsing can be achieved with the following

$$Q_{xG} = \frac{\sum_{g\epsilon G} Q_{xg}\phi_{0g}}{\sigma_{xG}\phi_{0G}} . \qquad (6)$$

Fission and delayed neutron spectra are represented by the fractions χ_g that are born into the various fine groups. Thus, the fraction born into coarse-group G is simply

$$\chi_G = \sum_{g\epsilon G} \chi_g . \qquad (7)$$

If a fission chi matrix is given in the ISOTXS file, it will have been produced by the following equation

$$\chi_{g\to g'} = \frac{\int_g dE \int_{g'} dE' \chi(E\to E') \nu(E) \sigma_f(E) C(E)}{\int_g \nu(E) \sigma_f(E) C(E) dE} , \quad (8)$$

where $\chi(E\to E')$ is the normalized fission spectrum due to a neutron captured at energy E. Preserving the reaction rate results in

$$\chi_{G\to G'} = \frac{\sum_{g\epsilon G} \sum_{g'\epsilon G'} \chi_{g\to g'} \nu_g \sigma_{fg} \phi_{0g}}{\nu_G \sigma_{fG} \phi_{0G}} . \quad (9)$$

The collapsing algorithm for the Legendre components of the group-to-group scattering matrices can be derived by preserving the transfer reaction rates. The result is

$$\sigma_{x\ell;G\to G'} = \frac{\sum_{g\epsilon G} \sum_{g'\epsilon G'} \sigma_{x\ell;g\to g'} \phi_{0g}}{\phi_{0G}} . \quad (10)$$

The coarse-group elastic removal cross section is computed from the already collapsed elastic and elastic in-group cross section

$$\sigma_{rG} = \sigma_{eG} - \sigma_{e0;G\to G} . \quad (11)$$

The coarse-group $\ell = 1$ transport cross section is also computed from already collapsed quantities

$$\sigma_{tr,G} = \sigma_{tG} - \bar{\mu}_G \sigma_{eG} . \quad (12)$$

The quantities considered up to this point were derived assuming the isotope was present in low concentration. When a material's concentration is not negligible, its resonance structure affects the neutron flux in the mixture. For the purpose of cross-section averaging, the weight function for the isotope being considered is taken to be

$$\phi(E,T,\sigma_0) = \frac{C(E)}{\sigma_0 + \sigma_t(E,T)} , \quad (13)$$

where σ_0 is a parameter provided to account for the environment of the isotope (mixture and geometry). The value of σ_0 is usually taken to equal the part of the total macroscopic cross section contributed by the other isotopes of the mixture divided by the density of the isotope in question; it is often modified by equivalence principles appropriate to the geometry of the system. The effective cross section at T and σ_0 is then given by

$$\sigma_{xg}(T,\sigma_0) = \frac{\int_g \frac{\sigma_x(E,T) C(E)}{\sigma_0 + \sigma_t(E,T)} dE}{\int_g \frac{C(E)}{\sigma_0 + \sigma_t(E,T)} dE} . \quad (14)$$

For library purposes, it has proven to be convenient to represent the T and σ_0 dependent cross sections of Eq. (14) using the infinite dilution cross sections of Eq. (1) and a set of correction (or self-shielding) factors as follows

$$\sigma_{xg}(T,\sigma_0) = f_{xg}(T,\sigma_0) \sigma_{xg} . \quad (15)$$

Tables of f-factors are precomputed for the elastic, fission, capture, total, and transport cross sections and for an arbitrary set of T and σ_0 values. The f-factors (and the effective cross section via a multiplication) for any given T and σ_0 can then be obtained by interpolating in these tables.

The ability to exactly collapse these f-factors depends on the ability to reproduce the fine-group flux used in the original generation of the multigroup constants. First, note that the effective total cross section is given by

$$\sigma_{tg}(T,\sigma_0) = f_{tg}(T,\sigma_0) \sigma_{tg} =$$

$$\int_g \frac{\sigma_t(E,T) \phi_0(E)}{\sigma_t(E,T) + \sigma_0} dE \bigg/ \int_g \frac{\phi_0(E)}{\sigma_t(E,T) + \sigma_0} dE , \quad (16)$$

where σ_{tg} is the infinitely dilute total cross section provided by the processing codes and where

$$f_{tg}(T,\sigma_0) = \frac{f_{fg}(T,\sigma_0)\sigma_{fg} + f_{cg}(T,\sigma_0)\sigma_{cg} + f_{eg}(T,\sigma_0)\sigma_{eg}}{\sigma_{fg} + \sigma_{cg} + \sigma_{eg}} \quad , \tag{17}$$

(all quantities to the right are also provided by the processing codes). Now, with just a little algebra, the original flux can be reproduced with the data provided

$$\phi_g(T,\sigma_0) = \int_g \frac{\phi_0(E)}{\sigma_t(E,T)+\sigma_0} dE = \int_g \phi_0(E)dE \Big/ [\sigma_{tg}(T,\sigma_0)+\sigma_0] = \phi_{0g} \Big/ [f_{tg}(T,\sigma_0)\sigma_{tg}+\sigma_0] \quad . \tag{18}$$

The exact collapsing algorithm for the "x" f-factor can now be derived by rewriting Eq. (16) in terms of the coarse group and expanding in terms of the fine-group quantitities

$$f_{Gx}(T,\sigma_0) = \frac{\sigma_{xG}(T,\sigma_0)}{\sigma_{xG}}$$

$$= \frac{\int_G \sigma_x(E,T)\phi(E,T,\sigma_0)dE \Big/ \int_G \phi(E,T,\sigma_0)dE}{\int_G \sigma_x(E)\phi_0(E)dE \Big/ \int_G \phi_0(E)dE}$$

$$= \frac{\sum_{g\epsilon G}\int_g \sigma_x(E,T,)\phi(E,T,\sigma_0)dE \Big/ \sum_{g\epsilon G}\int_g \phi(E,T;\sigma_0)dE}{\sum_{g\epsilon G}\int_g \sigma_x(E)\phi_0(E)dE \Big/ \sum_{g\epsilon G}\int_g \phi_0(E)dE}$$

$$= \frac{\sum_{g\epsilon G} f_{gx}(T,\sigma_0)\sigma_{gx}\phi_g(T,\sigma_0) \Big/ \sum_{g\epsilon G}\phi_g(T,\sigma_0)}{\sum_{g\epsilon G}\sigma_{gx}\phi_{0g} \quad \sum_{g\epsilon G}\phi_{0g}}$$

$$= \frac{\sum_{g\epsilon G}\frac{f_{xg}(T,\sigma_0)\sigma_{xg}\phi_{0g}}{f_{fg}(T,\sigma_0)\sigma_{tg}+\sigma_0} \Big/ \sum_{g\epsilon G}\frac{\phi_{0g}}{f_{tg}(T,\sigma_0)\sigma_{tg}+\sigma_0}}{\sigma_{xG}}$$

$$\text{for } x = c,e,f, \quad . \tag{19}$$

One f-factor, f_{tot}, is provided so that one can compute an effective diffusion coefficient for use in diffusion theory codes.

This requires that the total cross section be weighted by the current rather than the flux. MINX assumes that the current can be approximated by

$$\phi_1(E,\sigma_0,T) \cong \frac{\phi_0(E)}{[\sigma_t(E,T) + \sigma_0]^2} \quad . \tag{20}$$

Algebra similar to that used to obtain Eq. (18) gives

$$\phi_{1g}(T,\sigma_0) = \frac{\phi_{0g}}{[f_{tg}(T,\sigma_0)\sigma_{tg}+\sigma_0][f_{totg}(T,\sigma_0)\sigma_{tg}+\sigma_0]} . \tag{21}$$

The final algorithm for collapsing f_{totg} becomes

$$f_{totg}(T,\sigma_0) = \frac{\sum_{g\epsilon G} f_{totg}(T,\sigma_0)\sigma_{tg}\phi_{1g} \Big/ \sum_{g\epsilon G}\phi_{1g}}{\sigma_{tg}} \quad . \tag{22}$$

The transport self-shielding factor f_{tr} is provided so that one can compute an effective current weighted transport cross section. The collapsed transport self-shielding factors can be calculated from already collapsed quantities

$$f_{trG}(T,\sigma_0) = \frac{f_{totG}(T,\sigma_0)\sigma_{tG} - \bar{\mu}_G f_{eG}(T,\sigma_0)\sigma_{eG}}{\sigma_{tG} - \bar{\mu}_G\sigma_{eG}} . \tag{23}$$

III. CODING ASSUMPTIONS AND LIMITATIONS

The purpose of this section is to enumerate variances, arbitrary choices, or assumptions that may affect the use of CINX results.

If any $\ell > 1$ transport (STRPL) or $\ell > 0$ total (STOTPL) cross-section arrays are provided, they will be collapsed according to Eq. (2).

If the CCCC cross sections were provided with MINX, one should be aware of the following points.

1. The total scattering matrix will be the sum of elastic and all inelastic scattering reactions times their multiplicities (for instance, 3 × (n,3n) is added to the total).
2. The inelastic matrix will be the sum of all inelastic scattering reactions times their multiplicities, except (n,2n) is not included.
3. The (n,2n) scattering matrix will not have the 2x multiplicity included, i.e., the elements will sum to the (n,2n) reaction cross sections (SN2N).
4. The inelastic cross section, XSIN, is the sum of all scattering reactions with secondary neutrons times their multiplicities, except (n,2n) is not included, and (n,3n) is added without its multiplicity.
5. The capture self-shielding factor, FCAP, is actually the self-shielding factor for only the (n,γ) reaction.

MINX normally generates all Legendre order scattering matrices using the zero-order weighting flux. Since CINX will usually be processing MINX data, CINX will also collapse all Legendre order scattering matrices with the zero-order flux [as per Eq. (10)].

Some quantities in the CCCC format are not explicitly defined. Thus, in CINX (and MINX) the total self-shielding factor FTOT is taken to be a current weighted quantity that can be used to compute an effective diffusion coefficient for use in diffusion theory calculations. FTOT is therefore collapsed according to Eq. (22). CINX and MINX assume that the transport self-shielding factor FTR is derived from a current weighted transport cross section and can therefore be collapsed according to Eq. (23).

The CCCC definition of XSED is the elastic downscattering to the adjacent group. As Eq. (11) shows, CINX changes XSED to be the elastic removal cross section.

Some adjustment of the CCCC data is required to put it in proper 1DX format. The (n,γ), (n,α), (n,p), (n,D), and (n,T) reactions are summed to form the 1DX capture cross section, SIGC. Hence the capture self-shielding factors of 1DX are computed in the following manner

$$FCAP_{1DX} = [SIGC_{1DX} - SNGAM_{CCCC} + FCAP_{CCCC} * SNGAM_{CCCC}]/SIGC_{1DX} \ . \quad (24)$$

The inelastic matrix for 1DX is formed by summing all the inelastic scattering reactions times their multiplicities. The 1DX total inelastic cross section SIGIN is likewise a sum of all inelastic scattering reactions times their multiplicities, except the (n,2n) and (n,3n) reactions are added without multiplying by their multiplicities.

One of the CINX options for 1DX output is the number of downscattering terms for the 1DX inelastic matrix. If this number is less than the terms provided in the CCCC format, then the additional downscattering terms will be summed into the last 1DX downscattering term.

IV. INPUT AND OPERATION

The CINX input and operation information has been condensed into Table II. At most, there are only four types of input cards required and, if one is only going to switch from CCCC to 1DX format, just one card is required.

The major function (MF) indicator gives one the option to collapse in CCCC format, to switch from CCCC to 1DX format, or to collapse and put the result in both CCCC and 1DX format.

The number of coarse groups (NCG) indicator and the second card (number of fine groups per coarse group) allow one to collapse to any subset group structure.

The ICF option allows collapsing to proceed with a parameter specified (card 3) built-in collapsing flux, or with a completely arbitrary read-in flux (card 4). Collapsing will be exact if this flux is identical to the original.

The number of downscattering terms (NDT) determines the size of the inelastic scattering matrix for the 1DX format.

The neutron precursor file (NPF) indicator in conjunction with MF gives one the option to simply not process the delayed neutron data, to collapse in CCCC format, to switch from CCC to PERT-V format, or to collapse and put the results in both CCCC and PERT-V format. (Data terminators ["3"] have to be added by hand to the PERT-V cards.)

CINX running times on the CDC-7600 are relatively short. For instance, it takes 29 s to collapse 240-group ^{239}Pu to 50 groups. It takes 64 s to combine 50-group, 101-isotope ISOTXS and BRKOXS files into the 1DX format.

As a reminder, both the ISOTXS and BRKOXS files have to be supplied for any CINX run. Isotopes have to be in the same order on both files. The DLAYXS file does not have to be supplied if one does not wish to process it. Usually the DLAYXS file has fewer isotopes than the ISOTXS and BRKOXS files...which is all right as long as ISOTXS and BRKOXS contain the DLAYXS isotopes in the DLAYXS order (neglecting isotopes with no delayed neutron data).

TABLE II

CINX OPERATING INFORMATION

Input Files

3,4,12 - Fine-group binary CCCC-III ISOTXS, BRKOXS, and DLAYXS files, respectively.

Output Files

8,9,13 - Coarse-group binary CCCC-III ISOTXS, BRKOXS, and DLAYXS files, respectively.

10 - Coarse-group 1DX binary format.

System Files

5 - Data cards.

6 - Computer printout.

PUN - PERT-V output on cards.

Data Cards

1 - Run options input card (Format 5I6)

- MF Major functions (0/1/2 = collapse/1DX/both).
- NCG Number of coarse groups (omit if MF = 1).
- ICF Collapsing flux (0/1 = thermal-Fermi-Watt/input) (omit if MF = 1).
- NDT Number of downscattering terms (including ingroup) (omit if MF = 0).
- NPF Neutron precursor file (0/1 = No/Yes) (-for PERT-V data).

2 - Number of fine groups per each coarse group (Format 12I6) (omit if MF = 1).

3 - Parameters for ICF = 0 option (Format 4E12.5) (omit if MF = 1 or ICF ≠ 0).

- TB Nuclear temperature (eV) for thermal spectrum region (0.025 used for LIB-IV).
- EB Upper limit (eV) for thermal region (0.1 used for LIB-IV).
- TC Nuclear temperature (eV) for WATT spectrum region (1.4×10^6 used for LIB-IV).
- EC Lower limit (eV) for WATT region (0.8208×10^6 used for LIB-IV).

4 - Input flux (format 6E12.5) (omit if MF = 1 or ICF = 0).

APPENDIX A

LISTING OF CINX CODE

LASL IDENTIFICATION NO: LP-0509

```
      PROGRAM MAIN (INP,OUT,PUN,FSET3,FSET4,FSET7,FSET8,FSET9,FSET10,FSE CINX
     1T11,FSET12,FSET13,FSET5=INP,FSET6=OUT)                             CINX
C                                                                        CINX
C     ****************************************************************** CINX
C     MAIN PROGRAM FOR COLLAPSING FINE GROUP ISOTXS AND BROKXS FILES.    CINX
C     FINE GROUP ISOTXS ON FSET3.                                        CINX
C     FINE GROUP BROKXS ON FSET4.                                        CINX
C     FINE GROUP OLAYXS ON FSET12.                                       CINX
C     COURSE GROUP ISOTXS ON FSET8.                                      CINX
C     COURSE GROUP BROKXS ON FSET9.                                      CINX
C     COURSE GROUP OLAYXS ON FSET13.                                     CINX
C     IOX OUTPUT ON FSET10.                                              CINX
C     PERTV OUTPUT ON PUNCHED CARDS.                                     CINX
C     ****************************************************************** CINX
C                                                                        CINX
C     * * * *  SUBROUTINE DESCRIPTIONS  * * * *                          CINX
C                                                                        CINX
C     MAIN     MAIN PROGRAM                                              CINX
C                                                                        CINX
C     INPUT    READS AND WRITES THE INPUT DATA AND FORMS THE FINE GROUP  CINX
C              FLUX, COURSE GROUP FLUX, AND MARKS EACH FINE GROUP AS TO  CINX
C              WHICH COURSE GROUP IT BELONGS.                            CINX
C                                                                        CINX
C     MAX      COMPUTES THE MAXIMUM NUMBER OF GROUPS DOWNSCATTER AND     CINX
C              UPSCATTER FOR THE COURSE GROUP STRUCTURE.                 CINX
C                                                                        CINX
C     FIZZ     COLLAPSES A FINE GROUP FISSION SOURCE MATRIX TO A COURSE  CINX
C              GROUP FISSION SOURCE MATRIX.                              CINX
C                                                                        CINX
C     JBIJ     COMPUTES THE SCATTERING BANDWIDTHS AND THE IN-GROUP       CINX
C              SCATTERING POSITIONS FOR THE COLLAPSED GROUPS.            CINX
C                                                                        CINX
C     COLLAP   COLLAPSES THE FINE GROUP X-SECS.                          CINX
C                                                                        CINX
C     COLLFF   COLLAPSES THE FINE GROUP SELF-SHIELDING FACTORS.          CINX
C                                                                        CINX
C     * * * *  VARIABLE DESCRIPTIONS  * * * *                            CINX
C                                                                        CINX
C     MF                    MAJOR FUNCTION INDICATOR.                    CINX
C                                                                        CINX
C     ICF                   FLUX OPTION INDICATOR.                       CINX
C                                                                        CINX
C     NOT                   NUMBER OF DOWNSCATTERING TERMS.              CINX
C                                                                        CINX
C     NPF                   DELAYED NEUTRON PROCESSING INDICATOR.        CINX
C                                                                        CINX
C     NGROUP                NUMBER OF FINE GROUPS.                       CINX
C                                                                        CINX
C     NCG                   NUMBER OF COURSE GROUPS.                     CINX
C                                                                        CINX
C     NGG(I)                NUMBER OF FINE GROUPS IN COURSE GROUP I.     CINX
C                                                                        CINX
C     LG(I)                 COURSE GROUP NUMBER FOR FINE GROUP I.        CINX
C                                                                        CINX
C     F(I)                  ABSOLUTE FLUX IN FINE GROUP I.               CINX
C                                                                        CINX
C     TF(I)                 ABSOLUTE FLUX IN COURSE GROUP I.             CINX
C                                                                        CINX
C IBM REAL*8 HABSID,HIDENT,HMAT                                          CINX
      COMMON A(31000),X(600),JBFL(100),JBFH(100),NTABP(100),NTABT(100),J CINX
     1BL(100),JBH(100),NGG(240),LG(240),F(240),TF(240),XSED(240),XSXI(24 CINX
     20),W(240),LORD(4),XSPO(240),XSIN(240),XSF(240),XSMU(240),STOTPL(24 CINX
     30),SNGAM(240),SFIS(240),STRPL(240),JBAND(240,4),JBAN(240,4),IOSCT( CINX
     44),CAP(240),SNUTOT(240),SN2N(240),TB(300)                          CINX
      DIMENSION HSETID(24), HISONM(200), CHI(240), VEL(240), EMAX(241),  CINX
```

```
     1LOCA(100), G(960), IJJ(240,4), IJ(240,4), GG(240,4), FTOT(6,3,240) CINX
     2, FCAP(6,3,240), FFIS(6,3,240), FTR(6,3,240), FEL(6,3,240), FT(6,3 CINX
     3,240)                                                             CINX
      DIMENSION HABS(200), NKFAM(100), PERTV(10), FLAM(500), CHIO(240,12 CINX
     10), NUMFAM(100), SNUDEL(240,100)                                  CINX
      EQUIVALENCE (A(1),HSETID(1)), (A(225),CHI(1)), (A(465),VEL(1)), (A CINX
     1(705),EMAX(1)), (A(1346),IJJ(1,1)), (A(2306),IJ(1,1)), (A(29081),G CINX
     2(1)), (A(1),FTOT(1,1,1)), (A(4321),FCAP(1,1,1)), (A(8641),FFIS(1,1 CINX
     3,1)), (A(12961),FTR(1,1,1)), (A(17281),FEL(1,1,1)), (A(21601),FT(1 CINX
     4,1,1)), (A(30041),GG(1,1))                                        CINX
      EQUIVALENCE (A(1346),FLAM(1)), (A(2001),CHIO(1,1)), (A(1847),NUMFA CINX
     1M(1)), (A(3001),SNUDEL(1,1))                                      CINX
C     CREATE AN END-OF-FILE-SIMULATOR FOR WRITING BETWEEN FTR ISOTOPES. CINX
      DATA EOFS/4HEOFS/                                                 CINX
      DO 10 I=1,38748                                                   CINX
   10 A(I)=0                                                            CINX
      MULT=1                                                            CINX
C IBM MULT=2                                                            CINX
      IDIM=31000                                                        CINX
C     FILE IDENTIFICATION RECORDS.                                      CINX
      NWDS=1+3*MULT                                                     CINX
      READ (3)(A(I),I=1,NWDS)                                           CINX
      READ (4)(A(I),I=1,NWDS)                                           CINX
      WRITE (7)(A(I),I=1,NWDS)                                          CINX
      WRITE (9)(A(I),I=1,NWDS)                                          CINX
C     FILE CONTROL RECORDS.                                             CINX
      READ (3)NGROUP,NISO,MAXUP,MAXDN,MAXORD,ICHIST,NSCMAX,NSBLOK       CINX
      READ (4)NGROUP,NISOSH,NSIGPT,NTEMPT                               CINX
C     FILE DATA RECORDS.                                                CINX
      ID2=12*MULT                                                       CINX
      NM1=NISO*MULT                                                     CINX
      IF (ICHIST.EQ.1) READ (3)(HSETID(I),I=1,ID2),(HISONM(I),I=1,NM1),( CINX
     1CHI(J),J=1,NGROUP),(VEL(J),J=1,NGROUP),(EMAX(J),J=1,NGROUP),EMIN,( CINX
     2LOCA(I),I=1,NISO)                                                 CINX
      IF (ICHIST.NE.1) READ (3)(HSETID(I),I=1,ID2),(HISONM(I),I=1,NM1),( CINX
     1VEL(J),J=1,NGROUP),(EMAX(J),J=1,NGROUP),EMIN,(LOCA(I),I=1,NISO)   CINX
C     WE NOW HAVE THE FINE GROUP ENERGY STRUCTURE SO WE CAN READ THE    CINX
C     USER INPUT, FINISH WORKING ON THE FILE CONTROL RECORDS AND WRITE  CINX
C     THEM OUT.                                                         CINX
      NG1=NGROUP+1                                                      CINX
      EMAX(NG1)=EMIN                                                    CINX
      CALL INPUT (NGROUP,NCG,NGG,LG,NG1,EMAX,F,IF,MF,NDT,NPF)           CINX
      IF (NPF.EQ.0) GO TO 40                                            CINX
      READ (12)(A(I),I=1,NWDS)                                          CINX
      WRITE (13)(A(I),I=1,NWDS)                                         CINX
      READ (12)NGROUP,NISOD,NFAM,IDUM                                   CINX
      WRITE (13)NCG,NISOD,NFAM,IDUM                                     CINX
      NDY=NISOD*MULT                                                    CINX
      READ (12)(HABS(I),I=1,NDY),(FLAM(N),N=1,NFAM),((CHIO(J,N),J=1,NGRO CINX
     1UP),N=1,NFAM),(EMAX(J),J=1,NGROUP),EMIN,(NKFAM(I),I=1,NISOD),(LOCA CINX
     2(I),I=1,NISOD)                                                    CINX
      DO 30 N=1,NFAM                                                    CINX
      L=0                                                               CINX
      DO 30 JI=1,NCG                                                    CINX
      J=NGG(JI)                                                         CINX
      S=0.0                                                             CINX
      DO 20 K=1,J                                                       CINX
      L=L+1                                                             CINX
   20 S=S+CHIO(L,N)                                                     CINX
      IF (S.LT.0.0) S=0.0                                               CINX
   30 CHIO(JI,N)=S                                                      CINX
      IF (NPF.GT.0) GO TO 40                                            CINX
      PUNCH 840, (FLAM(K),K=1,NFAM)                                     CINX
      PUNCH 840, ((CHIO(J,K),J=1,NCG),K=1,NFAM)                         CINX
   40 CONTINUE                                                          CINX
      IF (MF.EQ.1) GO TO 50                                             CINX
      CALL MAX (MAXUP,MAXDN,MUP,MDN,NGG,NCG)                            CINX
      WRITE (7)NCG,NISO,MUP,MDN,MAXORD,ICHIST,NSCMAX,NCG                CINX
      WRITE (9)NCG,NISOSH,NSIGPT,NTEMPT                                 CINX
C     RESUME WORKING WITH THE FILE DATA RECORDS.                        CINX
   50 NM2=NISOSH*MULT                                                   CINX
      READ (4)(HISONM(I),I=1,NM2),(X(K),K=1,NSIGPT),(TB(K),K=1,NTEMPT),( CINX
```

```
     1EMAX(J),J=1,NGROUP),EMIN,(JBFL(I),I=1,NISOSH),(JBFH(I),I=1,NISOSH) CINX
     2,(NTABP(I),I=1,NISOSH),(NTABT(I),I=1,NISOSH)                     CINX
      IF (MF.EQ.1) GO TO 90                                            CINX
C     DETERMINE THE LOWEST,JBL, AND THE HIGHEST,JBH, COURSE GROUPS FOR CINX
C     WHICH SELF-SHIELDING FACTORS WILL BE GIVEN.                      CINX
      DO 60 I=1,NISOSH                                                 CINX
      JL=JBFL(I)                                                       CINX
      JH=JBFH(I)                                                       CINX
      JBL(I)=LG(JL)                                                    CINX
   60 JBH(I)=LG(JH)                                                    CINX
C     DETERMINE THE COURSE GROUP ENERGY BOUNDARIES (STORING THEM IN THE CINX
C     ORGINAL EMAX ARRAY) AND COLLAPSE THE SET FISSION SOURCE VECTOR.  CINX
      M=1                                                              CINX
      DO 70 I=1,NCG                                                    CINX
      N=NGG(I)                                                         CINX
      CHI(I)=0.0                                                       CINX
      EMAX(I)=EMAX(M)                                                  CINX
      DO 70 J=1,N                                                      CINX
      CHI(I)=CHI(I)+CHI(M)                                             CINX
   70 M=M+1                                                            CINX
C     COMPUTE THE COURSE GROUP VELOCITIES.                             CINX
      NCG1=NCG-1                                                       CINX
      C=SQRT(1.602/(1.67482*2.))*1.E6                                  CINX
      DO 80 I=1,NCG1                                                   CINX
   80 VEL(I)=C*(SQRT(EMAX(I))+SQRT(EMAX(I+1)))                         CINX
      VEL(NCG)=C*SQRT(EMAX(NCG))                                       CINX
C     WRITE OUT THE FILE DATA RECORDS                                  CINX
      IF (ICHIST.EQ.1) WRITE (7)(HSETID(I),I=1,ID2),(HISONM(I),I=1,NM1), CINX
     1(CHI(J),J=1,NCG),(VEL(J),J=1,NCG),(EMAX(J),J=1,NCG),EMIN,(LOCA(I), CINX
     2I=1,NISO)                                                        CINX
      IF (ICHIST.NE.1) WRITE (7)(HSETID(I),I=1,ID2),(HISONM(I),I=1,NM1), CINX
     1(VEL(J),J=1,NCG),(EMAX(J),J=1,NCG),EMIN,(LOCA(I),I=1,NISO)       CINX
      WRITE (9)(HISONM(I),I=1,NM2),(X(K),K=1,NSIGPT),(TB(K),K=1,NTEMPT), CINX
     1(EMAX(J),J=1,NCG),EMIN,(JBL(I),I=1,NISOSH),(JBH(I),I=1,NISOSH),(NT CINX
     2ABP(I),I=1,NISOSH),(NTABT(I),I=1,NISOSH)                         CINX
      IF (NPF.EQ.0) GO TO 90                                           CINX
      WRITE (13)(HABS(I),I=1,NDY),(FLAM(N),N=1,NFAM),((CHID(J,N),J=1,NCG CINX
     1),N=1,NFAM),(EMAX(J),J=1,NCG),EMIN,(NKFAM(I),I=1,NISOD),(LOCA(I),I CINX
     2=1,NISOD)                                                        CINX
   90 DO 100 K=1,NSIGPT                                                CINX
  100 X(K)=10.**X(K)                                                   CINX
      DO 110 K=1,NTEMPT                                                CINX
  110 TB(K)=TB(K)+273.16                                               CINX
C     SET CHI MATRIX.                                                  CINX
      IF (ICHIST.LE.1) GO TO 130                                       CINX
      NWDS=NGROUP*(ICHIST+1)                                           CINX
      IF (NWDS+NCG*NCG+2*NGROUP.GT.IDIM) GO TO 830                     CINX
      READ (3)(A(I),I=1,NWDS)                                          CINX
      IF (MF.EQ.1) GO TO 130                                           CINX
      N2=2*NGROUP                                                      CINX
      DO 120 I=1,N2                                                    CINX
  120 A(NWDS+I)=1.                                                     CINX
      CALL FIZZ (A(1),A(ICHIST*NGROUP+1),A(NWDS+1),A(NWDS+NGROUP+1),F,NG CINX
     1G,ICHIST,NGROUP,NCG,A(NWDS+2*NGROUP+1))                          CINX
      NCGNCG=NCG*NCG                                                   CINX
      WRITE (7)(A(NWDS+2*NGROUP+J),J=1,NCGNCG),(A(ICHIST*NGROUP+J),J=1,N CINX
     1CG)                                                              CINX
  130 CONTINUE                                                         CINX
C     LOOP OVER ALL ISOTOPES.                                          CINX
      NX=0                                                             CINX
      KT=0                                                             CINX
      NOR=0                                                            CINX
      II=1                                                             CINX
      DO 740 I=1,NISO                                                  CINX
      DO 140 J=1,NGROUP                                                CINX
      SFIS(J)=0                                                        CINX
      SNUTOT(J)=0                                                      CINX
      SN2N(J)=0                                                        CINX
  140 CONTINUE                                                         CINX
      LOCA(I)=NOR                                                      CINX
C     ISOTOPE CONTROL AND GROUP INDEPENDENT DATA.                      CINX
      READ (3)HABSID,HIDENT,HMAT,AMASS,EFISS,ECAPT,TEMP,SIGPOT,ADENS,KBR CINX
```

```
     1,ICHI,IFIS,IALF,INP,IN2N,IND,INT,LTOT,LTRN,ISTRPO,(IDSCT(N),N=1,NS CINX
     2CMAX),(LORD(N),N=1,NSCMAX),((JBAND(J,N),J=1,NGROUP),N=1,NSCMAX),(( CINX
     3IJJ(J,N),J=1,NGROUP),N=1,NSCMAX)                                   CINX
      IF (MF.EQ.1) GO TO 150                                             CINX
      CALL JBIJ (JBAND,IJJ,JBAN,IJ,NGG,NSCMAX,NGROUP,NCG)                CINX
      WRITE (7)HABSID,HIDENT,HMAT,AMASS,EFISS,ECAPT,TEMP,SIGPOT,ADENS,KB CINX
     1R,ICHI,IFIS,IALF,INP,IN2N,IND,INT,LTOT,LTRN,ISTRPO,(IDSCT(N),N=1,N CINX
     2SCMAX),(LORD(N),N=1,NSCMAX),((JBAN(J,N),J=1,NCG),N=1,NSCMAX),((IJ( CINX
     3J,N),J=1,NCG),N=1,NSCMAX)                                          CINX
      NOR=NOR+1                                                          CINX
C     PRINCIPAL CROSS SECTIONS.                                          CINX
  150 NWDS=(1+LTRN+LTOT+IALF+INP+IN2N+IND+INT+ISTRPO+2*IFIS+ICHI*(2/(ICH CINX
     1I+1)))*NGROUP                                                      CINX
      READ (3)(A(J),J=1,NWDS)                                            CINX
C     SAVING AND COLLAPSING THE TRANSPORT X-SEC.                         CINX
      DO 170 L=1,LTRN                                                    CINX
      IF (L.GT.1) GO TO 170                                              CINX
      DO 160 J=1,NGROUP                                                  CINX
  160 STRPL(J)=A(J)                                                      CINX
  170 CALL COLLAP (A(NGROUP*(L-1)+1),A(NCG*(L-1)+1),F,NGG,NGROUP,NCG)    CINX
C     SAVING AND COLLAPSING THE TOTAL X-SEC.                             CINX
      M=LTRN*NGROUP                                                      CINX
      DO 190 L=1,LTOT                                                    CINX
      IF (L.GT.1) GO TO 190                                              CINX
      DO 180 J=1,NGROUP                                                  CINX
  180 STOTPL(J)=A(J+M)                                                   CINX
  190 CALL COLLAP (A(M+NGROUP*(L-1)+1),A(LTRN*NCG+NCG*(L-1)+1),F,NGG,NGR CINX
     1OUP,NCG)                                                           CINX
C     SAVING AND COLLAPSING THE N,G X-SEC.                               CINX
      M=(LTRN+LTOT)*NGROUP                                               CINX
      DO 200 J=1,NGROUP                                                  CINX
      CAP(J)=A(J+M)                                                      CINX
  200 SNGAM(J)=A(J+M)                                                    CINX
      CALL COLLAP (A(M+1),A(NCG*(LTRN+LTOT)+1),F,NGG,NGROUP,NCG)         CINX
C     SAVING AND COLLAPSING THE FISSION X-SEC.                           CINX
      IF (IFIS.LE.0) GO TO 270                                           CINX
      M=(1+LTRN+LTOT)*NGROUP                                             CINX
      DO 210 J=1,NGROUP                                                  CINX
  210 SFIS(J)=A(J+M)                                                     CINX
      CALL COLLAP (A(M+1),A(1+(1+LTRN+LTOT)*NCG),F,NGG,NGROUP,NCG)       CINX
C     SAVING AND COLLAPSING THE NEUTRON YIELD/FISSION.                   CINX
      M=M+NGROUP                                                         CINX
      DO 220 J=1,NGROUP                                                  CINX
      SNUTOT(J)=A(J+M)                                                   CINX
  220 W(J)=SFIS(J)*F(J)                                                  CINX
      CALL COLLAP (A(M+1),A(1+(2+LTRN+LTOT)*NCG),W,NGG,NGROUP,NCG)       CINX
      IF (NPF.EQ.0.OR.HISONM(I*MULT).NE.HABS(II*MULT)) GO TO 270         CINX
      NKFAMI=NKFAM(II)                                                   CINX
      READ (12)((SNUDEL(J,K),J=1,NGROUP),K=1,NKFAMI),(NUMFAM(K),K=1,NKFA CINX
     1MI)                                                                CINX
      IF (NPF.GT.0) GO TO 250                                            CINX
      SUM=0.0                                                            CINX
      DO 230 K=1,NKFAMI                                                  CINX
      CALL COLLAP (SNUDEL(1,K),PERTV(K),W,NGROUP,NGROUP,1)               CINX
  230 SUM=SUM+PERTV(K)                                                   CINX
      DO 240 K=1,NKFAMI                                                  CINX
  240 PERTV(K)=PERTV(K)/SUM                                              CINX
      PUNCH 840, SUM                                                     CINX
      PUNCH 840, (PERTV(K),K=1,NKFAMI)                                   CINX
  250 CONTINUE                                                           CINX
      DO 260 K=1,NKFAMI                                                  CINX
  260 CALL COLLAP (SNUDEL(1,K),SNUDEL(1,K),W,NGG,NGROUP,NCG)             CINX
      WRITE (13)((SNUDEL(J,K),J=1,NCG),K=1,NKFAMI),(NUMFAM(K),K=1,NKFAMI CINX
     1)                                                                  CINX
      II=II+1                                                            CINX
  270 IF (ICHI.LE.0) GO TO 300                                           CINX
C     COLLAPSING THE ISOTOPE FISSION SOURCE VECTOR.                      CINX
      M=M+NGROUP                                                         CINX
      L=0                                                                CINX
      N=(LTRN+LTOT+1+2*IFIS)*NCG                                         CINX
      DO 290 JI=1,NCG                                                    CINX
      J=NGG(JI)                                                          CINX
```

```
      S=0.0                                                             CINX
      DO 280 K=1,J                                                      CINX
      L=L+1                                                             CINX
  280 S=S+A(M+L)                                                        CINX
  290 A(JI+N)=S                                                         CINX
C     COLLAPSE THE REMAINING X-SEC.                                     CINX
  300 MM=NCG*(LTRN+LTOT+2*IFIS+ICHI*(2/(ICHI+1)))                       CINX
      IF (IALF.EQ.0) GO TO 320                                          CINX
      M=M+NGROUP                                                        CINX
      MM=MM+NCG                                                         CINX
      DO 310 J=1,NGROUP                                                 CINX
  310 CAP(J)=CAP(J)+A(J+M)                                              CINX
      CALL COLLAP (A(M+1),A(MM+1),F,NGG,NGROUP,NCG)                     CINX
  320 IF (INP.EQ.0) GO TO 340                                           CINX
      M=M+NGROUP                                                        CINX
      MM=MM+NCG                                                         CINX
      DO 330 J=1,NGROUP                                                 CINX
  330 CAP(J)=CAP(J)+A(J+M)                                              CINX
      CALL COLLAP (A(M+1),A(MM+1),F,NGG,NGROUP,NCG)                     CINX
  340 IF (IN2N.EQ.0) GO TO 360                                          CINX
      M=M+NGROUP                                                        CINX
      MM=MM+NCG                                                         CINX
      DO 350 J=1,NGROUP                                                 CINX
  350 SN2N(J)=A(M+J)                                                    CINX
      CALL COLLAP (A(M+1),A(MM+1),F,NGG,NGROUP,NCG)                     CINX
  360 IF (IND.EQ.0) GO TO 380                                           CINX
      M=M+NGROUP                                                        CINX
      MM=MM+NCG                                                         CINX
      DO 370 J=1,NGROUP                                                 CINX
  370 CAP(J)=CAP(J)+A(J+M)                                              CINX
      CALL COLLAP (A(M+1),A(MM+1),F,NGG,NGROUP,NCG)                     CINX
  380 IF (INT.EQ.0) GO TO 400                                           CINX
      M=M+NGROUP                                                        CINX
      MM=MM+NCG                                                         CINX
      DO 390 J=1,NGROUP                                                 CINX
  390 CAP(J)=CAP(J)+A(J+M)                                              CINX
      CALL COLLAP (A(M+1),A(MM+1),F,NGG,NGROUP,NCG)                     CINX
  400 IF (ISTRPO.EQ.0) GO TO 420                                        CINX
      DO 410 L=1,ISTRPO                                                 CINX
      M=M+NGROUP                                                        CINX
      MM=MM+NCG                                                         CINX
      CALL COLLAP (A(M+1),A(MM+1),F,NGG,NGROUP,NCG)                     CINX
  410 CONTINUE                                                          CINX
  420 NWOS=(1+LTRN+LTOT+IALF+INP+IN2N+IND+INT+ISTRPO+2*IFIS+ICHI*(2/(ICH CINX
     1I+1)))*NCG                                                        CINX
      IF (MF.NE.1) WRITE (7)(A(J),J=1,NWOS)                             CINX
      NOR=NOR+1                                                         CINX
C     SELF-SHIELDING FACTORS.                                           CINX
      NBINT=NTABP(I)                                                    CINX
      NBTEM=NTABT(I)                                                    CINX
      JBFLI=JBFL(I)                                                     CINX
      JBFHI=JBFH(I)                                                     CINX
      JBLI=JBL(I)                                                       CINX
      JBHI=JBH(I)                                                       CINX
      DO 430 J=1,NGROUP                                                 CINX
      DO 430 K=1,NBTEM                                                  CINX
      DO 430 N=1,NBINT                                                  CINX
      FTOT(N,K,J)=1.                                                    CINX
      FCAP(N,K,J)=1.                                                    CINX
      FFIS(N,K,J)=1.                                                    CINX
      FTR(N,K,J)=1.                                                     CINX
  430 FEL(N,K,J)=1.                                                     CINX
      READ (4)(((FTOT(N,K,J),N=1,NBINT),K=1,NBTEM),J=JBFLI,JBFHI),(((FCA CINX
     1P(N,K,J),N=1,NBINT),K=1,NBTEM),J=JBFLI,JBFHI),(((FFIS(N,K,J),N=1,N CINX
     2BINT),K=1,NBTEM),J=JBFLI,JBFHI),(((FTR(N,K,J),N=1,NBINT),K=1,NBTEM CINX
     3),J=JBFLI,JBFHI),(((FEL(N,K,J),N=1,NBINT),K=1,NBTEM),J=JBFLI,JBFHI CINX
     4)                                                                 CINX
      READ (4)(XSPO(J),J=1,NGROUP),(XSIN(J),J=1,NGROUP),(XSE(J),J=1,NGRO CINX
     1UP),(XSMU(J),J=1,NGROUP),(XSEO(J),J=1,NGROUP),(XSXT(J),J=1,NGROUP) CINX
      DO 440 J=1,NGROUP                                                 CINX
  440 SN2N(J)=SN2N(J)+XSIN(J)                                           CINX
      IF (MF.EQ.1) GO TO 480                                            CINX
```

```
      DO 450 J=1,NGROUP                                                 CINX
      DO 450 K=1,NBTEM                                                  CINX
      DO 450 N=1,NBINT                                                  CINX
  450 FT(N,K,J)=(FFIS(N,K,J)*SFIS(J)+FCAP(N,K,J)*SNGAM(J)+FEL(N,K,J)*XSE CINX
     1(J)+STOTPL(J)-SFIS(J)-SNGAM(J)-XSE(J))/STOTPL(J)                  CINX
      CALL COLLFF (FTOT,STOTPL,FT,STOTPL,F,X,NX,NGG,NBINT,NBTEM,NGROUP,N CINX
     1CG,NSIGPT,1)                                                      CINX
      CALL COLLFF (FCAP,SNGAM,FT,STOTPL,F,X,NX,NGG,NBINT,NBTEM,NGROUP,NC CINX
     1G,NSIGPT,0)                                                       CINX
      CALL COLLFF (FFIS,SFIS,FT,STOTPL,F,X,NX,NGG,NBINT,NBTEM,NGROUP,NCG CINX
     1,NSIGPT,0)                                                        CINX
      CALL COLLFF (FEL,XSE,FT,STOTPL,F,X,NX,NGG,NBINT,NBTEM,NGROUP,NCG,N CINX
     1SIGPT,0)                                                          CINX
      DO 460 J=1,NGROUP                                                 CINX
  460 W(J)=XSE(J)*F(J)                                                  CINX
      CALL COLLAP (XSPO,XSPO,F,NGG,NGROUP,NCG)                          CINX
      CALL COLLAP (XSIN,XSIN,F,NGG,NGROUP,NCG)                          CINX
      CALL COLLAP (XSE,XSE,F,NGG,NGROUP,NCG)                            CINX
      CALL COLLAP (XSMU,XSMU,W,NGG,NGROUP,NCG)                          CINX
      CALL COLLAP (XSXI,XSXI,W,NGG,NGROUP,NCG)                          CINX
C     COMPUTE COURSE GROUP TRANSPORT F-FACTORS.                         CINX
      CALL COLLAP (STOTPL,STOTPL,F,NGG,NGROUP,NCG)                      CINX
      DO 470 J=1,NCG                                                    CINX
      STRPL(J)=STOTPL(J)-XSMU(J)*XSE(J)                                 CINX
      DO 470 K=1,NBTEM                                                  CINX
      DO 470 N=1,NBINT                                                  CINX
  470 FTR(N,K,J)=(FTOT(N,K,J)*STOTPL(J)-XSMU(J)*FEL(N,K,J)*XSE(J))/STRPL CINX
     1(J)                                                               CINX
      WRITE (9)(((FTOT(N,K,J),N=1,NBINT),K=1,NBTEM),J=JBLI,JBHI),(((FCAP CINX
     1(N,K,J),N=1,NBINT),K=1,NBTEM),J=JBLI,JBHI),(((FFIS(N,K,J),N=1,NBTN CINX
     2T),K=1,NBTEM),J=JBLI,JBHI),(((FTR(N,K,J),N=1,NBINT),K=1,NBTEM),J=J CINX
     3BLI,JBHI),(((FEL(N,K,J),N=1,NBINT),K=1,NBTEM),J=JBLI,JBHI)        CINX
C     WRITE OUT F-FACTORS IN FTR FORMAT.                                CINX
  480 IF (MF.EQ.0) GO TO 500                                            CINX
      IF (MF.EQ.1) WRITE (10)HABSIO,AMASS,NBTEM,JBFL(I),JBFH(I),NBINT,NB CINX
     1INT,NBTNT,NBINT,(TB(KT+K),K=1,NBTEM)                              CINX
      IF (MF.EQ.2) WRITE (10)HABSIO,AMASS,NBTEM,JBL(I),JBH(I),NBINT,NBIN CINX
     1T,NBTNT,NBINT,(TB(KT+K),K=1,NBTEM)                                CINX
      NB=JBFLI                                                          CINX
      NE=JBFHI                                                          CINX
      IF (MF.EQ.2) NB=JBLI                                              CINX
      IF (MF.EQ.2) NE=JBHI                                              CINX
      WRITE (10)(X(NX+K),K=1,NBINT)                                     CINX
      WRITE (10)(((FFIS(N,K,J),N=1,NBINT),K=1,NBTEM),J=NB,NE)           CINX
      WRITE (10)(X(NX+K),K=1,NBINT)                                     CINX
      IF (MF.EQ.2) CALL COLLAP (CAP,CAP,F,NGG,NGROUP,NCG)               CINX
      IF (MF.EQ.2) CALL COLLAP (SNGAM,SNGAM,F,NGG,NGROUP,NCG)           CINX
      DO 490 N=1,NBINT                                                  CINX
      DO 490 K=1,NBTEM                                                  CINX
      DO 490 J=NB,NE                                                    CINX
      IF (CAP(J).NE.0.0) FCAP(N,K,J)=1.+(FCAP(N,K,J)-1.)*SNGAM(J)/CAP(J) CINX
  490 CONTINUE                                                          CINX
      WRITE (10)(((FCAP(N,K,J),N=1,NBINT),K=1,NBTEM),J=NB,NE)           CINX
      WRITE (10)(X(NX+K),K=1,NBINT)                                     CINX
      WRITE (10)(((FTOT(N,K,J),N=1,NBINT),K=1,NBTEM),J=NB,NE)           CINX
      WRITE (10)(X(NX+K),K=1,NBINT)                                     CINX
      WRITE (10)(((FEL(N,K,J),N=1,NBINT),K=1,NBTEM),J=NB,NE)            CINX
  500 CONTINUE                                                          CINX
C     COLLAPSING THE ISOTOPE FISSION SOURCE MATRIX.                     CINX
      IF (ICHI.LE.1) GO TO 510                                          CINX
      NWDS=NGROUP*(ICHI+1)                                              CINX
      IF (NWDS+NCG*NCG.GT.IDIM) GO TO 830                               CINX
      READ (3)(A(J),J=1,NWDS)                                           CINX
      IF (MF.EQ.1) GO TO 510                                            CINX
      CALL FIZZ (A(1),A(ICHI*NGROUP+1),SFIS,SNUTOT,F,NGG,ICHI,NGROUP,NCG CINX
     1,A(NWDS+2*NGROUP+1))                                              CINX
      NCGNCG=NCG*NCG                                                    CINX
      WRITE (7)(A(NWDS+2*NGROUP+J),J=1,NCGNCG),(A(ICHIST*NGROUP+J),J=1,N CINX
     1CG)                                                               CINX
      NOR=NOR+1                                                         CINX
C     COLLAPSING THE SCATTERING MATRICES.                               CINX
  510 NN=(NGROUP**2-NGROUP)/2+NGROUP                                    CINX
      DO 520 N=1,NN                                                     CINX
```

```
  520 A(N)=0.0
      DO 640 N=1,NSCMAX
      LORON=LORO(N)
      IF (LORON.EQ.0) GO TO 640
      IOSCTN=IOSCT(N)
      IF (MF.NE.1) GO TO 560
      M=0
      DO 550 J=1,NSBLOK
      M=M+NGROUP-J+1
      JL=JBAND(J,N)
      IF (JL.EQ.0) GO TO 550
      READ (3)(G(K),K=1,JL)
      IF (IOSCTN.EQ.0) GO TO 550
      TF (IOSCTN.NE.100) GO TO 530
      XSED(J)=XSE(J)-G(1)
      GO TO 550
  530 MM=M
      DO 540 K=1,JL
      MM=MM-NGROUP-K+J
      A(MM+K)=A(MM+K)+G(K)
      IF (IOSCTN.EQ.300) A(MM+K)=A(MM+K)+G(K)
  540 CONTINUE
  550 CONTINUE
      GO TO 640
  560 CONTINUE
      MMM=0
      IFG=0
      DO 630 ICGP=1,NCG
      MMM=MMM+NCG-ICGP+1
      NN=NGG(ICGP)
      DO 570 M=1,4
      DO 570 L=1,240
  570 GG(L,M)=0.0
      DO 590 M=1,NN
      IFG=IFG+1
      JBANDI=JBAND(IFG,N)
      JL=JBANDI*LORON
      IF (JL.EQ.0) GO TO 590
      READ (3)(G(K),K=1,JL)
      DO 580 L=1,LORON
      DO 580 J=1,JBANDI
      ICG=LG(IFG-J+1)
      II=ICGP+1-ICG
      GG(II,L)=G(J+(L-1)*JBANDI)*F(IFG-J+1)/TF(ICG)+GG(II,L)
  580 CONTINUE
  590 CONTINUE
      II=JBAN(ICGP,N)
      IF (II.EQ.0) GO TO 600
      IF (MF.NE.1) WRITE (7)((GG(J,L),J=1,II),L=1,LORON)
      NOR=NOR+1
  600 CONTINUE
      IF (IOSCTN.EQ.0) GO TO 630
      IF (IOSCTN.NE.100) GO TO 610
      XSED(ICGP)=XSE(ICGP)-GG(1,1)
      GO TO 630
  610 MM=MMM
      DO 620 K=1,II
      MM=MM-NCG-K+ICGP
      A(MM+K)=A(MM+K)+GG(K,1)
      IF (IOSCTN.EQ.300) A(MM+K)=A(MM+K)+GG(K,1)
  620 CONTINUE
  630 CONTTNUE
  640 CONTINUE
      IF (MF.NE.1) WRITE (9)(XSPO(J),J=1,NCG),(XSIN(J),J=1,NCG),(XSE(J),
     1J=1,NCG),(XSMU(J),J=1,NCG),(XSED(J),J=1,NCG),(XSXI(J),J=1,NCG)
      NG=NGROUP
      IF (MF.EQ.0) GO TO 730
      IF (MF.EQ.1) GO TO 660
      NG=NCG
      DO 650 J=1,NGROUP
  650 W(J)=SFIS(J)*F(J)
      CALL COLLAP (SNUTOT,SNUTOT,W,NGG,NGROUP,NCG)
```

```
      CALL COLLAP (SFIS,SFIS,F,NGG,NGROUP,NCG)
      CALL COLLAP (SN2N,SN2N,F,NGG,NGROUP,NCG)
  660 CONTINUE
      WRITE (10)(STOTPL(N),SFIS(N),SNUTOT(N),CAP(N),SN2N(N),XSE(N),XSMU(
     1N),XSXI(N),XSED(N),N=1,NG)
      Z=0.0
      M=-NG-1
      DO 710 J=1,NG
      M=M+NG-J+2
      NGJ=NG+1-J
      NN=NOT-NGJ
      IF (NN) 680,700,670
  670 WRITE (11)(A(M+K),K=1,NGJ),(Z,K=1,NN)
      GO TO 710
  680 NOT1=NOT+1
      DO 690 N=NOT1,NGJ
  690 A(M+NOT)=A(M+NDT)+A(M+N)
  700 WRITE (11)(A(M+K),K=1,NDT)
  710 CONTINUE
      REWIND 11
      NGNOT=NG*NOT
      IF (NGNDT.GT.38748) GO TO 820
      DO 720 J=1,NG
      NN=(J-1)*NDT
  720 READ (11)(A(NN+N),N=1,NOT)
      REWIND 11
      WRITE (10)(A(J),J=1,NGNOT)
      WRITE (10)EOFS
  730 NX=NX+NBINT
      KT=KT+NBTEM
  740 CONTINUE
      IF (MF.EQ.1) GO TO 810
C     ACCOMODATING THE CONFOUNDED LOCA ARRAY
      END FILE 7
      REWIND 7
      NWOS=1+3*MULT
      READ (7)(A(I),I=1,NWDS)
      WRITE (8)(A(I),I=1,NWOS)
      READ (7)NGROUP,NISO,MAXUP,MAXON,MAXORD,ICHIST,NSCMAX,NSBLOK
      WRITE (8)NGROUP,NISO,MAXUP,MAXDN,MAXORD,ICHIST,NSCMAX,NSBLOK
      IF (ICHIST.EQ.1) READ (7)(HSETID(I),I=1,ID2),(HISONM(I),I=1,NM1),(
     1CHI(J),J=1,NGROUP),(VEL(J),J=1,NGROUP),(EMAX(J),J=1,NGROUP),EMIN,(
     2LARK,I=1,NISO)
      IF (ICHIST.NE.1) READ (7)(HSETID(I),I=1,ID2),(HISONM(I),I=1,NM1),(
     1VEL(J),J=1,NGROUP),(EMAX(J),J=1,NGROUP),EMIN,(LARK,I=1,NISO)
      IF (ICHIST.EQ.1) WRITE (8)(HSETID(I),I=1,ID2),(HISONM(I),I=1,NM1),
     1(CHI(J),J=1,NGROUP),(VEL(J),J=1,NGROUP),(EMAX(J),J=1,NGROUP),EMIN,
     2(LOCA(I),I=1,NISO)
      IF (ICHIST.NE.1) WRITE (8)(HSETID(I),I=1,ID2),(HISONM(I),I=1,NM1),
     1(VEL(J),J=1,NGROUP),(EMAX(J),J=1,NGROUP),EMIN,(LOCA(I),I=1,NISO)
      IF (ICHIST.LE.1) GO TO 750
      NWOS=NGROUP*(ICHIST+1)
      READ (7)(A(I),I=1,NWDS)
      WRITE (8)(A(I),I=1,NWOS)
  750 DO 800 I=1,NISO
      READ (7)HABSID,HIDENT,HMAT,AMASS,EFISS,ECAPT,TEMP,SIGPOT,ADENS,KBR
     1,ICHI,IFIS,IALF,INP,IN2N,IND,INT,LTOT,LTRN,ISTRPD,(IDSCT(N),N=1,NS
     2CMAX),(LORD(N),N=1,NSCMAX),((JBAND(J,N),J=1,NGROUP),N=1,NSCMAX),((
     3IJJ(J,N),J=1,NGROUP),N=1,NSCMAX)
      WRTTE (8)HABSID,HIDENT,HMAT,AMASS,EFISS,ECAPT,TEMP,SIGPOT,ADENS,KB
     1R,TCHI,IFIS,IALF,INP,IN2N,TND,TNT,LTOT,LTRN,ISTRPD,(IDSCT(N),N=1,N
     2SCMAX),(LORD(N),N=1,NSCMAX),((JBAND(J,N),J=1,NGROUP),N=1,NSCMAX),(
     3(IJJ(J,N),J=1,NGROUP),N=1,NSCMAX)
      NWOS=(1+LTRN+LTOT+IALF+INP+IN2N+IND+INT+ISTRPD+2*IFIS+TCHI*(2/(ICH
     1I+1)))*NGROUP
      READ (7)(A(J),J=1,NWOS)
      DO 760 J=1,NGROUP
  760 A(J)=STRPL(J)
      WRITE (8)(A(J),J=1,NWOS)
      IF (ICHI.LE.1) GO TO 770
      NWDS=NGROUP*(ICHI+1)
      READ (7)(A(J),J=1,NWOS)
      WRITE (8)(A(J),J=1,NWOS)
```

```
  770 DO 790 N=1,NSCMAX                                                   CINX
      IF (LORD(N).EQ.0) GO TO 790                                         CINX
      DO 780 J=1,NSBLOK                                                   CINX
      LJ=LORD(N)*JBAND(J,N)                                               CINX
      IF (LJ.EQ.0) GO TO 780                                              CINX
      READ (7)(A(M),M=1,LJ)                                               CINX
      WRITE (8)(A(M),M=1,LJ)                                              CINX
  780 CONTINUE                                                            CINX
  790 CONTINUE                                                            CINX
  800 CONTINUE                                                            CINX
  810 CONTINUE                                                            CINX
      WRITE (6,850)                                                       CINX
      RETURN                                                              CINX
  820 WRITE (6,860)                                                       CINX
      RETURN                                                              CINX
  830 WRITE (6,870)                                                       CINX
C                                                                         CINX
      RETURN                                                              CINX
C                                                                         CINX
  840 FORMAT (6(3X,1PE9.3))                                               CINX
  850 FORMAT (1H0,86HCINX IS FINISHED.  RUN UNITS 8, 9 AND 13 THROUGH BI CINX
     1NX TO GET A PRINT OF YOUR COLLAPSED/20X,68HCCCC DATA AND/OR RUN UN CINX
     2IT 10 THROUGH PUPX TO GET A PRINT OF YOUR 10X/20X,66HDATA.  IF YOU CINX
     3 CALLED FOR DELAYED NEUTRON DATA FOR PERTV IT WILL BE/20X,23HFOUND CINX
     4 ON PUNCHED CARDS.)                                                 CINX
  860 FORMAT (76H THIS VERSION OF CINX CANNOT HANDLE SUCH A LARGE 1DX IN CINX
     1ELASTIC MATRIX RECORD)                                              CINX
  870 FORMAT (68H THIS VERSION OF CINX CANNOT HANDLE SUCH A LARGE SET CH CINX
     1I DATA RECORD)                                                      CINX
      END                                                                 CINX
      SUBROUTINE COLLAP(XS,X,F,NGG,NG,NCG)                                CINX
C     *****************************************************************  CINX
C     COLLAPSES THE FINE GROUP X-SECS TO THE COURSE GROUP STRUCTURE.     CINX
C     *****************************************************************  CINX
      DIMENSION XS(1), F(1), X(1), NGG(1)                                 CINX
      L=0                                                                 CINX
      DO 20 I=1,NCG                                                       CINX
      J=NGG(I)                                                            CINX
      S=0.0                                                               CINX
      T=0.0                                                               CINX
      DO 10 K=1,J                                                         CINX
      L=L+1                                                               CINX
      S=S+XS(L)*F(L)                                                      CINX
   10 T=T+F(L)                                                            CINX
      IF (T.LE.0.0) X(I)=0.0                                              CINX
      IF (T.GT.0.0) X(I)=S/T                                              CINX
   20 CONTINUE                                                            CINX
      RETURN                                                              CINX
      END                                                                 CINX
      SUBROUTINE JBIJ(JBAND,IJJ,JBAN,IJ,NGG,NSCMAX,NGROUP,NCG)            CINX
C     *****************************************************************  CINX
C     COMPUTES THE SCATTERING BANDWIDTHS AND THE IN-GROUP SCATTERING      CINX
C     POSITIONS FOR THE COLLAPSED GROUPS.  ASSUMES ALL IJJ=1.             CINX
C     *****************************************************************  CINX
      DIMENSION JBAND(240,4), IJJ(240,4), JBAN(240,4), IJ(240,4), NGG(1) CINX
      DO 40 N=1,NSCMAX                                                    CINX
      M=0                                                                 CINX
      DO 40 I=1,NCG                                                       CINX
      L=NGG(I)                                                            CINX
      MIN=M+1                                                             CINX
      JCK=0                                                               CINX
      DO 10 J=1,L                                                         CINX
      M=M+1                                                               CINX
      IF (JBAND(M,N).NE.0) JCK=1                                          CINX
   10 MIN=MIN0(MIN,M+IJJ(M,N)-JBAND(M,N))                                 CINX
      MC=0                                                                CINX
      DO 20 K=1,NCG                                                       CINX
      MC=MC+NGG(K)                                                        CINX
      IF (MC.GE.MIN) GO TO 30                                             CINX
   20 CONTINUE                                                            CINX
   30 JBAN(I,N)=I-K+1                                                     CINX
      IF (JCK.EQ.0) JBAN(I,N)=0                                           CINX
```

```
   40 IJ(I,N)=1
      RETURN
      END
      SUBROUTINE MAX(MAXUP,MAXDN,MUP,MDN,NGG,NCG)
C     *******************************************************************
C     COMPUTES THE MAXIMUM NUMBER OF GROUPS DOWNSCATTER, MDN, AND THE
C     MAXIMUM NUMBER OF GROUPS UPSCATTER, MUP, FOR THE COURSE GROUP
C     STRUCTURE.
C     *******************************************************************
      DIMENSION NGG(1)
      NCG1=NCG-1
      IF (MAXDN.GT.0) GO TO 10
      MDN=0
   10 MDN=1
      DO 40 I=1,NCG1
      M=0
      N=0
      DO 20 J=I,NCG1
      M=M+1
      N=N+NGG(J+1)
      IF (N.GE.MAXDN) GO TO 30
   20 CONTINUE
   30 MDN=MAX0(MDN,M)
   40 CONTINUE
      IF (MAXUP.GT.0) GO TO 50
      MUP=0
      GO TO 90
   50 MUP=1
      DO 80 I=1,NCG1
      M=0
      N=0
      DO 60 J=I,NCG1
      M=M+1
      N=N+NGG(NCG-J)
      IF (N.GE.MAXUP) GO TO 70
   60 CONTINUE
   70 MUP=MAX0(MUP,M)
   80 CONTINUE
   90 RETURN
      END
      SUBROUTINE FIZZ(CHI,ISSPEC,SFIS,SNUTOT,F,NGG,ICHIST,NGROUP,NCG,X)
C     *******************************************************************
C     COLLAPSES THE FINE GROUP FISSION SOURCE MATRIX TO A COURSE
C     GROUP FISSION SOURCE MATRIX.
C     *******************************************************************
      DIMENSION CHI(ICHIST,NGROUP), ISSPEC(NGROUP), SFIS(NGROUP), SNUTOT
     1(NGROUP), F(NGROUP), NGG(NCG), X(NCG,NCG)
C     COLLAPSE CHI(ICHIST,NGROUP) TO CHI(ICHIST,NCG).
      DO 20 K=1,ICHIST
      M=0
      DO 20 J=1,NCG
      N=NGG(J)
      SUM=0.0
      DO 10 L=1,N
      M=M+1
   10 SUM=SUM+CHI(K,M)
   20 CHI(K,J)=SUM
C     COMPUTE X(I,J)=FRACTION OF NEUTRONS EMITTED IN BROAD GROUP J AS A
C     RESULT OF A FISSION IN BROAD GROUP I.
      M=0
      DO 50 J=1,NCG
      N=NGG(J)
      DO 30 JP=1,NCG
   30 X(J,JP)=0.0
      BOT=0
      DO 40 L=1,N
      M=M+1
      I=ISSPEC(M)
      W=SNUTOT(M)*SFIS(M)*F(M)
      BOT=BOT+W
      DO 40 JP=1,NCG
   40 X(J,JP)=X(J,JP)+CHI(I,JP)*W
      DO 50 JP=1,NCG
```

```
   50 X(J,JP)=X(J,JP)/BOT
C     EACH BROAD GROUP HAS ITS OWN FISSION SPECTRUM.
      DO 60 J=1,NCG
   60 ISSPEC(J)=J
      RETURN
      END
      SUBROUTINE COLLFF(FF,XS,FT,XT,F,X,NX,NGG,NBINT,NBTEM,NG,NCG,NSIGPT
     1,NTOTAL)
C     ******************************************************************
C     COLLAPSES THE SELF-SHIELDING FACTORS.
C     ******************************************************************
      DIMENSION FF(6,3,240), XS(1), FT(6,3,240), XT(1), F(1), NGG(1), X(
     11)
      M=0
      DO 30 J=1,NCG
      LL=NGG(J)
      DO 20 K=1,NBTEM
      DO 20 N=1,NBINT
      SIGPO=X(NX+N)
      S1=0.0
      S2=0.0
      S3=0.0
      S4=0.0
      DO 10 L=1,LL
      ML=M+L
      W=F(ML)/(FT(N,K,ML)*XT(ML)+SIGPO)
      IF (NTOTAL.EQ.1) W=F(ML)/((FT(N,K,ML)*XT(ML)+SIGPO)*(FF(N,K,ML)*XT
     1(ML)+SIGPO))
      S1=S1+W*FF(N,K,ML)*XS(ML)
      S2=S2+W
      S3=S3+F(ML)
      S4=S4+XS(ML)*F(ML)
   10 CONTINUE
      IF (S2.LE.0.0.OR.S4.LE.0.0) FF(N,K,J)=1.
      IF (S2.GT.0.0.AND.S4.GT.0.0) FF(N,K,J)=S1*S3/(S2*S4)
   20 CONTINUE
   30 M=M+LL
      RETURN
      END
      SUBROUTINE INPUT(NGROUP,NCG,NGG,LG,NG1,EMAX,F,TF,MF,NDT,NPF)
C     ******************************************************************
C     READS THE INPUT DATA AND FORMS THE FINE GROUP AND COURSE GROUP
C     SPECTRA.
C     ******************************************************************
      DIMENSION NGG(1), LG(1), F(1), TF(1), EMAX(1)
      READ (5,100)MF,NCG,ICF,NDT,NPF
      WRITE (6,110)
      WRITE (6,120)MF,NCG,ICF,NDT,NPF
      IF (MF.EQ.1) GO TO 90
      READ (5,100)(NGG(I),I=1,NCG)
      WRITE (6,130)(NGG(I),I=1,NCG)
      IF (ICF.EQ.1) GO TO 60
      READ (5,150)TB,EB,TC,EC
      WRITE (6,140)TB,EB,TC,EC
      AB=1./(EXP(-EB/TB)*EB**2.0)
      AC=1./(EXP(-EC/TC)*EC**1.5)
      PI=.5*SQRT(3.141592654)
      DO 50 I=1,NGROUP
      F(I)=0.0
      A=EMAX(I+1)
      B=EMAX(I)
      IF (A.GT.EC) GO TO 30
      IF (B.LT.EB) GO TO 40
      IF (EC.LE.B.AND.EC.GE.A) GO TO 10
      IF (EB.LE.B.AND.EB.GE.A) GO TO 20
      F(I)=ALOG(B/A)
      GO TO 50
   10 F(I)=F(I)+ALOG(EC/A)
      A=EC
      GO TO 30
   20 F(I)=F(I)+ALOG(B/EB)
      B=EB
```

```
      GO TO 40
   30 F(I)=F(I)+AC*TC**1.5*(SQRT(A/TC)*EXP(-A/TC)-SQRT(B/TC)*EXP(-B/TC)+
     1PI*(ERRF(SQRT(B/TC))-ERRF(SQRT(A/TC))))
      GO TO 50
   40 F(I)=F(I)+AB*TB*((A+TB)*EXP(-A/TB)-(B+TB)*EXP(-B/TB))
   50 CONTINUE
      GO TO 70
   60 READ (5,150)(F(I),I=1,NGROUP)
   70 WRITE (6,160)(F(I),I=1,NGROUP)
C     COMPUTE THE TOTAL FLUX IN EACH COURSE GROUP AND MARK EACH FINE
C     GROUP AS TO WHICH COURSE GROUP IT BELONGS.
      M=0
      DO 80 I=1,NCG
      TF(I)=0.0
      N=NGG(I)
      DO 80 J=1,N
      M=M+1
      LG(M)=I
      TF(I)=TF(I)+F(M)
   80 CONTINUE
      WRITE (6,170)(TF(I),I=1,NCG)
   90 CONTINUE
      RETURN
C
  100 FORMAT (12I6)
  110 FORMAT (1H1,40X,4HCINX///)
  120 FORMAT (36H RUN OPTIONS INPUT CARD (FORMAT 5I6)/13X,2HMF,5X,41HMAJ
     1OR FUNCTIONS (0/1/2=COLLAPSE/10X/BOTH),19X,I6/12X,3HNCG,5X,23HNUMB
     2ER OF COURSE GROUPS,37X,I6/12X,3HICF,5X,46HCOLLAPSING FLUX (0/1=TH
     3ERMAL-FERMI-WATT/INPUT),14X,I6/12X,3HNDT,5X,50HNUMBER OF DOWNSCATT
     4ERING TERMS (INCLUDING INGROUP),10X,I6/12X,3HNPF,5X,54HNEUTRON PRE
     5CURSOR FILE (0/1=NO/YES) (- FOR PERIV DATA),6X,I6)
  130 FORMAT (1H0,57HNUMBER OF FINE GROUPS PER EACH COURSE GROUP (FORMAT
     1 12I6)/(14X,12I6))
  140 FORMAT (44H0PARAMETERS FOR ICF=0 OPTION (FORMAT 4E12.5)/13X,2HTB,5
     1X,52HNUCLEAR TEMPERATURE (EV) FOR THERMAL SPECTRUM REGION,2X,E12.5
     2/13X,2HEB,5X,35HUPPER LIMIT (EV) FOR THERMAL REGION,19X,E12.5/13X,
     32HTC,5X,49HNUCLEAR TEMPERATURE (EV) FOR WATT SPECTRUM REGION,5X,E1
     42.5/13X,2HEC,5X,32HLOWER LIMIT (EV) FOR WATT REGION,22X,E12.5)
  150 FORMAT (6E12.6)
  160 FORMAT (1H0,26HINPUT FLUX (FORMAT 6E12.5)/(14X,6E12.5))
  170 FORMAT (1H0,33HCOURSE GROUP FLUX (FORMAT 6E12.5)/(14X,6E12.5))
      END
      FUNCTION ERRF (Y)
C
C                           ****  SUBPROGRAM  ****
C
C     ERRF(Y)        THIS SUBPROGRAM CALCULATES THE ERROR FUNCTION OF Y.
C                SUBPROGRAM IS A PROGRAM OF RATIONAL APPROXIMATION 7.1
C                PAGE 299, OF THE NATIONAL BUREAU OF STANDARDS HANDBOO
C                MATHEMATICAL FUNCTIONS, JUNE 1974.
C
      DIMENSION A(7)
      DATA A/1.000,70.5230784E-3,42.2820123E-3,9.2705272E-3,1.520143E-4,
     12.765672E-4,4.30638E-5/
      YY=ABS(Y)
      IF (YY-6.0) 20,10,10
   10 ERRF=1.
      GO TO 60
   20 IF (YY-.000010) 30,30,40
   30 ERRF=2.*YY/1.7725
      GO TO 60
   40 SOFQ=0.
      DO 50 I=1,7
   50 SOFQ=SOFQ+(A(I))*(YY**(I-1))
      ERRF=1.-SOFQ**(-16)
   60 ERRF=SIGN(ERRF,Y)
      RETURN
      END
```

APPENDIX B

LISTING OF SAMPLE PROBLEM INPUT AND OUTPUT

CARD INPUT:

```
    2     4     0     4     0
    3     1     2     1
      .025            .1          1.4+6       .8208+6
```

COMPUTER OUTPUT:

```
                                        CINX


RUN OPTIONS INPUT CARD (FORMAT 5I6)
          MF     MAJOR FUNCTIONS (0/1/2=COLLAPSE/1DX/BOTH)                                 2
          NCG    NUMBER OF COURSE GROUPS                                                   4
          ICF    COLLAPSING FLUX (0/1=THERMAL-FERMI-WATT/INPUT)                            0
          NOT    NUMBER OF DOWNSCATTERING TERMS (INCLUDING INGROUP)                        4
          NPF    NEUTRON PRECURSOR FILE (0/1=NO/YES) (- FOR PERTV DATA)                    0

NUMBER OF FINE GROUPS PER EACH COURSE GROUP (FORMAT 12I6)
                 3     1     2     1

PARAMETERS FOR ICF=0 OPTION (FORMAT 4E12.5)
          TB     NUCLEAR TEMPERATURE (EV) FOR THERMAL SPECTRUM REGION      .25000E-01
          EB     UPPER LIMIT (EV) FOR THERMAL REGION                       .10000E+00
          TC     NUCLEAR TEMPERATURE (EV) FOR WATT SPECTRUM REGION         .14000E+07
          EC     LOWER LIMIT (EV) FOR WATT REGION                          .82080E+06

INPUT FLUX (FORMAT 6E12.5)
            .50000E+00  .50000E+00  .50000E+00  .50000E+00  .50000E+00  .50000E+00
            .50206E+01

COURSE GROUP FLUX (FORMAT 6E12.5)
            .15000E+01  .50000E+00  .10000E+01  .50206E+01

CINX IS FINISHED.  RUN UNITS 8, 9 AND 13 THROUGH BINX TO GET A PRINT OF YOUR COLLAPSED
                   CCCC DATA AND/OR RUN UNIT 10 THROUGH PUPX TO GET A PRINT OF YOUR 1DX
                   DATA.  IF YOU CALLED FOR DELAYED NEUTRON DATA FOR PERTV IT WILL BE
                   FOUND ON PUNCHED CARDS.
```

APPENDIX C

BINX LISTING OF SAMPLE PROBLEM INPUT ISOTXS AND BRKOXS FILES

```
BINX...CONVERT MODE OF CCCC FILE

MODE=1  (1 MEANS BIN TO BCD, 2 MEANS BCD TO BIN)
TYPE=1  (1 MEANS ISOTXS, 2 MEANS BRKOXS, 3 MEANS DLAYXS)
IRO=   1   1   1   1   1   1   1   1   1   1

*** FILEISOTXS -- VERSION  1 -- UNIT  3***
**USER IDENTIFICATION**T2LASL   MINX

FILE CONTROL PARAMETERS

 NGROUP    NUMBER OF ENERGY GROUPS IN SET                         7
 NISO      NUMBER OF ISOTOPES IN SET                              1
 MAXUP     MAXIMUM NUMBER OF UPSCATTER GROUPS                     0
 MAXDN     MAXIMUM NUMBER OF DOWNSCATTER GROUPS                   7
 MAXORD    MAXIMUM SCATTERING ORDER                               3
 ICHIST    SET FISSION SPECTRUM FLAG                              0
             ICHIST=1        SET VECTOR
                   =NGROUP, SET MATRIX
 NSCMAX    MAXIMUM NUMBER OF BLOCKS OF                            2
             SCATTERING DATA
 NSBLOK    BLOCKING CONTROL FOR SCATTERING DATA                   7

AM-241 7-GP FOR CINX APPENDIX

ISOTOPE              NAME
   1                 AM241

GROUP STRUCTURE

          NEUTRON VELOCITY          UPPER ENERGY
GROUP         (CM/SEC)                   (EV)
   1        4.55483E+06             1.37096E+01
   2        3.54730E+06             8.31529E+00
   3        2.76264E+06             5.04348E+00
   4        2.15155E+06             3.05902E+00
   5        1.67563E+06             1.85539E+00
   6        1.30498E+06             1.12535E+00
   7        5.73538E+05             6.82560E-01
                                    1.00000E-05

NUMBER OF RECORDS TO BE SKIPPED

ISOTOPE            RECORDS
   1                  0

ISOTOPE  1

ISOTOPE CONTROL PARAMETERS

 HABSID  ABSOLUTE ISOTOPE LABEL                                 AM241
 HIDENT  LIBRARY IDENTIFIER                                     ENDFB
 HMAT    ISOTOPE IDENTIFICATION                                  1056
 AMASS   GRAM ATOMIC WEIGHT                                .24102E+03
 EFISS   THERMAL ENERGY/FISSION (W*SEC/FISS)               .33740E-10
 ECAPT   THERMAL ENERGY/CAPTURE (W*SEC/CAPT)               .25060E-11
 TEMP    ISOTOPE TEMPERATURE (DEG K)                      0.
 SIGPOT  AVE. POTENTIAL SCATTERING (BARNS/ATOM)            .10000E+11
 ADENS   REFERENCE ATOM DENSITY (A/B*CM)                  0.
 KBR     ISOTOPE CLASSIFICATION                                     3
 ICHI    FISSION SPECTRUM FLAG (0/1/N=SET CHI/VECTOR/MATRIX)        1
 IFIS    (N,F) X-SEC FLAG (0/1=NO/YES)                              1
 IALF    (N,A) X-SEC FLAG (0/1=NO/YES)                              0
 INP     (N,P) X-SEC FLAG (0/1=NO/YES)                              0
 IN2N    (N,2N) X-SEC FLAG (0/1=NO/YES)                             0
 IND     (N,D) X-SEC FLAG (0/1=NO/YES)                              0
```

INT	(N,T) X-SEC FLAG (0/1=NO/YES)	0
LTOT	NUMBER OF TOTAL X-SEC MOMENTS	1
LTRN	NUMBER OF TRANSPORT X-SEC MOMENTS	1
ISTRPD	NUMBER OF TRANSPORT X-SEC DIRECTIONS	0

SCATTERING BLOCKS

BLOCK	NAME	TYPE	ORDERS
1	ELASTC	100	4
2	TOTAL	0	4

SCATTERING BANDWIDTH AND IN-GROUP SCATTERING POSITION

GROUP/BLOCK	1	2	1	2
1	1	1	1	1
2	2	2	1	1
3	2	2	1	1
4	2	2	1	1
5	2	2	1	1
6	2	2	1	1
7	2	2	1	1

PRINCIPAL CROSS SECTIONS

GROUP	STRPL	STOTPL	SNGAM	SFIS	SNUTOT	CHISO
1	9.58519E+01	9.58803E+01	8.52114E+01	4.83847E-01	3.09000E+00	5.27633E-01
2	2.14086E+02	2.14127E+02	1.98107E+02	1.51044E+00	3.09000E+00	2.49237E-01
3	1.43234E+02	1.43260E+02	1.33883E+02	2.48191E-01	3.09000E+00	1.17731E-01
4	3.61953E+02	3.61984E+02	3.50028E+02	9.79400E-01	3.09000E+00	5.56124E-02
5	1.01304E+03	1.01309E+03	9.88950E+02	6.56400E+00	3.09000E+00	2.62695E-02
6	1.69405E+02	1.69427E+02	1.60874E+02	8.83848E-01	3.09000E+00	1.24088E-02
7	7.37421E+02	7.37449E+02	7.23144E+02	4.40148E+00	3.09000E+00	1.11082E-02

BLOCK 1 ELASTC SCATTERING, ORDER 4

GROUP	POSN	ORDER 1	ORDER 2	ORDER 3	ORDER 4
1	1	1.00294E+01	7.95843E-02	2.95852E-04	0.
2	1	1.42812E+01	1.06639E-01	4.73289E-03	0.
	2	1.54811E-01	-5.11704E-02	-2.60178E-04	0.
3	1	8.96323E+00	7.99534E-02	2.96215E-04	0.
	2	2.27105E-01	-6.61607E-02	-4.68207E-03	0.
4	1	1.08545E+01	6.99356E-02	6.75874E-04	0.
	2	1.64795E-01	-5.44865E-02	-2.64241E-04	0.
5	1	1.74983E+01	7.56254E-02	3.13688E-04	0.
	2	1.21106E-01	-3.93138E-02	-6.37428E-04	0.
6	1	7.50000E+00	7.74826E-02	3.86423E-04	0.
	2	8.10071E-02	-2.65794E-02	-2.52111E-04	0.
7	1	9.73760E+00	2.71677E-02	3.41089E-05	0.
	2	1.70068E-01	-5.60832E-02	-3.59557E-04	0.

BLOCK 2 TOTAL SCATTERING, ORDER 4

GROUP	POSN	ORDER 1	ORDER 2	ORDER 3	ORDER 4
1	1	1.00294E+01	7.95843E-02	2.95852E-04	0.

```
      GROUP    2
        POSN       ORDER  1      ORDER  2      ORDER  3      ORDER  4
         1       1.42812E+01  1.06639E-01  4.73289E-03  0.
         2       1.54811E-01 -5.11704E-02 -2.60178E-04  0.
      GROUP    3
        POSN       ORDER  1      ORDER  2      ORDER  3      ORDER  4
         1       8.96323E+00  7.99534E-02  2.96215E-04  0.
         2       2.27105E-01 -6.61607E-02 -4.68207E-03  0.
      GROUP    4
        POSN       ORDER  1      ORDER  2      ORDER  3      ORDER  4
         1       1.08545E+01  6.99356E-02  6.75874E-04  0.
         2       1.64795E-01 -5.44865E-02 -2.64241E-04  0.
      GROUP    5
        POSN       ORDER  1      ORDER  2      ORDER  3      ORDER  4
         1       1.74983E+01  7.56254E-02  3.13688E-04  0.
         2       1.21106E-01 -3.93138E-02 -6.37428E-04  0.
      GROUP    6
        POSN       ORDER  1      ORDER  2      ORDER  3      ORDER  4
         1       7.50000E+00  7.74826E-02  3.86423E-04  0.
         2       8.10071E-02 -2.65794E-02 -2.52111E-04  0.
      GROUP    7
        POSN       ORDER  1      ORDER  2      ORDER  3      ORDER  4
         1       9.73760E+00  2.71677E-02  3.41089E-05  0.
         2       1.70068E-01 -5.60832E-02 -3.59557E-04  0.


BINX...CONVERT MODE OF CCCC FILE

MODE=1  (1 MEANS BIN TO BCD, 2 MEANS BCD TO BIN)
TYPE=2  (1 MEANS ISOTXS, 2 MEANS BRKOXS, 3 MEANS DLAYXS)
IRD=   1    1    1    1    1    1    1    1    1    1

*** FILEBRKOXS -- VERSION  1 -- UNIT  3***
**USER IDENTIFICATION**T2LASL    MINX

FILE CONTROL PARAMETERS

 NGROUP    NUMBER OF ENERGY GROUPS IN SET                          7
 NISOSH    NUMBER OF ISOTOPES WITH SELF-
             SHIELDING FACTORS                                     1
 NSIGPT    TOTAL NUMBER OF VALUES OF VARIABLE X
             WHICH ARE GIVEN.  NSIGPT IS EQUAL TO
             THE SUM FROM 1 TO NISOSH OF NTABP(I)                  3
 NTEMPT    TOTAL NUMBER OF VALUES OF VARIABLE TB
             WHICH ARE GIVEN.  NTEMPT IS EQUAL TO
             THE SUM FROM 1 TO NISOSH OF NTABT(I)                  3

ISOTOPE          NAME
     1           AM241

LN(SIGPO)/LN(10) VALUES FOR ALL ISOTOPES

ISOTOPE       1ST VALUE       2ND VALUE              . . .
     1     4.00000E+00     2.00000E+00     0.

TEMPERATURES (DEG C) FOR ALL ISOTOPES

ISOTOPE       1ST VALUE       2ND VALUE              . . .
     1     2.68400E+01     6.26840E+02     1.82684E+03

GROUP STRUCTURE

  GROUP      TOP ENERGY
     1     1.37096E+01
     2     8.31529E+00
     3     5.04348E+00
     4     3.05902E+00
     5     1.85539E+00
     6     1.12535E+00
     7     6.82560E-01
           1.00000E-05
```

F-FACTOR START END GROUPS AND NUMBER OF SIGPO TEMP VALUES

ISOTOPE	JBFH	JBFL	NTABP	NTABT
1	1	7	3	3

TOTAL SELF-SHIELDING FACTORS ISOTOPE 1

GROUP	1		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.69404E-01	9.81417E-01	9.89069E-01
2	4.92773E-01	5.44876E-01	6.11973E-01
3	3.90327E-01	4.01827E-01	4.24233E-01
GROUP	2		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	8.27421E-01	8.77994E-01	9.16151E-01
2	2.62275E-01	2.70872E-01	2.82090E-01
3	2.03664E-01	2.05174E-01	2.08030E-01
GROUP	3		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.22047E-01	9.33662E-01	9.43920E-01
2	4.71083E-01	4.91419E-01	5.25436E-01
3	4.19915E-01	4.28098E-01	4.43877E-01
GROUP	4		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.19528E-01	9.35136E-01	9.34651E-01
2	3.32057E-01	3.52370E-01	3.91112E-01
3	2.55864E-01	2.59740E-01	2.73012E-01
GROUP	5		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	6.63519E-01	7.13436E-01	7.73821E-01
2	1.57295E-01	1.60409E-01	1.68650E-01
3	1.36625E-01	1.38688E-01	1.44110E-01
GROUP	6		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	1.00660E+00	1.02383E+00	1.06954E+00
2	9.57428E-01	9.67556E-01	9.89957E-01
3	9.36262E-01	9.44427E-01	9.61451E-01
GROUP	7		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	8.70755E-01	8.82599E-01	8.98557E-01
2	5.61789E-01	5.66677E-01	5.75878E-01
3	5.39833E-01	5.44381E-01	5.52730E-01

CAPTURE SELF-SHIELDING FACTORS ISOTOPE 1

GROUP	1		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.82899E-01	9.89848E-01	9.94164E-01
2	5.94264E-01	6.67457E-01	7.41453E-01
3	4.31736E-01	4.77254E-01	5.37285E-01
GROUP	2		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.08186E-01	9.41774E-01	9.65308E-01
2	3.36821E-01	3.64881E-01	3.97606E-01
3	2.37857E-01	2.50584E-01	2.66853E-01
GROUP	3		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.47310E-01	9.50403E-01	9.54486E-01
2	5.48725E-01	5.85697E-01	6.34556E-01
3	4.59785E-01	4.83517E-01	5.19868E-01
GROUP	4		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.56122E-01	9.60142E-01	9.50114E-01
2	4.87875E-01	5.35444E-01	5.93794E-01
3	3.80643E-01	4.12296E-01	4.60236E-01
GROUP	5		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	8.05471E-01	8.40960E-01	8.80392E-01
2	2.49429E-01	2.64592E-01	2.94899E-01
3	2.04568E-01	2.15153E-01	2.37575E-01
GROUP	6		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	1.00779E+00	1.02600E+00	1.07440E+00
2	9.79698E-01	9.93544E-01	1.02713E+00
3	9.66016E-01	9.78289E-01	1.00711E+00

GROUP 7

SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.27139E-01	9.35319E-01	9.45924E-01
2	6.60308E-01	6.68692E-01	6.83119E-01
3	6.37649E-01	6.45484E-01	6.59132E-01

FISSION SELF-SHIELDING FACTORS ISOTOPE 1

GROUP 1

SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.82481E-01	9.89575E-01	9.93919E-01
2	5.68920E-01	6.42456E-01	7.13684E-01
3	3.97863E-01	4.39562E-01	4.91639E-01

GROUP 2

SIGO	TEMP 1	TEMP 2	TEMP 3
1	8.71708E-01	9.06447E-01	9.31716E-01
2	2.41239E-01	2.60787E-01	2.88477E-01
3	1.60226E-01	1.65985E-01	1.75561E-01

GROUP 3

SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.86762E-01	9.88767E-01	9.94851E-01
2	8.93224E-01	9.06547E-01	9.24732E-01
3	8.65708E-01	8.76603E-01	8.92590E-01

GROUP 4

SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.65429E-01	9.70648E-01	9.66235E-01
2	5.66672E-01	6.10641E-01	6.63714E-01
3	4.67687E-01	4.97008E-01	5.40622E-01

GROUP 5

SIGO	TEMP 1	TEMP 2	TEMP 3
1	7.98860E-01	8.32547E-01	8.67193E-01
2	2.24827E-01	2.37852E-01	2.63502E-01
3	1.78500E-01	1.87350E-01	2.05921E-01

GROUP 6

SIGO	TEMP 1	TEMP 2	TEMP 3
1	1.00822E+00	1.02753E+00	1.07909E+00
2	9.77718E-01	9.92180E-01	1.02721E+00
3	9.63116E-01	9.75874E-01	1.00575E+00

GROUP 7

SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.22075E-01	9.30503E-01	9.41672E-01
2	6.51175E-01	6.59118E-01	6.72780E-01
3	6.29762E-01	6.37160E-01	6.50007E-01

TRANSPORT SELF-SHIELDING FACTORS ISOTOPE 1

GROUP 1

SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.69395E-01	9.81412E-01	9.89066E-01
2	4.92632E-01	5.44749E-01	6.11864E-01
3	3.90160E-01	4.01662E-01	4.24074E-01

GROUP 2

SIGO	TEMP 1	TEMP 2	TEMP 3
1	8.27395E-01	8.77976E-01	9.16140E-01
2	2.62179E-01	2.70776E-01	2.81994E-01
3	2.03562E-01	2.05072E-01	2.07928E-01

GROUP 3

SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.22033E-01	9.33650E-01	9.43909E-01
2	4.70994E-01	4.91332E-01	5.25355E-01
3	4.19818E-01	4.28001E-01	4.43782E-01

GROUP 4

SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.19521E-01	9.35130E-01	9.34646E-01
2	3.32004E-01	3.52318E-01	3.91063E-01
3	2.55806E-01	2.59681E-01	2.72953E-01

GROUP 5

SIGO	TEMP 1	TEMP 2	TEMP 3
1	6.63507E-01	7.13426E-01	7.73813E-01
2	1.57271E-01	1.60384E-01	1.68625E-01
3	1.36601E-01	1.38664E-01	1.44085E-01

GROUP	6		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	1.00660E+00	1.02384E+00	1.06955E+00
2	9.57423E-01	9.67551E-01	9.89955E-01
3	9.36253E-01	9.44420E-01	9.61445E-01
GROUP	7		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	8.70752E-01	8.82597E-01	8.98556E-01
2	5.61776E-01	5.66664E-01	5.75866E-01
3	5.39819E-01	5.44367E-01	5.52717E-01

ELASTIC SELF-SHIELDING FACTORS ISOTOPE 1

GROUP	1		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.98573E-01	9.99566E-01	1.00063E+00
2	9.67164E-01	9.72898E-01	9.78969E-01
3	9.53941E-01	9.57030E-01	9.61341E-01
GROUP	2		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.61065E-01	9.70363E-01	9.77433E-01
2	7.73873E-01	7.80863E-01	7.89360E-01
3	7.43031E-01	7.44799E-01	7.45893E-01
GROUP	3		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.98994E-01	1.00223E+00	1.00493E+00
2	9.72727E-01	9.77990E-01	9.84070E-01
3	9.69897E-01	9.73887E-01	9.79416E-01
GROUP	4		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.96331E-01	9.98945E-01	9.99710E-01
2	9.55190E-01	9.63188E-01	9.70825E-01
3	9.49525E-01	9.55963E-01	9.62683E-01
GROUP	5		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.07279E-01	9.24713E-01	9.45373E-01
2	6.57801E-01	6.67525E-01	6.87134E-01
3	6.38286E-01	6.46006E-01	6.61982E-01
GROUP	6		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	1.00038E+00	1.00124E+00	1.00719E+00
2	1.00209E+00	1.00304E+00	1.00804E+00
3	1.00252E+00	1.00345E+00	1.00788E+00
GROUP	7		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.52570E-01	9.41212E-01	9.35474E-01
2	9.30429E-01	9.15493E-01	9.08931E-01
3	9.27722E-01	9.11858E-01	9.04798E-01

CROSS SECTIONS

GROUP	XSPO	XSIN	XSE	XSMU	XSFD
1	9.51136E+00	0.	1.01843E+01	2.79039E-03	1.54811E-01
2	9.51141E+00	0.	1.45083E+01	2.79039E-03	2.27105E-01
3	9.51144E+00	0.	9.12802E+00	2.79039E-03	1.64795E-01
4	9.51146E+00	0.	1.09756E+01	2.79039E-03	1.21106E-01
5	9.51147E+00	0.	1.75793E+01	2.79039E-03	8.10071E-02
6	9.51148E+00	0.	7.67007E+00	2.79039E-03	1.70068E-01
7	9.51148E+00	0.	9.73760E+00	2.79039E-03	9.17466E-09

APPENDIX D

BINX LISTING OF SAMPLE PROBLEM OUTPUT ISOTXS AND BRKOXS FILES

```
BINX...CONVERT MODE OF CCCC FILE

MODE=1   (1 MEANS BIN TO BCD, 2 MEANS BCD TO BIN)
TYPE=1   (1 MEANS ISOTXS, 2 MEANS BRKOXS, 3 MEANS OLAYXS)
IRO=    1    1    1    1    1    1    1    1    1    1

*** FILEAM-241 -- VERSION  R -- UNIT  3***
**USER IDENTIFICATION** 7-GP    FOR CI

FILE CONTROL PARAMETERS

 NGROUP    NUMBER OF ENERGY GROUPS IN SET                  4
 NISO      NUMBER OF ISOTOPES IN SET                       1
 MAXUP     MAXIMUM NUMBER OF UPSCATTER GROUPS              0
 MAXDN     MAXIMUM NUMBER OF DOWNSCATTER GROUPS            3
 MAXORD    MAXIMUM SCATTERING ORDER                        3
 ICHIST    SET FISSION SPECTRUM FLAG                       0
             ICHIST=1        SET VECTOR
                  =NGROUP, SET MATRIX
 NSCMAX    MAXIMUM NUMBER OF BLOCKS OF                     2
             SCATTERING DATA
 NSBLOK    BLOCKING CONTROL FOR SCATTERING DATA            4

AM-241 7-GP FOR CINX APPENDIX

ISOTOPE                 NAME
   1                    AM241

GROUP STRUCTURE

          NEUTRON VELOCITY          UPPER ENERGY
GROUP             (CM/SEC)                  (EV)
   1          3.77017E+06          1.37096E+01
   2          2.15155E+06          3.05902E+00
   3          1.51335E+06          1.85539E+00
   4          5.71351E+05          6.82560E-01
                                   1.00000E-05

NUMBER OF RECORDS TO BE SKIPPED

ISOTOPE              RECORDS
   1                      0

ISOTOPE  1

ISOTOPE CONTROL PARAMETERS

 HABSID  ABSOLUTE ISOTOPE LABEL                                  AM241
 HIDENT  LIBRARY IDENTIFIER                                      ENDFB
 HMAT    ISOTOPE IDENTIFICATION                                   1056
 AMASS   GRAM ATOMIC WEIGHT                                 .24102E+03
 EFISS   THERMAL ENERGY/FISSION (W*SEC/FISS)                .33740E-10
 ECAPT   THERMAL ENERGY/CAPTURE (W*SEC/CAPT)                .25060E-11
 TEMP    ISOTOPE TEMPERATURE (DEG K)                       0.
 SIGPOT  AVE. POTENTIAL SCATTERING (BARNS/ATOM)             .10000E+11
 ADENS   REFERENCE ATOM DENSITY (A/B*CM)                   0.
 KBR     ISOTOPE CLASSIFICATION                                      3
 ICHI    FISSION SPECTRUM FLAG (0/1/N=SET CHI/VECTOR/MATRIX)         1
 IFIS    (N,F) X-SEC FLAG (0/1=NO/YES)                               1
 IALF    (N,A) X-SEC FLAG (0/1=NO/YES)                               0
 INP     (N,P) X-SEC FLAG (0/1=NO/YES)                               0
 IN2N    (N,2N) X-SEC FLAG (0/1=NO/YES)                              0
 IND     (N,D) X-SEC FLAG (0/1=NO/YES)                               0
 INT     (N,T) X-SEC FLAG (0/1=NO/YES)                               0
 LTOT    NUMBER OF TOTAL X-SEC MOMENTS                               1
 LTRN    NUMBER OF TRANSPORT X-SEC MOMENTS                           1
 ISTRPD  NUMBER OF TRANSPORT X-SEC DIRECTIONS                        0
```

SCATTERING BLOCKS

BLOCK	NAME	TYPE	ORDERS
1	ELASTC	100	4
2	TOTAL	0	4

SCATTERING BANDWIDTH AND IN-GROUP SCATTERING POSITION

GROUP/BLOCK	1	2	1	2
1	1	1	1	1
2	2	2	1	1
3	2	2	1	1
4	2	2	1	1

PRINCIPAL CROSS SECTIONS

GROUP	STRPL	STOTPL	SNGAM	SFIS	SNUTOT	CHISO
1	1.51057E+02	1.51089E+02	1.39067E+02	7.47493E-01	3.09000E+00	8.94601E-01
2	3.61953E+02	3.61984E+02	3.50028E+02	9.79400E-01	3.09000E+00	5.56124E-02
3	5.91225E+02	5.91260E+02	5.74912E+02	3.72393E+00	3.09000E+00	3.86783E-02
4	7.37421E+02	7.37449E+02	7.23144E+02	4.40148E+00	3.09000E+00	1.11082E-02

BLOCK 1 ELASTC SCATTERING, ORDER 4

GROUP 1

POSN	ORDER 1	ORDER 2	ORDER 3	ORDER 4
1	1.12186E+01	4.96151E-02	1.27569E-04	0.

GROUP 2

POSN	ORDER 1	ORDER 2	ORDER 3	ORDER 4
1	1.08545E+01	6.99356E-02	6.75874E-04	0.
2	5.49317E-02	-1.81622E-02	-8.80805E-05	0.

GROUP 3

POSN	ORDER 1	ORDER 2	ORDER 3	ORDER 4
1	1.25397E+01	6.32643E-02	2.24000E-04	0.
2	1.21106E-01	-3.93138E-02	-6.37428E-04	0.

GROUP 4

POSN	ORDER 1	ORDER 2	ORDER 3	ORDER 4
1	9.73760E+00	2.71677E-02	3.41089E-05	0.
2	8.50338E-02	-2.80416E-02	-1.79778E-04	0.

BLOCK 2 TOTAL SCATTERING, ORDER 4

GROUP 1

POSN	ORDER 1	ORDER 2	ORDER 3	ORDER 4
1	1.12186E+01	4.96151E-02	1.27569E-04	0.

GROUP 2

POSN	ORDER 1	ORDER 2	ORDER 3	ORDER 4
1	1.08545E+01	6.99356E-02	6.75874E-04	0.
2	5.49317E-02	-1.81622E-02	-8.80805E-05	0.

GROUP 3

POSN	ORDER 1	ORDER 2	ORDER 3	ORDER 4
1	1.25397E+01	6.32643E-02	2.24000E-04	0.
2	1.21106E-01	-3.93138E-02	-6.37428E-04	0.

GROUP 4

POSN	ORDER 1	ORDER 2	ORDER 3	ORDER 4
1	9.73760E+00	2.71677E-02	3.41089E-05	0.
2	8.50338E-02	-2.80416E-02	-1.79778E-04	0.

```
BINX...CONVERT MODE OF CCCC FILE

MODE=1  (1 MEANS BIN TO BCO, 2 MEANS BCO TO BIN)
TYPE=2  (1 MEANS ISOTXS, 2 MEANS BRKOXS, 3 MEANS OLAYXS)
IRD=   1   1   1   1   1   1   1   1   1   1

*** FILEAM-241 -- VERSION  R -- UNIT  3***
**USER IDENTIFICATION** 7-GP     FOR CI

FILE CONTROL PARAMETERS

 NGROUP    NUMBER OF ENERGY GROUPS IN SET                      4
 NISOSH    NUMBER OF ISOTOPES WITH SELF-
             SHIELDING FACTORS                                 1
 NSIGPT    TOTAL NUMBER OF VALUES OF VARIABLE X
             WHICH ARE GIVEN.  NSIGPT IS EQUAL TO
             THE SUM FROM 1 TO NISOSH OF NTABP(I)              3
 NTEMPT    TOTAL NUMBER OF VALUES OF VARIABLE TB
             WHICH ARE GIVEN.  NTEMPT IS EQUAL TO
             THE SUM FROM 1 TO NISOSH OF NTABT(I)              3

ISOTOPE          NAME
    1            AM241

LN(SIGPO)/LN(10) VALUES FOR ALL ISOTOPES

ISOTOPE       1ST VALUE       2ND VALUE           . . .
    1      4.00000E+00     2.00000E+00     0.

TEMPERATURES (DEG C) FOR ALL ISOTOPES

ISOTOPE       1ST VALUE       2ND VALUE           . . .
    1      2.68400E+01     6.26840E+02     1.82684E+03

GROUP STRUCTURE

  GROUP      TOP ENERGY
    1      1.37096E+01
    2      3.05902E+00
    3      1.85539E+00
    4      6.82560E-01
           1.00000E-05

F-FACTOR START END GROUPS AND NUMBER OF SIGPO TEMP VALUES

ISOTOPE           JBFH           JBFL           NTABP           NTABT
    1               1              4               3               3

TOTAL SELF-SHIELDING FACTORS          ISOTOPE  1
      GROUP      1
      SIGO       TEMP    1     TEMP    2     TEMP    3
        1        8.85663E-01  9.15396E-01  9.37975E-01
        2        3.71340E-01  3.94074E-01  4.24955E-01
        3        2.90949E-01  2.97489E-01  3.09127E-01
      GROUP      2
      SIGO       TEMP    1     TEMP    2     TEMP    3
        1        9.19528E-01  9.35136E-01  9.34651E-01
        2        3.32057E-01  3.52370E-01  3.91112E-01
        3        2.55864E-01  2.59740E-01  2.73012E-01
      GROUP      3
      SIGO       TEMP    1     TEMP    2     TEMP    3
        1        6.89401E-01  7.30703E-01  7.84360E-01
        2        2.72283E-01  2.76250E-01  2.85795E-01
        3        2.52328E-01  2.55574E-01  2.63084E-01
      GROUP      4
      SIGO       TEMP    1     TEMP    2     TEMP    3
        1        8.70755E-01  8.82599E-01  8.98557E-01
        2        5.61789E-01  5.66677E-01  5.75878E-01
        3        5.39833E-01  5.44381E-01  5.52730E-01
```

CAPTURE SELF-SHIELOING FACTORS ISOTOPE 1

GROUP 1

SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.34850E-01	9.53056E-01	9.66306E-01
2	4.53569E-01	4.94225E-01	5.40606E-01
3	3.36747E-01	3.61054E-01	3.93591E-01

GROUP 2

SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.56122E-01	9.60142E-01	9.50114E-01
2	4.87875E-01	5.35444E-01	5.93794E-01
3	3.80643E-01	4.12296E-01	4.60236E-01

GROUP 3

SIGO	TEMP 1	TEMP 2	TEMP 3
1	8.16766E-01	8.48107E-01	8.87048E-01
2	3.40024E-01	3.51912E-01	3.76056E-01
3	3.05665E-01	3.14646E-01	3.33583E-01

GROUP 4

SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.27139E-01	9.35319E-01	9.45924E-01
2	6.60308E-01	6.68692E-01	6.83119E-01
3	6.37649E-01	6.45484E-01	6.59132E-01

FISSION SELF-SHIELDING FACTORS ISOTOPE 1

GROUP 1

SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.06320E-01	9.31171E-01	9.49581E-01
2	3.84200E-01	4.15349E-01	4.51847E-01
3	2.87193E-01	3.03159E-01	3.24561E-01

GROUP 2

SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.65429E-01	9.70648E-01	9.66235E-01
2	5.66672E-01	6.10641E-01	6.63714E-01
3	4.67687E-01	4.97008E-01	5.40622E-01

GROUP 3

SIGO	TEMP 1	TEMP 2	TEMP 3
1	8.05687E-01	8.35907E-01	8.70861E-01
2	3.01898E-01	3.12151E-01	3.32764E-01
3	2.65875E-01	2.73475E-01	2.89419E-01

GROUP 4

SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.22075E-01	9.30503E-01	9.41672E-01
2	6.51175E-01	6.59118E-01	6.72780E-01
3	6.29762E-01	6.37160E-01	6.50007E-01

TRANSPORT SELF-SHIELOING FACTORS ISOTOPE 1

GROUP 1

SIGO	TEMP 1	TEMP 2	TEMP 3
1	8.85643E-01	9.15381E-01	9.37964E-01
2	3.71232E-01	3.93970E-01	4.24856E-01
3	2.90828E-01	2.97369E-01	3.09008E-01

GROUP 2

SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.19521E-01	9.35130E-01	9.34646E-01
2	3.32004E-01	3.52318E-01	3.91063E-01
3	2.55806E-01	2.59681E-01	2.72953E-01

GROUP 3

SIGO	TEMP 1	TEMP 2	TEMP 3
1	6.89387E-01	7.30691E-01	7.84350E-01
2	2.72255E-01	2.76222E-01	2.85768E-01
3	2.52299E-01	2.55546E-01	2.63056E-01

GROUP 4

SIGO	TEMP 1	TEMP 2	TEMP 3
1	8.70752E-01	8.82597E-01	8.98556E-01
2	5.61776E-01	5.66664E-01	5.75866E-01
3	5.39819E-01	5.44367E-01	5.52717E-01

ELASTIC SELF-SHIELDING FACTORS ISOTOPE 1

GROUP 1

SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.81995E-01	9.87082E-01	9.91112E-01
2	8.86062E-01	8.92082E-01	8.99138E-01
3	8.71989E-01	8.74920E-01	8.78609E-01

GROUP	2		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.96331E-01	9.98945E-01	9.99710E-01
2	9.55190E-01	9.63188E-01	9.70825E-01
3	9.49525E-01	9.55963E-01	9.62683E-01
GROUP	3		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.25456E-01	9.36978E-01	9.52259E-01
2	7.39429E-01	7.42937E-01	7.51269E-01
3	7.30283E-01	7.32689E-01	7.38619E-01
GROUP	4		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.52570E-01	9.41212E-01	9.35474E-01
2	9.30429E-01	9.15493E-01	9.08931E-01
3	9.27722E-01	9.11858E-01	9.04798E-01

CROSS SECTIONS

GROUP	XSPO	XSIN	XSE	XSMU	XSEO
1	9.51140E+00	0.	1.12735E+01	2.79039E-03	5.49317E-02
2	9.51146E+00	0.	1.09756E+01	2.79039E-03	1.21106E-01
3	9.51147E+00	0.	1.26247E+01	2.79039E-03	8.50338E-02
4	9.51148E+00	0.	9.73760E+00	2.79039E-03	9.17464E-09

APPENDIX E

PUPX LISTING OF SAMPLE PROBLEM 1DX OUTPUT

1 CROSS SECTION DATA FOR AM241

GROUP	SIGT	SIGF	NU	SIGC	SIGIN	SIGEL	MUEL	XT	SIGDEL
1	151.089	.747	3.090	139.067	0.000	11.274	.003	.008	.055
2	361.984	.979	3.090	350.028	0.000	10.976	.003	.008	.121
3	591.260	3.724	3.090	574.912	0.000	12.625	.003	.008	.085
4	737.449	4.401	3.090	723.144	0.000	9.738	.003	.008	.000

INELASTIC SCATTERING MATRIX FOR AM241

GROUP	GXG	GXG+1	GXG+2	. . .
1	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000

FISSION SELF-SHIELDING FACTORS FOR AM241 ARE GIVEN AT T = 300, 900, AND 2100 DEGREES KELVIN

SIGO GROUP	.1E+05	.1E+03	.1E+01	.1E+05	.1E+03	.1E+01	.1E+05	.1E+03	.1E+01
1	.906	.384	.287	.931	.415	.303	.950	.452	.325
2	.965	.567	.468	.971	.611	.497	.966	.664	.541
3	.806	.302	.266	.836	.312	.273	.871	.333	.289
4	.922	.651	.630	.931	.659	.637	.942	.673	.650

CAPTURE SELF-SHIELDING FACTORS FOR AM241 ARE GIVEN AT T = 300, 900, AND 2100 DEGREES KELVIN

SIGO GROUP	.1E+05	.1E+03	.1E+01	.1E+05	.1E+03	.1E+01	.1E+05	.1E+03	.1E+01
1	.935	.454	.337	.953	.494	.361	.966	.541	.394
2	.956	.488	.381	.960	.535	.412	.950	.594	.460
3	.817	.340	.306	.848	.352	.315	.887	.376	.334
4	.927	.660	.638	.935	.669	.645	.946	.683	.659

TOTAL SELF-SHIELDING FACTORS FOR AM241 ARE GIVEN AT T = 300, 900, AND 2100 DEGREES KELVIN

SIGO GROUP	.1E+05	.1E+03	.1E+01	.1E+05	.1E+03	.1E+01	.1E+05	.1E+03	.1E+01
1	.886	.371	.291	.915	.394	.297	.938	.425	.309
2	.920	.332	.256	.935	.352	.260	.935	.391	.273
3	.689	.272	.252	.731	.276	.256	.784	.286	.263
4	.871	.562	.540	.883	.567	.544	.899	.576	.553

ELASTIC SELF-SHIELDING FACTORS FOR AM241 ARE GIVEN AT T = 300, 900, AND 2100 DEGREES KELVIN

SIGO GROUP	.1E+05	.1E+03	.1E+01	.1E+05	.1E+03	.1E+01	.1E+05	.1E+03	.1E+01
1	.982	.886	.872	.987	.892	.875	.991	.899	.879
2	.996	.955	.950	.999	.963	.956	1.000	.971	.963
3	.925	.739	.730	.937	.743	.733	.952	.751	.739
4	.953	.930	.928	.941	.915	.912	.935	.909	.905

REFERENCES

1. B. M. Carmichael, D. A. Meneley, and D. R. Vondy, "Report of the Subcommittee on Standard Interface Files," prepared for the Committee on Computer Code Coordination, Los Alamos Scientific Laboratory report LA-5324-MS (1973).

2. I. I. Bondarenko, Ed., Group Constants for Nuclear Reactor Calcuations (Consultants Bureau, New York 1964).

3. R. B. Kidman, R. E. Schenter, R. W. Hardie, and W. W. Little, "The Shielding Factor Method for Generating Multigroup Cross Sections for Fast Reactor Analysis," Nucl. Sci. and Eng. 48, 189 (1972).

4. B. M. Carmichael, "Standard Interface Files and Procedures for Reactor Physics Codes, Version III," Los Alamos Scientific Laboratory report LA-5486-MS (1974).

5. M. K. Drake, Ed., "Data Formats and Procedures for the ENDF Neutron Cross Section Library," Brookhaven National Laboratory report BNL-50274 (1970)

6. R. E. MacFarlane and R. M. Boicourt, "NJOY: A Neutron and Photon Cross Section Processing System," Trans. Am. Nucl. Soc. 22, 720 (1975).

7. R. E. MacFarlane and R. B. Kidman, "LINX and BINX: CCCC Utility Codes for the MINX Multigroup Processing Code," Los Alamos Scientific Laboratory report LA-6219-MS (1976).

8. N. C. Paik, C. Durston, W. Davis, and M. B. Yarborough, "Physics Evaluation and Applications Quarterly Progress Report for Period Ending October 31, 1973," Westinghouse Advanced Reactor Division report WARD-XS-3045-4; see other reports in this series, WARD-XS-3045-5, -6, and -7.

9. R. W. Hardie and W. W. Little, Jr., "1DX, A One-Dimensional Diffusion Code for Generating Effective Nuclear Cross Sections," Battelle Northwest Laboratory report BNWL-954 (March 1969).

10. W. W. Engle, Jr., "A User's Manual for ANISN," Oak Ridge National Laboratory report K-1693 (1967).

11. C. R. Weisbin and R. J. LaBauve, "Specification of a Generally Useful Multigroup Structure for Neutron Transport," Los Alamos Scientific Laboratory report LA-5277-MS (1973).

12. T. R. Hill, "ONETRAN: A Discrete Ordinates Finite Element Code for the Solution of the One-Dimensional Multigroup Transport Equation," Los Alamos Scientific Laboratory report LA-5990-MS (June 1975).

13. W. W. Little, Jr., and T. W. Hardie, "2DB User's Manual -- Revision 1," Battelle Northwest Laboratory report BNWL-831 REV1 (1969).

14. R. W. Hardie and W. W. Little, Jr., "3DB, A Three-Dimensional Diffusion Theory Burnup Code," Battelle Northwest Laboratory report BNWL-1264 (1970).

15. R. W. Hardie and W. W. Little, "3DP, A Three-Dimensional Perturbation Theory Code," Hanford Engineering Development Laboratory report HEDL-TME-72-134 (1972).

16. R. W. Hardie and W. W. Little, Jr., "PERT-V, A Two-Dimensional Perturbation Code for Fast Reactor Analysis," Battelle Northwest Laboratory report BNWL-1162 (1969).

17. R. E. Schenter, J. L. Baker, and R. B. Kidman, "ETOX, A Code to Calculate Group Constants for Nuclear Reactor Calculations," Battelle Northwest Laboratory report BNWL-1002 (1969).

☆ US GOVERNMENT PRINTING OFFICE: 1976—677-343/119