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**Westinghouse  
Astronuclear  
Laboratory**



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AUGUST 1970

FINAL PROGRESS REPORT

Contract No. NAS-8-24919

Control No. DCN 1 - X - 80 - 00056

**NUCLEAR ROCKET SHIELDING METHODS , MODIFICATION ,  
UPDATING , AND INPUT DATA PREPARATION**

**VOLUME 3**

**CROSS SECTION GENERATION AND DATA PROCESSING TECHNIQUES**

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Prepared by:

R. G. Soltesz  
R. K. Disney  
S. L. Zeigler

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## FOREWORD

This report is Volume 3 of six volumes of the final report on "Nuclear Rocket Shielding Methods, Modification, Updating, and Input Data Preparation". This work was performed for the George C. Marshall Space Flight Center (MSFC), Huntsville, Alabama, under Contract No. NAS-8-24919, Control No. DCN 1-X-80-00056. The technical monitor of this contract was Mr. Henry E. Stern, Deputy Manager of the Nuclear and Plasma Physics Division of the Space Sciences Laboratory, MSFC. A description of the GAMLEG-W, APPROPOS, NAGS, and SATURN codes are presented in this volume.

In summary, the six volumes of the final report are as follows:

- Volume 1: "Synopsis of Methods and Results of Analyses" - A summary of the work performed under this contract,
- Volume 2: "Compilation of Neutron and Photon Cross Section Data" - A description of the six Master Libraries of neutron and photon, cross section data,
- Volume 3: "Cross Section Generation and Data Processing Techniques" - A description of the GAMLEG-W, APPROPOS, NAGS, and SATURN codes,
- Volume 4: "One-Dimensional, Discrete Ordinates Transport Technique" - A description of the ANISN-W code,
- Volume 5: "Two Dimensional, Discrete Ordinates Transport Techniques" - A description of DOT-IIW, DOQ, ADOQ, and MAP codes, and
- Volume 6: "Point Kernel Techniques" - A description of the KAP-VI and SCAP codes.

## ABSTRACT

A description of the cross section generation and data processing techniques for analyzing nuclear reactor systems is given. These techniques include 1) the GAMLEG-W code for generating multigroup, photon cross sections for use in discrete ordinate and Monte Carlo transport codes; 2) the APPROPOS code for preparing multigroup, simultaneous, neutron-photon cross section data and neutron reaction cross section data for radiation transport codes; 3) the NAGS code for processing the output fluxes from one- and two-dimensional discrete ordinate transport codes to provide neutron and gamma ray, distributed source data as well as nuclear energy deposition; and 4) the SATURN code for processing master library, cross section data including optional, transverse leakage corrections, adjoint reversals, and mixture operations.

Detailed user information is supplied for each code. This information includes problem setup, running time, required input data, and tape and core storage requirements. A sample problem card input and printout as well as a description of printed, punched and tape output is included for each code.

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## 1.0 INTRODUCTION

This report is Volume 3 of the six volumes of the final report on "Nuclear Rocket Shielding Methods, Modification, Updating, and Input Data Preparation". Presented in this volume is a description of the cross section generation and data processing techniques provided for the Marshall Space Flight Center (MSFC) under the contractual effort. The four computer codes described in this volume are:

- 1) GAMLEG-W,
- 2) APPROPOS,
- 3) NAGS, and
- 4) SATURN

The GAMLEG-W code provides multigroup, photon cross sections for use in discrete ordinate and Monte Carlo transport codes. Output data from GAMLEG-W on magnetic tape or cards is admissible to the discrete ordinate transport or data processing techniques discussed in this report. The GAMLEG-W code is described in Section 2.0.

The APPROPOS code is a data preparation technique for processing multigroup, neutron cross section data and multigroup, neutron reaction cross section data (e.g., radiative capture, fission, inelastic scatter, and elastic scatter) to provide spectral-weighted, neutron cross section data in a reduced number of energy groups. These data are then processed with input specified elemental atom densities, gamma ray production data due to neutron reactions, and photon cross section data to provide macroscopic, coupled, neutron-photon cross section data, neutron cross section data and photon cross section data. The format of the output data is admissible to multigroup, discrete ordinate and Monte Carlo transport codes. The APPROPOS code is described in Section 3.0.

The NAGS code processes multigroup, neutron and photon flux distributions for one-dimensional, slab or cylinder geometry models, or two-dimensional,  $r, z$ , or  $r, \theta$  geometry models. Flux data input to the NAGS code are read from magnetic tape or disk as produced by

the ANISN-W or DOT-IIW discrete ordinate transport codes described in Volumes 4 and 5 of this report. Additional input data required by the NAGS code are prepared by the APPROPOS code described in this volume. The NAGS code provides: 1) neutron and photon source data for use in point kernel, Monte Carlo, or discrete ordinate transport analyses, 2) neutron and photon dose rates, or 3) nuclear energy deposition data (neutron and photon) for use in subsequent thermal and hydraulic design analyses. Source distribution data are generated on punched data cards for input into the KAP VI code (Volume 6) and on magnetic tape for use in the ANISN-W or DOT-IIW codes. The NAGS code is described in Section 4.0.

The SATURN code processes  $P_g$  or transport corrected  $P_0$  cross section data using a minimum amount of core storage to produce multigroup cross section data tapes in two formats for use in the ANISN-W or DOT-IIW codes. The two formats are the normal, group-dependent data tape or the specially prepared, group-independent data tape. Options provided in the SATURN code include mixing table operations, adjoint reversals, transverse leakage corrections, and output tape labeling or relabeling capabilities. The SATURN code is described in Section 5.0.

The GAMLEG-W, APPROPOS, NAGS, and SATURN codes are an integral part of both the preliminary or parametric and the detailed design radiation analysis methods provided for the Marshall Space Flight Center under this contract and the previous contractual work (NAS-8-20414). A simplified, schematic diagram of each method is shown in Figures 1-1 and 1-2. Both methods are fully described in Volume 1 of this report.

In the preliminary or parametric design method (Figure 1-1), the APPROPOS code (Volume 3) is used to prepare neutron and photon cross sections and other basic data for use in the transport and data processing codes. These cross sections are input to the ANISN-W code (Volume 4). The ANISN-W code computes one-dimensional neutron and photon fluxes in the reactor geometry. From the neutron and photon fluxes, neutron and



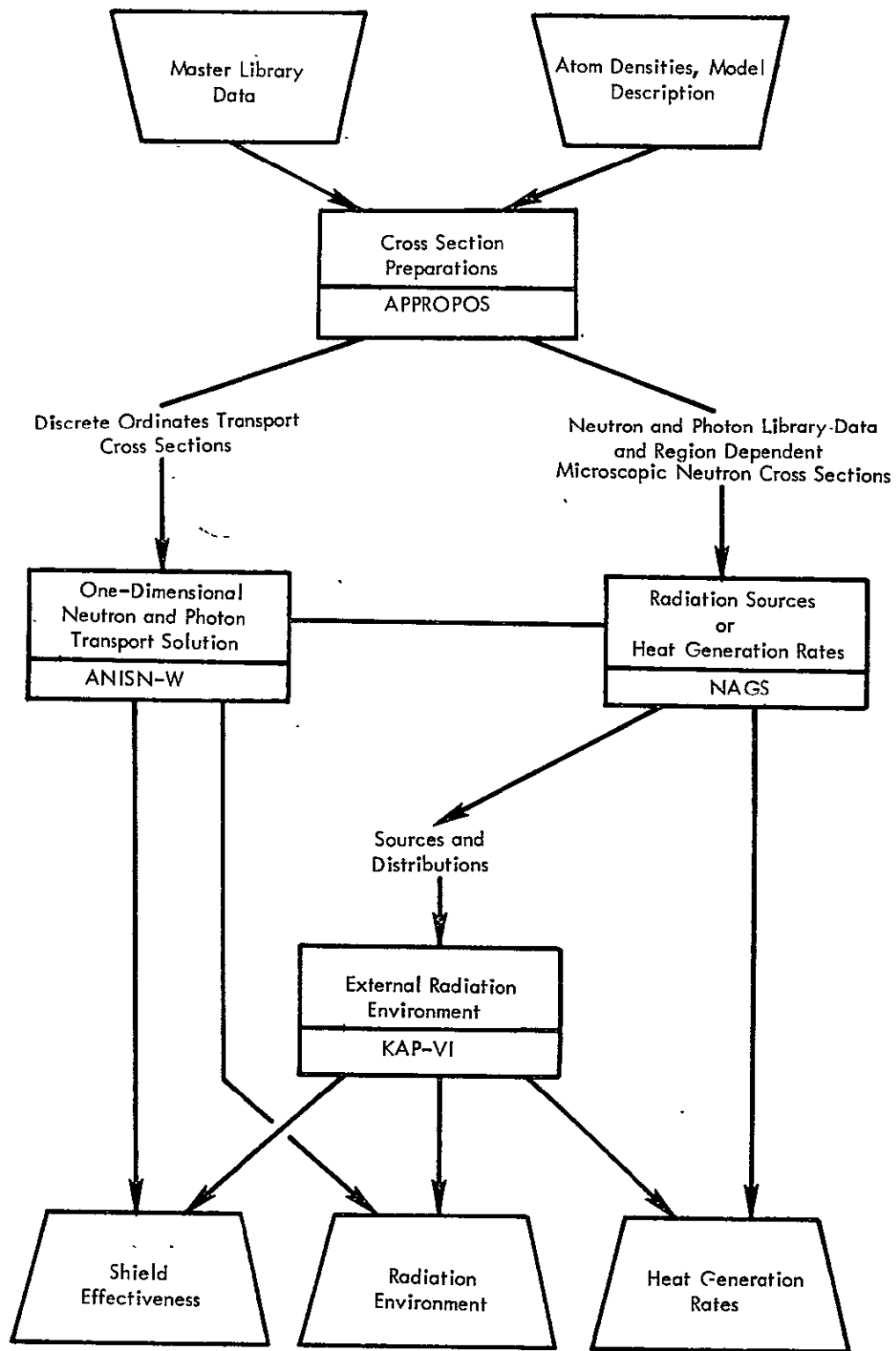


Figure 1-1. Flow Chart for Preliminary or Parametric Radiation Analysis

photon energy sources and distributions or heat generation rates are obtained using the NAGS data processing code (Volume 3). These sources and distributions are used as input to the KAP-VI point kernel code (Volume 6). The KAP-VI code provides gamma ray and fast neutron radiation levels at locations external to the reactor. Radiation sources, heat generation rates, and radiation environment, both internal and external to the reactor as well as shield effectiveness can be computed using the preliminary or parametric design method.

In the detailed design method (Figure 1-2), the neutron and photon cross sections prepared by the APPROPOS code (Volume 3) are used as input data to the DOT-IIW, two-dimensional, discrete ordinates transport code. The DOT-IIW code (Volume 5) computes the two-dimensional neutron and photon fluxes throughout the reactor geometry. The NAGS data processing code (Volume 3) processes these fluxes and calculates neutron and photon energy deposition and neutron and photon energy sources and distributions within the reactor system. These sources and distributions are used as input to the KAP-VI point kernel code (Volume 6). The KAP-VI code provides gamma ray and fast neutron radiation levels at locations external to the reactor. In addition, the surface leakage fluxes from the DOT-IIW problem geometry are used as input to the MAP radiation transport code (Volume 5). The MAP code computes the radiation environment at selected surfaces or points external to the DOT-IIW geometry and includes provisions for last-flight transport using optional point kernel techniques. The SCAP single-or albedo-scatter code (Volume 6) is used to compute external radiation environment using, as source input data, the output from either the KAP-VI or the MAP codes. Radiation sources, heat generation rates, and radiation environment, both internal and external to the reactor as well as shield effectiveness can be computed using the detailed design method.

The SATURN (Volume 3), DOQ (Volume 5), and ADOQ (Volume 5), codes are additional data preparation and handling codes. These codes are provided as convenient tools for manipulating large quantities of data or providing selected input data.

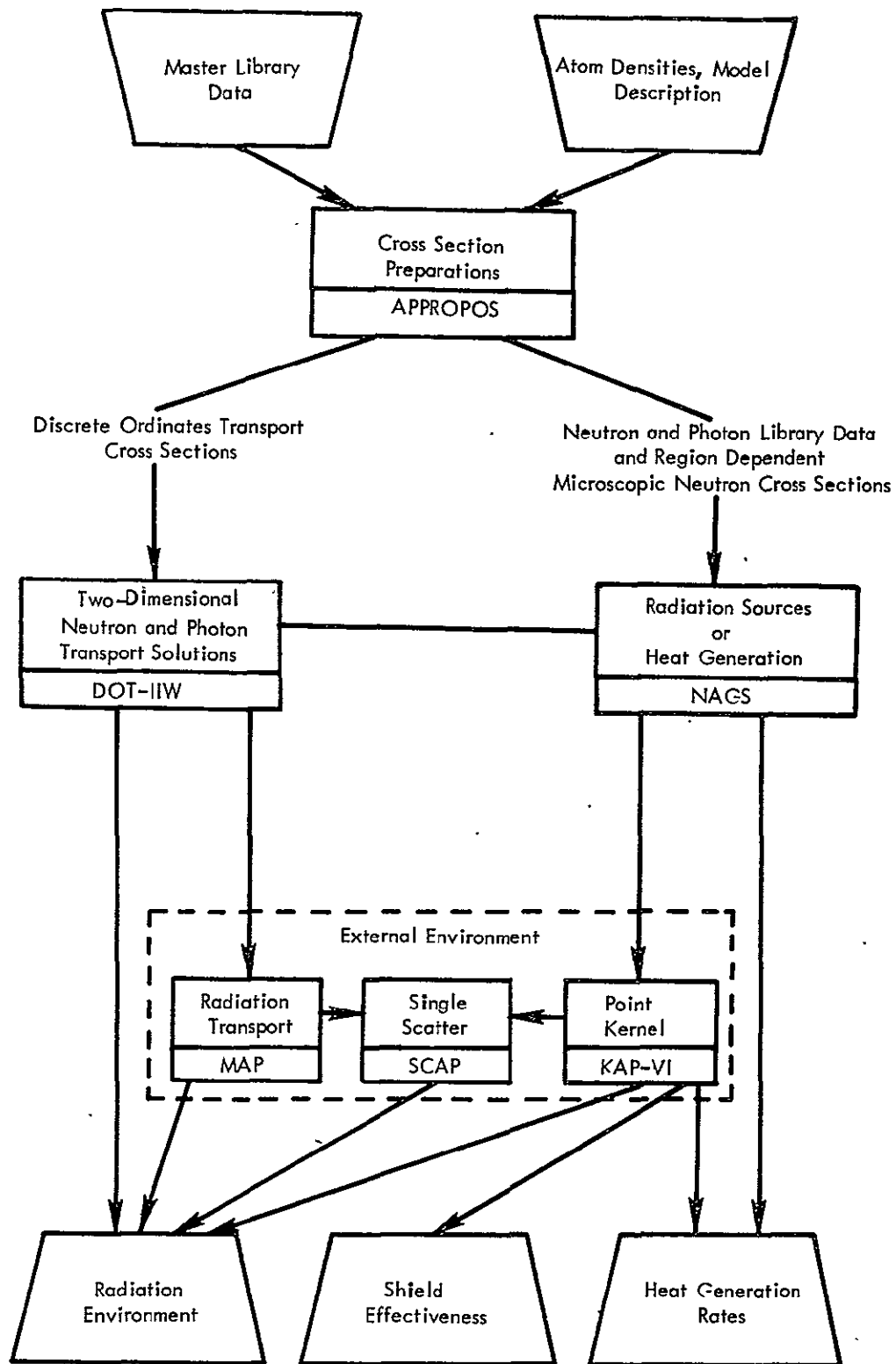


Figure 1-2. Flow Chart for Detailed Radiation Analysis

## 2.0 GAMLEG-W CODE

GAMLEG-W, a revised version of the GAMLEG code<sup>(1)</sup>, provides multigroup, photon transport cross sections for use in multigroup, discrete ordinate transport or Monte Carlo transport codes. The code is designed to provide photon transport cross sections in a maximum of 100 groups with scatter transfer cross sections represented as a Legendre expansion ( $P_p$ ) of arbitrary order. The code performs a numerical integration with a user specified weighting function to obtain multigroup, absorption and scatter-transfer cross sections. Absorption cross sections are obtained from pointwise, photoelectric and pair-production data on punched data cards or magnetic tape, and Compton absorption from the Klein-Nishina equation for the inelastic scattering of a photon with a free electron.<sup>(2)</sup> Scatter-transfer cross sections are obtained from the differential form of the Klein-Nishina equation for the inelastic scattering of a photon with a free electron.

The code can, at option, provide photon transport cross section data for use in energy flux or particle flux calculations. Production of a pair of 0.511 MeV photons due to pair production annihilation can be included in the energy scatter-transfer or particle scatter-transfer cross section data.

Output data from the GAMLEG-W code are compatible with the ANISN-W<sup>(3)</sup> or DOT-IIW<sup>(4)</sup> computer codes and are placed on either punched data cards or magnetic tape.

## 2.1 COMPUTER CODE SYNOPSIS

- 1) Name: GAMLEG-W<sup>(1)</sup>
- 2) Computer: The code is designed for the UNIVAC-1108 computer.
- 3) Nature of Physical Problem Solved:

GAMLEG-W solves for multigroup, photon transport cross sections for use in multigroup, discrete ordinate or Monte Carlo transport codes. GAMLEG-W uses a numerical integration (with a specified weighting function) of 1) pointwise photoelectric or pair-production data and 2) the Klein-Nishina equations for inelastic scattering of a photon with a free electron to provide group averaged cross sections. Energy scatter-transfer or particle scatter-transfer cross sections are calculated at option. Pair-production absorption may, at option, be treated as the production of a pair of 0.511 MeV photons in the scatter-transfer cross sections.

A maximum of 100 groups is allowed with an arbitrary order of the Legendre expansion of the Compton scattering cross sections as a multigroup, scatter-transfer matrix.

4) Method of Solution: GAMLEG-W uses a Simpson's rule integration method with a specified weighting function to evaluate group averaged quantities. A maximum of 50 integration points per group is allowed in the scatter-transfer cross section averaging, and a factor of two greater number of integration points (maximum of 100) in the group averaging.

5) Restrictions on the Complexity of the Problem: The GAMLEG-W computer code is limited to a maximum of 100 groups and 50 integration points per group. Cyclic calculation of the multigroup data for each element after the calculation of the  $P_\ell$  scatter-transfer data of order  $\ell$  allows for the calculation of a maximum of 100 sets of multigroup element data. Photoelectric and pair-production cross section data are represented as a maximum of 99 point-wise values of data for each element.

6) Typical Running Time: The equation for the GAMLEG-W code running time can be approximated by the number of groups, number of integration points per group, and the order of the Legendre expansion of the cross section data. The CPU time on the UNIVAC-1108 computer is estimated from the following equation:

$$t(\text{CPU seconds}) = 20 + \frac{N_{\text{MAX}} * N * (IG-1)}{10} + \frac{N * N_{\text{MAX}} * IZ * (IG-1)}{4000}$$

where: IG is the number of group energy bounds,  
N is the number of integration points in each group,  
NMAX is the order of the Legendre expansion in the scatter-transfer cross sections ( $\ell + 1$ ), and  
IZ is the number of set element data to be calculated.

7) Unusual Features of the Code: The code employs a numerical integration technique to solve for multigroup photon scatter-transfer cross sections, of arbitrary order, using the Legendre polynomial scattering approximation. Energy-or particle scatter-transfer cross sections are calculated.

8) Related or Auxiliary Codes: Photon cross section tapes generated by GAMLEG-W are used as input to the ANISN-W<sup>(2)</sup>, DOT-IIW<sup>(3)</sup>, or, APPROPOS<sup>(1)</sup> computer codes.

9) Status: The code is in production use at the Marshall Space Flight Center (MSFC). Users at MSFC load the code from a tape with control cards followed by user's input data.

- 10) References:
1. R. G. Soltesz, R. K. Disney, and S. L. Zeigler, WANL-PR(LL)-034, Volume 3, "Cross Section Generation and Data Processing Techniques", August 1970.
  2. R. G. Soltesz and R. K. Disney, WANL-PR(LL)-034, Volume 4, "One Dimensional, Discrete Ordinate Transport Technique", August 1970.
  3. R. G. Soltesz, R. K. Disney, J. Jedruch, and S. L. Zeigler WANL-PR(LL)-034, Volume 5, "Two Dimensional, Discrete Ordinate Transport Techniques", August 1970.

11) Machine Requirements: The GAMLEG-W code is in production use at MSFC on a UNIVAC-1108 computer with a 65 K core. The source code requires 49 K decimal locations for instructions and data storage: Up to 2 tape or disk devices are required in addition to the input, output, and punch devices.

12) Programming Language Used: The code is written entirely in standard, USASI FORTRAN-IV.

13) Operating System Under Which Program is Executed: The GAMLEG-W code is operational under the UNIVAC-1108, EXEC 8 Monitor System at MSFC.

14) Other Programming or Operating Information or Restrictions: None.

15) Name and Establishment of Authors:

R. G. Soltesz and R. K. Disney  
Westinghouse Astronuclear Laboratory  
P. O. Box 10864  
Pittsburgh, Pennsylvania 15236

## 2.2 INPUT DATA DESCRIPTION

### 2.2.1 Input Format

The input data for the GAMLEG-W code are divided into the following three data sets:

- a) Overall problem specifications,
- b) Weighting function and energy grouping data, and
- c) Element data.

The first data set consists of a problem title card and integer data specifying the problem parameters. All integer data are input as right adjusted in the data field specified in the input.

The second data set consists of weighting function data, source data, and the multi-group energy specifications. The third data set is the element data. The GAMLEG-W code processes the element data in sequence to obtain the  $P_0$  cross section data;  $P_\ell$  cross section data are generated in sequence for the entire set of element data.

### 2.2.2 Input Data Instructions

This section describes the problem input data required (Table 2-1) for the GAMLEG-W code. Section 2.3 presents a more detailed description of the required input data. The quantity in slashes represents the input data array dimension and the expression brackets is the condition requiring the array or set of arrays as input to the code.



TABLE 2-1

## INPUT INSTRUCTIONS FOR THE GAMLEG-W CODE

## DATA SET A - Overall Problem Parameter Specifications

<u>Card Number</u>	<u>FORTRAN Format</u>	<u>Card Column</u>	<u>Variable Name</u>	<u>Description</u>
1	(12A6)	1 - 72	---	Overall problem descriptive title
2	(14I5)	1 - 5	IG	Number of energy group limits for energy grouping (Number of groups plus one). /IG-1 ≤ 100/
		6 - 10	N	Number of integration intervals per group /N ≤ 50/
		11 - 15	NMAX	Order of Legendre expansion for which scatter-transfer cross sections are to be calculated NMAX = 1/2/3/4/5/6/, ... P <sub>0</sub> /P <sub>1</sub> /P <sub>2</sub> /P <sub>3</sub> /P <sub>4</sub> /P <sub>5</sub> ...
		16 - 20	KON	Weighting function input option -2/-1/0/+1/+2, Particle Flux/Energy Flux/ Uniform or Flat/Energy Source/ Particle Source
		21 - 25	NMAT	Number of cross section sets to be placed on binary output tape 10 for ANISN-W or DOT-IIW NMAT = IZ
		26 - 30	IDT	Tape identification number for ANISN-W or DOT-IIW binary output tape

TABLE 2-1 (CONTINUED)

DATA SET A				
<u>Card Number</u>	<u>FORTRAN Format</u>	<u>Card Column</u>	<u>Variable Name</u>	<u>Description</u>
		31 - 35	NPUNCH	Punched card output option for ANISN-W or DOT-IW data. NPUNCH = 0/1, No Punched Card Output/ Punched Card Output
		36 -40	NODD	Compton scatter loss calculation option NODD = 0/1; Calculate/ Do not calculate
		41 - 45	NREAD	Library tape option: NREAD = 0/1; $\sigma_{pp}$ and $\sigma_{pe}$ input from cards/tape 11
		46 - 50	NPP	Pair-production calculation option NPP = 0/1, Pair-production treated as absorption/ Pair-production treated as absorption plus scatter-transfer
		51 - 55	NPF	Output Scatter-Transfer Cross Section Calculation Option  NPF = 0/1, Energy flux cross section output/ particle flux cross section output.

TABLE 2-1 (CONTINUED)

DATA SET B - Weighting Function and Energy Grouping Data

The following data IF, EFLUX, or IS, ES, S are input according to the input variable, KON. The energy range of EFLUX and ES must span the energy range of the input energy group structure.

<u>Card Number</u>	<u>FORTTRAN Format</u>	<u>Card Column</u>	<u>Variable Name</u>	<u>Description</u>
NOTE: Cards 1, 2, and 3 are required only if KON < 0				
1	(15)	1 - 5	IF	Number of input weighting flux values.
2	(6E 12.5)	---	EFLUX	Energy values corresponding to flux values in order of decreasing energy. /IF values/
3	(6E 12.5)	---	FLUX	Input flux values for cross section weighting /IF values/
4	(15)	1 - 5	IS	Number of input source values
5	(6E 12.5)	---	ES	Energy values in units of MeV corresponding to source value in order of decreasing energy. /IS values/
6	(6E 12.5)	---	S	Input source values (If KON > 0, used for cross section weighting) /IS values/
7	(6E 12.5)	---	EG	Group energy bounds (or limits) in order of decreasing energy including first (highest energy) value in units of Mev. /IG values/

TABLE 2-1 (CONTINUED)

## DATA SET C - Element Data

The following data, IZ, TITLE, IA, Z, AMU, EAI, SIGPP, SIGPE, are input only if the input variable in DATA SET A, NREAD = 0.

Card Number	FORTRAN Format	Card Column	Variable Name	Description
1	(14I5)	1 - 5	IZ	Number of sets of element data on punched cards
2	(12A6)	1 - 72	TITLE	Element Identification.
3	(15, 2F 10.5)	1 - 5	IA	Number of energy points in pointwise cross section for this element
		6 - 15	Z	Atomic number for this element
		16 - 25	AMU	Atomic mass units for this element
4	(6E 12.5)	---	EAI	Energy point values at which cross section data (photoelectric and pair-production are given in order of increasing energy and in units of Mev. /IA values/
5	(6E 12.5)	---	SIGPP	Pair-production cross section at each energy point, EAI, in order of increasing energy and in units of barns*(cm <sup>2</sup> /atom x 10 <sup>24</sup> ) /IA values/
6	(6E 12.5)	---	SIGPE	Photoelectric cross section at each energy point, EAI, in order of increasing energy in units of barns (cm <sup>2</sup> / atom x 10 <sup>24</sup> ) /IA values/

Cards 2 to 6 inclusive are repeated for each element (IZ sets). This concludes the required setup for a GAMLEG-W calculation.

\* a barn is (cm<sup>2</sup>/atom x 10<sup>24</sup>)

## 2.3 DETAILED INPUT INSTRUCTIONS

This section presents a more detailed definition of the input parameters and arrays defined in Section 2.2.2. Examples of input data are illustrated to assist the user in the setup of a GAMLEG-W problem.

### 2.3.1 Multigroup Specifications

The input parameter to the GAMLEG-W code specifying the number of energy bounds is the value,  $IG$ . The energy values,  $EG$ , are the energy limits of the multigroup structure in order of decreasing energy. The code internally computes the number of groups,  $IG-1$ ; the printed output data of the code is the quantity,  $IG-1$ . The input energy values for the multigroup input to GAMLEG-W must be within the range of the energy values of both the flux and/or source weighting data entered in DATA SET B and the cross section data entered in DATA SET C. This restriction requires that the lower energy value,  $EG(IG)$ , must be greater than or equal to the lower energy value of EFLUX, ES, and EAI. The upper energy,  $EG(1)$ , must be less than the highest energy value of EFLUX, ES, or EAI.

### 2.3.2 Group Integration Requirements

The user of GAMLEG-W specifies the number of Simpson's rule integration points to be used in calculating the group averaged quantities. The internal calculation uses the input value,  $N$ , in Data Set A as the number of points within each group for these calculations. The Simpson's rule numerical integration used to provide the scatter-transfer cross sections, however, requires a factor of two greater number of points. This requirement is coded in GAMLEG-W. The number of integration points is dependent upon the group energy widths and the average energy of the group. For groups of 0.5 - 1.0 MeV energy widths and energies greater than 0.1 MeV, the recommended value of  $N$  is 30 integration points per group.

### 2.3.3 Weighting Function Data Requirements

Four types of data can be used to input weighting function data to the GAMLEG-W code. The user specifies the type of input by the control word, KON. Based on the value

of KON, and the specified type of cross section output desired (i. e., energy or particle scatter-transfer), the code calculates the proper weighting function data. For example, the user may specify energy flux weighting function data as input and particle flux output data. In this example, the code would convert the weighting function to a particle flux by dividing by the energy value at each energy point. In addition to the weighting function option, the user may specify the weighting to be uniform (or flat) within the group.

Flux weighting is optional in the GAMLEG-W code. Only if KON is negative are flux weighting data required as input. The source data are always a required input data array. In addition, the user must specify an array which spans the range of the energy group specifications.

#### 2.3.4 Library Data Requirements

Library data of pair-production and photoelectric cross section data by element are required input to the GAMLEG-W code. These library data are entered in units of barns per atom ( $\text{cm}^2/\text{atom} * 10^{24}$ ). The user must specify the number of energy points, the energy values (in decreasing energy in units of MeV), and the cross section values at the energy points. The code employs a linear interpolation method in the logarithm of energy and the logarithm of the cross section value to provide energy point values in the integration. The user must, therefore, specify a sufficient number of point data to describe the variation of cross section with energy, including the K, L, M, etc. electron shell edges of the photoelectric cross section data.

The maximum number of energy point values allowed in the GAMLEG-W code is 99.

## 2.4 PROBLEM SETUP INFORMATION

This section describes the data deck setup for the GAMLEG-W code. Information on tape assignments, running time, recommended debug procedure, and error messages is provided.

### 2.4.1 Tape Assignment

The GAMLEG-W code has been placed on the MSFC UNIVAC-1108 computer system under the EXEC 8 Monitor System. Under this system the GAMLEG-W code may require a maximum of 5 tapes or disks. The tape assignments are as follows:

Tape 5, Input Disk

Tape 6, Output Disk

Tape 7, Punch Disk

Tape 10, Output Multigroup Cross Section Data Tape

Tape 11, Cross Section Library Input (or Output if NREAD = 0) Data Tape

The cross section library input data tape (Tape 11), which is required if NREAD = 1, can be generated by a previous GAMLEG-W problem. The capability to produce a library tape is provided in GAMLEG-W without option; the user may obtain this tape by saving tape 11 from a GAMLEG-W problem for which a punched data card library was input. The content and format of the library tape is discussed in Section 2.7.

The output cross section data tape from GAMLEG-W is written on tape 10 in the format required for the ANISN-W and DOT-IIW codes; the contents of this tape are described in Section 2.5.

### 2.4.2 Running Time

The required running time for a given GAMLEG-W problem on the MSFC UNIVAC-1108 computer is dependent upon the desired number of energy groups ( $IG-1$ ), the order of the  $P_\ell$  expansion of the scattering cross section (NMAX), the order of the Simpson's rule integration used in calculation group averaged data (N), and the number of sets of element data to be calculated (IZ). These input quantities are used in the following equation to obtain an estimate of the CPU time for a GAMLEG-W problem:

$$t \text{ (CPU seconds)} = 20 + \frac{NMAX * N * (IG-1)}{10} + \frac{N * NMAX * IZ * (IG-1)}{4000}$$

A finite setup time is required for a GAMLEG-W problem (usually less than 20 seconds) and is included in the above equation to provide a conservative estimate of the time required for a GAMLEG-W problem.

#### 2.4.3 Recommended Problem Debug Procedure

Because of the code logic employed in the GAMLEG-W code, a complete checkout of a GAMLEG-W input deck can be obtained by setting the order of the  $P_g$  expansion, NMAX, to 1 and the order of numerical integration, N, to a very few points (< 10). A complete printout of the GAMLEG-W problem data and the processing of the element data are obtained in less than 60 seconds of CPU time. This procedure is recommended when a complete set of library data or a new weighting function is prepared for a GAMLEG-W problem.

#### 2.4.4 Error Messages

The following error messages may be encountered when running a GAMLEG-W problem. These error messages are related to improper data or problem deck setup.

##### Error Message

"Error - Energy less than all energies"

"Interpolant out of range"

"The Interpretation of Meaningless Data was Attempted."

##### Explanation

The input multigroup structure extends below the range of the input flux or source data or below the range of the library data.

The input multigroup structure lies above or equal to the upper limit of the flux or source spectrum or the upper limit of the library data.

Floating point data where fixed point data belongs or a title card where data belongs.



#### 2.4.5 Sample Problem Input

A sample problem input data listing is included in Table 2-2 to illustrate the setup of a problem. This problem is used to generate 13 group, photon transport cross sections. The order the Legendre expansion ( $P_\ell$ ) of the scattering cross sections is  $\ell = 5$  and the number of numerical integration points is 30. The element data in the sample problem consist of hydrogen photoelectric and pair-production data. This card listing illustrates the deck setup; a problem with more than one element requires additional, similar element data input.

TABLE 2-2

SAMPLE PROBLEM CARD INPUT FOR THE GAMLEG-W CODE

GAMLEG W SAMPLE PROBLEM											
14	30	6	1	6	100	0	0	0			
105											
9.500001	9.4			9.3		9.2		9.1	9.0	E-1	
8.9	8.8			8.7		8.6		8.5	8.4	E-2	
8.3	8.2			8.1		8.0		7.9	7.8	E-3	
7.7	7.6			7.5		7.4		7.3	7.2	E-4	
7.1	7.0			6.9		6.8		6.7	6.6	E-5	
6.5	6.4			6.3		6.2		6.1	6.0	E-6	
5.9	5.8			5.7		5.6		5.5	5.4	E-7	
5.3	5.2			5.1		5.0		4.9	4.8	E-8	
4.7	4.6			4.5		4.4		4.3	4.2	E-9	
4.1	4.0			3.9		3.8		3.7	3.6	E-10	
3.5	3.4			3.3		3.2		3.1	3.0	E-11	
2.9	2.8			2.7		2.6		2.5	2.4	E-12	
2.3	2.2			2.1		2.0		1.9	1.8	E-13	
1.7	1.6			1.5		1.4		1.3	1.2	E-14	
1.1	1.0			0.9		0.8		0.7	0.6	E-15	
0.5	0.4			0.32		0.30		0.2	0.1	E-16	
0.09	0.08			0.07		0.06		0.05	0.04	E-17	
0.03	0.02			0.01						E-18	
	7.03-5			8.93-5		1.21-4		1.84-4	2.82-4	4.14-4	F-1
	6.23-4			7.92-4		1.26-3		1.68-3	2.17-3	2.94-3	F-2
	3.98-3			5.41-3		7.13-3		9.20-3	1.18-2	1.56-2	F-3
	1.92-2			2.36-2		2.62-2		3.18-2	3.43-2	3.53-2	F-4
	3.34-2			3.15-2		2.97-2		2.72-2	2.68-2	2.84-2	F-5
	3.25-2			3.84-2		4.41-2		4.96-2	6.10-2	7.20-2	F-6
	7.67-2			9.28-2		1.03-1		1.12-1	1.26-1	1.30-1	F-7
	1.38-1			1.25-1		1.12-1		1.10-1	1.27-1	1.44-1	F-8
	1.88-1			2.30-1		2.52-1		2.77-1	3.01-1	3.32-1	F-9
	3.69-1			3.80-1		4.10-1		4.56-1	4.81-1	5.04-1	F-10
	5.25-1			5.44-1		5.94-1		6.40-1	7.13-1	7.80-1	F-11
	8.41-1			9.24-1		9.72-1		1.09-0	1.22-0	1.32-0	F-12
	1.43-0			1.50-0		1.60-0		1.66-0	1.71-0	1.78-0	F-13
	1.87-0			1.92-0		2.10-0		2.80-0	2.99-0	2.88-0	F-14
	3.08-0			3.00-0		3.33-0		3.68-0	3.64-0	4.02-0	F-15
	4.50-0			4.40-0		5.12-0		3.30-0	1.63-0	8.15-1	F-16
	7.33-1			6.52-1		5.70-1		4.89-1	4.08-1	3.26-1	F-17
	2.44-1			1.63-1		8.15-2					F-18
	9.5			7.5		7.0		6.0	5.0	4.0	DE-1
	3.0			2.6		2.2		1.8	1.35	0.9	DE-2
	0.4			0.1							
* 1											
HYDROGEN											
27	1.0			1.00797							
.01		.015			.02		.03		.04	.05	E MEV
.06		.08			.1		.15		.2	.3	E MEV
.4		.5			.6		.8		1.0	1.5	E MEV

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TABLE 2-2 (Continued)

2.0	3.0	4.0	5.0	6.0	8.0	E MEV
10.0	15.0	20.0				E MEV
0.0	0.0	0.0	0.0	0.0	0.0	PP 1 H
0.0	0.0	0.0	0.0	0.0	0.0	PP 1 H
0.0	0.0	0.0	0.0	0.0	4.4	-5 PP 1 H
1.81	-4 5.54	-4 9.89	-4 1.42	-3 1.84	-3 2.62	-3 PP 1 H
3.28	-3 4.62	-3 5.63	-3			PP 1 H
1.04	-2 2.0	-3 0.0	0.0	0.0	0.0	PE 1 H
0.0	0.0	0.0	0.0	0.0	0.0	PE 1 H
0.0	0.0	0.0	0.0	0.0	0.0	PE 1 H
0.0	0.0	0.0	0.0	0.0	0.0	PE 1 H
0.0	0.0	0.0	0.0	0.0	0.0	PE 1 H

## 2.5 OUTPUT DATA DESCRIPTION

Output data from the GAMLEG-W code consist of printed output, punched card output, and magnetic tape output.

### 2.5.1 Printed Output

The printout of the sample problem discussed in Section 2.4.5 is shown in Table 2-3. This printout consists of an organized printout of the input data to the code. The input data from DATA SET A and DATA SET B (see Section 2.2) are the first printed data. The optional flux weighting function data are only printed if input.

This organized input printout is followed by an edit of the results of the numerical integration of the scatter-transfer cross section data. This printout consists of a line of printout for each group as follows:

DIFFERENCE - GROUP AVERAGE SCATTER CROSS SECTION AND SUM OF  
GROUP AVERAGED TRANSFERS = GROUP N, IS = X.XXXXXE-XX

This edit is dependent upon the type of cross section output. This difference is the error between the numerical integration of the Klein-Nishina equation to obtain the group-averaged, total,  $P_0$  scatter cross section and the sum of the  $P_0$  scatter-transfer cross section obtained from the numerical integration of the differential scatter-transfer cross section in the multigroup energy structure (see Section 2.7 for equations). If particle transfer cross section output is obtained, this difference is the fractional error between the numerical integrations.

If energy transfer cross section output is obtained, this difference is the Compton absorption cross sections in units of barns/electron ( $\text{cm}^2/\text{electron} * 10^{24}$ ).

The next section of printed output is the multigroup results of the Compton scatter cross section calculation. The columns of data are the group averaged values as follows:

- 1) ENERGY (MeV) is the average group energy based on the weighted average of the energy.
- 2) FLUX is the integral weighting flux (particle or energy) in each group.
- 3) SOURCE is the integral source (particle or energy) in each group.

TABLE 2-3

SAMPLE PROBLEM COMPUTER PRINTOUT FOR THE GAMLEG-W CODE

GAMLEG-W INPUT DATA

```

NO. OF GROUPS . . . . . 13
NO. OF INTEGRATION POINTS/GROUP . . . . . 30
NO. OF LEGENDRE MOMENTS . . . . . 6
WEIGHTING FUNC. (0/1/2, UNIFORM/ENERGY/PARTICLE) . . . . . 1
(MINUS IMPLIES FLUX-POSITIVE IMPLIES SOURCE)
NO. OF MATERIALS ON OUTPUT TAPE14 . . . . . 6
TAPE I/O NO. . . . . 100
PUNCH OUTPUT OPTION(0/1, NO/YES) . . . . . 0
COMPTON SCATTER-LOSS OPTION(0/1, YES/NO) . . . . . 0
LIBRARY OPTION(0/1, CARDS/TAPE11) . . . . . 0
PAIR PRODUCTION OPTION(0/1, NO/YES) . . . . . -0
CROSS SECTION OUTPUT OPTION(0/1, ENERGY/PARTICLE) . . . . . -0
    
```

	ENERGY (MEV)	SOURCE
1	9.5000010E+00	1.0300000E-05
2	9.4000000E+00	8.9300000E-05
3	9.3000000E+00	1.2100000E-04
4	9.2000000E+00	1.8400000E-04
5	9.1000000E+00	2.8200000E-04
6	9.0000000E+00	4.1400000E-04
7	8.9000000E+00	6.2300000E-04
8	8.8000000E+00	7.9200000E-04
9	8.7000000E+00	1.2600000E-03
10	8.6000000E+00	1.6800000E-03
11	8.5000000E+00	2.1700000E-03
12	8.4000000E+00	2.9400000E-03
13	8.3000000E+00	3.9800000E-03
14	8.2000000E+00	5.4100000E-03
15	8.1000000E+00	7.1300000E-03
16	8.0000000E+00	9.2000000E-03
17	7.9000000E+00	1.1800000E-02
18	7.8000000E+00	1.5600000E-02
19	7.7000000E+00	1.9200000E-02
20	7.6000000E+00	2.3600000E-02
21	7.5000000E+00	2.6200000E-02
22	7.4000000E+00	3.1800000E-02
23	7.3000000E+00	3.4300000E-02
24	7.2000000E+00	3.5300000E-02
25	7.1000000E+00	3.3400000E-02
26	7.0000000E+00	3.1500000E-02
27	6.9000000E+00	2.9700000E-02
28	6.8000000E+00	2.7200000E-02
29	6.7000000E+00	2.6800000E-02

TABLE 2-3 (Continued)

30	6.6000000E+00	2.8400000E-02
31	6.5000000E+00	3.2500000E-02
32	6.4000000E+00	3.8400000E-02
33	6.3000000E+00	4.4100000E-02
34	6.2000000E+00	4.9600000E-02
35	6.1000000E+00	6.1000000E-02
36	6.0000000E+00	7.2000000E-02
37	5.9000000E+00	7.6700000E-02
38	5.8000000E+00	9.2800000E-02
39	5.7800000E+00	1.0300000E-01
40	5.6000000E+00	1.1200000E-01
41	5.5000000E+00	1.2600000E-01
42	5.4000000E+00	1.3000000E-01
43	5.3000000E+00	1.3800000E-01
44	5.2000000E+00	1.2500000E-01
45	5.1000000E+00	1.1200000E-01
46	5.0000000E+00	1.1000000E-01
47	4.9000000E+00	1.2700000E-01
48	4.8000000E+00	1.4400000E-01
49	4.7000000E+00	1.8800000E-01
50	4.6000000E+00	2.3000000E-01
51	4.5000000E+00	2.5200000E-01
52	4.4000000E+00	2.7700000E-01
53	4.3000000E+00	3.0100000E-01
54	4.2000000E+00	3.3200000E-01
55	4.1000000E+00	3.6900000E-01
56	4.0000000E+00	3.8000000E-01
57	3.9000000E+00	4.1000000E-01
58	3.8000000E+00	4.5600000E-01
59	3.7000000E+00	4.8100000E-01
60	3.6000000E+00	5.0400000E-01
61	3.5000000E+00	5.2500000E-01
62	3.4000000E+00	5.4400000E-01
63	3.3000000E+00	5.9400000E-01
64	3.2000000E+00	6.4000000E-01
65	3.1000000E+00	7.1300000E-01
66	3.0000000E+00	7.8000000E-01
67	2.9000000E+00	8.4100000E-01
68	2.8000000E+00	9.2400000E-01
69	2.7000000E+00	9.7200000E-01
70	2.6000000E+00	1.0900000E+00
71	2.5000000E+00	1.2200000E+00
72	2.4000000E+00	1.3200000E+00
73	2.3000000E+00	1.4300000E+00
74	2.2000000E+00	1.5000000E+00
75	2.1000000E+00	1.6000000E+00
76	2.0000000E+00	1.6600000E+00

TABLE 2-3 (Continued)

77	1.9000000E+00	1.7100000E+00
78	1.8000000E+00	1.7800000E+00
79	1.7000000E+00	1.8700000E+00
80	1.6000000E+00	1.9200000E+00
81	1.5000000E+00	2.1000000E+00
82	1.4000000E+00	2.8000000E+00
83	1.3000000E+00	2.9900000E+00
84	1.2000000E+00	2.8800000E+00
85	1.1000000E+00	3.0800000E+00
86	1.0000000E+00	3.0000000E+00
87	9.0000000E-01	3.3300000E+00
88	8.0000000E-01	3.6800000E+00
89	7.0000000E-01	3.6400000E+00
90	6.0000000E-01	4.0200000E+00
91	5.0000000E-01	4.5000000E+00
92	4.0000000E-01	4.4000000E+00
93	3.2000000E-01	5.1200000E+00
94	3.0000000E-01	3.3000000E+00
95	2.0000000E-01	1.6300000E+00
96	1.0000000E-01	8.1500000E-01
97	9.0000000E-02	7.3300000E-01
98	8.0000000E-02	6.5200000E-01
99	7.0000000E-02	5.7000000E-01
100	6.0000000E-02	4.8900000E-01
101	5.0000000E-02	4.0800000E-01
102	4.0000000E-02	3.2600000E-01
103	3.0000000E-02	2.4400000E-01
104	2.0000000E-02	1.6300000E-01
105	1.0000000E-02	8.1500000E-02

GROUP ENERGY BOUNDS

1	9.5000000E+00
2	7.5000000E+00
3	7.0000000E+00
4	6.0000000E+00
5	5.0000000E+00
6	4.0000000E+00
7	3.0000000E+00
8	2.6000000E+00
9	2.2000000E+00
10	1.8000000E+00
11	1.3500000E+00
12	9.0000000E-01
13	4.0000000E-01
14	1.0000000E-01

DIFFERENCE=GROUP AVG SCATTER CROSS SECTION AND SUM OF GROUP AVERAGED TRANSFERS, GROUP 1, IS= 4.03754E-02

TABLE 2-3 (Continued)

DIFFERENCE-GROUP AVG SCATTER CROSS SECTION AND SUM OF GROUP AVERAGED TRANSFERS, GROUP 2 , IS= 4.23578E-02  
 DIFFERENCE-GROUP AVG SCATTER CROSS SECTION AND SUM OF GROUP AVERAGED TRANSFERS, GROUP 3 , IS= 4.54490E-02  
 DIFFERENCE-GROUP AVG SCATTER CROSS SECTION AND SUM OF GROUP AVERAGED TRANSFERS, GROUP 4 , IS= 4.96733E-02  
 DIFFERENCE-GROUP AVG SCATTER CROSS SECTION AND SUM OF GROUP AVERAGED TRANSFERS, GROUP 5 , IS= 5.56102E-02  
 DIFFERENCE-GROUP AVG SCATTER CROSS SECTION AND SUM OF GROUP AVERAGED TRANSFERS, GROUP 6 , IS= 6.25761E-02  
 DIFFERENCE-GROUP AVG SCATTER CROSS SECTION AND SUM OF GROUP AVERAGED TRANSFERS, GROUP 7 , IS= 6.85182E-02  
 DIFFERENCE-GROUP AVG SCATTER CROSS SECTION AND SUM OF GROUP AVERAGED TRANSFERS, GROUP 8 , IS= 7.28670E-02  
 DIFFERENCE-GROUP AVG SCATTER CROSS SECTION AND SUM OF GROUP AVERAGED TRANSFERS, GROUP 9 , IS= 7.77711E-02  
 DIFFERENCE-GROUP AVG SCATTER CROSS SECTION AND SUM OF GROUP AVERAGED TRANSFERS, GROUP 10 , IS= 8.40375E-02  
 DIFFERENCE-GROUP AVG SCATTER CROSS SECTION AND SUM OF GROUP AVERAGED TRANSFERS, GROUP 11 , IS= 9.09307E-02  
 DIFFERENCE-GROUP AVG SCATTER CROSS SECTION AND SUM OF GROUP AVERAGED TRANSFERS, GROUP 12 , IS= 9.74632E-02  
 DIFFERENCE-GROUP AVG SCATTER CROSS SECTION AND SUM OF GROUP AVERAGED TRANSFERS, GROUP 13 , IS= 9.32599E-02  
 GROUP AVERAGE VALUES, CROSS SECTIONS (BARNS/ELECTRON)

GRP NO.	ENERGY (MEV)	FLUX	SOURCE	COMPTON SCATTER	COMPTON ABSORPTION	COMPTON SCAT-LOSS	COMPTON ABS. (E)	COMPTON SCAT-LOSS (E)
1	7.86563E+00	2.32894E-02	5.95017E-03	6.06481E-02	4.03754E-02	0.	3.17270E-01	0.
2	7.24460E+00	3.20010E-02	3.27035E-02	6.42331E-02	4.23578E-02	0.	3.06798E-01	0.
3	6.41510E+00	7.60884E-02	3.88794E-02	6.99880E-02	4.54490E-02	0.	2.91215E-01	0.
4	5.46238E+00	2.16425E-01	1.10588E-01	7.81517E-02	4.96733E-02	0.	2.70973E-01	0.
5	4.40093E+00	4.81831E-01	2.46205E-01	9.03219E-02	5.56102E-02	0.	2.44279E-01	0.
6	3.44560E+00	1.06534E+00	5.44366E-01	1.05880E-01	6.25761E-02	0.	2.14932E-01	0.
7	2.78942E+00	7.18014E-01	9.17221E-01	1.20386E-01	6.85182E-02	0.	1.90991E-01	0.
8	2.38748E+00	1.02952E+00	1.31516E+00	1.32104E-01	7.28670E-02	0.	1.73962E-01	0.
9	1.99479E+00	1.29316E+00	1.65194E+00	1.46726E-01	7.77711E-02	0.	1.54962E-01	0.
10	1.55561E+00	1.87453E+00	2.12854E+00	1.68637E-01	8.40375E-02	0.	1.30464E-01	0.
11	1.12143E+00	2.65817E+00	3.01837E+00	2.00361E-01	9.09307E-02	0.	1.01695E-01	0.
12	6.36876E-01	3.85162E+00	3.93618E+00	2.64214E-01	9.74632E-02	0.	6.19046E-02	0.
13	2.93788E-01	1.61787E+00	2.75564E+00	3.61725E-01	9.32599E-02	9.67233E-03	2.78282E-02	1.15650E-03

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TABLE 2-3 (Continued)

HYDROGEN

	ENERGY (MEV)	PAIR PROD.	PHOTO ELEC
1	2.0000000E+01	5.6300000E-03	0.
2	1.5000000E+01	4.6200000E-03	0.
3	1.0000000E+01	3.2800000E-03	0.
4	8.0000000E+00	2.6200000E-03	0.
5	6.0000000E+00	1.8400000E-03	0.
6	5.0000000E+00	1.4200000E-03	0.
7	4.0000000E+00	9.8900000E-04	0.
8	3.0000000E+00	5.5400000E-04	0.
9	2.0000000E+00	1.8100000E-04	0.
10	1.5000000E+00	4.4000000E-05	0.
11	1.0000000E+00	0.	0.
12	8.0000000E-01	0.	0.
13	6.0000000E-01	0.	0.
14	5.0000000E-01	0.	0.
15	4.0000000E-01	0.	0.
16	3.0000000E-01	0.	0.
17	2.0000000E-01	0.	0.
18	1.5000000E-01	0.	0.
19	1.0000000E-01	0.	0.
20	8.0000000E-02	0.	0.
21	6.0000000E-02	0.	0.
22	5.0000000E-02	0.	0.
23	4.0000000E-02	0.	0.
24	3.0000000E-02	0.	0.
25	2.0000000E-02	0.	0.
26	1.5000000E-02	0.	2.0000000E-03
27	1.0000000E-02	0.	1.0400000E-02

TABLE 2-3 (Continued)

GRP NO.	PHOTO ELECT ABSORPTION	PAIR PRODUC ABSORPTION	ENERGY ABS(PP+PE)	ENERGY ABS(TOTAL)	PAIR PRODUC TRANSFER
1	0.	2.56048E-03	2.01776E-02	3.37448E-01	0.
2	0.	2.31957E-03	1.68121E-02	3.23610E-01	0.
3	0.	1.99819E-03	1.28520E-02	3.04067E-01	0.
4	0.	1.61138E-03	8.83300E-03	2.79806E-01	0.
5	0.	1.15682E-03	5.12234E-03	2.49401E-01	0.
6	0.	7.37476E-04	2.57676E-03	2.17508E-01	0.
7	0.	4.55095E-04	1.27543E-03	1.92267E-01	0.
8	0.	2.97371E-04	7.15077E-04	1.74677E-01	0.
9	0.	1.73016E-04	3.49460E-04	1.55311E-01	0.
10	0.	4.31715E-05	7.19531E-05	1.30536E-01	0.
11	0.	0.	0.	1.01695E-01	0.
12	0.	0.	0.	6.19046E-02	0.
13	0.	0.	0.	2.89847E-02	0.

P 0 CROSS SECTION TABLE ATOMIC NUMBER= 1.000

	GROUP= 1	GROUP= 2	GROUP= 3	GROUP= 4	GROUP= 5	GROUP= 6	GROUP= 7	GROUP= 8
1	4.293583E-02	4.467733E-02	4.744720E-02	5.128466E-02	5.676699E-02	6.331359E-02	6.897327E-02	7.316433E-02
2	0.	0.	0.	0.	0.	0.	0.	0.
3	6.320458E-02	6.655262E-02	7.198616E-02	7.976305E-02	9.147869E-02	1.066173E-01	1.208413E-01	1.324012E-01
4	1.358288E-03	1.135998E-03	2.308255E-03	3.540375E-03	4.595867E-03	7.976986E-03	5.628376E-03	7.552934E-03
5	0.	1.913813E-03	4.362165E-03	5.378622E-03	7.150757E-03	1.070034E-02	7.207608E-03	1.121046E-02
6	0.	0.	3.455478E-03	3.758235E-03	4.534115E-03	5.833580E-03	3.553383E-03	6.252495E-03
7	0.	0.	0.	3.016081E-03	3.248292E-03	3.846248E-03	2.032404E-03	3.208891E-03
8	0.	0.	0.	0.	2.645167E-03	2.893306E-03	1.381576E-03	1.890197E-03
9	0.	0.	0.	0.	0.	2.343501E-03	1.038805E-03	1.307666E-03
10	0.	0.	0.	0.	0.	0.	8.687658E-04	9.944068E-04
11	0.	0.	0.	0.	0.	0.	0.	8.365844E-04
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
	GROUP= 9	GROUP=10	GROUP=11	GROUP=12	GROUP=13	GROUP=		
1	7.794410E-02	8.408063E-02	9.093075E-02	9.746316E-02	1.029323E-01			
2	0.	0.	0.	0.	0.			
3	1.468992E-01	1.686797E-01	2.003609E-01	2.642135E-01	3.617249E-01			
4	1.049040E-02	1.773583E-02	3.424888E-02	9.076806E-02	2.587927E-01			
5	1.482354E-02	2.246264E-02	3.383393E-02	5.796568E-02	7.598229E-02			

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TABLE 2-3 (Continued)

6	9.372847E-03	1.323511E-02	1.647075E-02	2.448548E-02	1.721563E-02
7	5.429427E-03	8.722831E-03	1.042234E-02	1.406833E-02	8.543827E-03
8	2.913339E-03	5.296927E-03	7.250667E-03	9.717641E-03	5.062962E-03
9	1.768769E-03	2.489042E-03	4.652098E-03	7.148529E-03	3.485280E-03
10	1.244819E-03	1.872605E-03	2.766258E-03	4.815575E-03	2.534318E-03
11	9.568007E-04	1.340317E-03	1.785009E-03	2.979094E-03	1.672547E-03
12	8.093971E-04	1.040758E-03	1.296819E-03	1.959177E-03	1.005496E-03
13	0.	8.849628E-04	1.015749E-03	1.435283E-03	6.455219E-04
14	0.	0.	8.673838E-04	1.129067E-03	4.652361E-04
15	0.	0.	0.	9.659761E-04	3.617103E-04
16	0.	0.	0.	0.	3.073483E-04

P 1 CROSS SECTION TABLE ATOMIC NUMBER= 1.000

	GROUP= 1	GROUP= 2	GROUP= 3	GROUP= 4	GROUP= 5	GROUP= 6	GROUP= 7	GROUP= 8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	4.065255E-03	3.402718E-03	6.899897E-03	1.056780E-02	1.369129E-02	2.363894E-02	1.674866E-02	2.241185E-02
5	0.	5.711966E-03	1.298207E-02	1.593207E-02	2.104149E-02	3.119106E-02	2.096948E-02	3.267490E-02
6	0.	0.	1.022864E-02	1.102305E-02	1.314795E-02	1.659220E-02	9.967882E-03	1.761593E-02
7	0.	0.	0.	8.798062E-03	9.324946E-03	1.077463E-02	5.558808E-03	8.707068E-03
8	0.	0.	0.	0.	7.551063E-03	7.854587E-03	3.719964E-03	4.996442E-03
9	0.	0.	0.	0.	0.	6.458856E-03	2.767111E-03	3.400977E-03
10	0.	0.	0.	0.	0.	0.	2.300219E-03	2.557624E-03
11	0.	0.	0.	0.	0.	0.	0.	2.138249E-03
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

GROUP= 9      GROUP=10      GROUP=11      GROUP=12      GROUP=13      GROUP=

1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.
4	3.215608E-02	5.175217E-02	9.725145E-02	2.275174E-01	2.924312E-01
5	4.270922E-02	6.302944E-02	8.973577E-02	1.200946E-01	2.464228E-02
6	2.611656E-02	3.537537E-02	3.970568E-02	3.862707E-02	1.541939E-02
7	1.459735E-02	2.248323E-02	2.371777E-02	1.850703E-02	9.894580E-03
8	7.530126E-03	1.312860E-02	1.579963E-02	1.139045E-02	6.565189E-03
9	4.447774E-03	7.097370E-03	9.668687E-03	7.658794E-03	4.789105E-03
10	3.077254E-03	4.314720E-03	5.460056E-03	4.659479E-03	3.622724E-03

TABLE 2-3 (Continued)

11	2.337716E-03	3.031020E-03	3.397122E-03	2.568779E-03	-2.487799E-03
12	1.964531E-03	2.323565E-03	2.412444E-03	1.551275E-03	-1.556075E-03
13	0.	1.961432E-03	1.860205E-03	1.075532E-03	-1.025406E-03
14	0.	0.	1.574426E-03	8.138762E-04	-7.506166E-04
15	0.	0.	0.	6.808986E-04	-5.896868E-04
16	0.	0.	0.	0.	-5.039699E-04

P 2 CROSS SECTION TABLE ATOMIC NUMBER= 1.000

	GROUP= 1	GROUP= 2	GROUP= 3	GROUP= 4	GROUP= 5	GROUP= 6	GROUP= 7	GROUP= 8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	6.743492E-03	5.653638E-03	1.141729E-02	1.743630E-02	2.250051E-02	3.843899E-02	2.746378E-02	3.654036E-02
5	0.	9.422193E-03	2.129125E-02	2.588201E-02	3.372356E-02	4.903203E-02	3.283167E-02	5.135154E-02
6	0.	0.	1.659349E-02	1.754769E-02	2.043882E-02	2.475053E-02	1.442074E-02	2.574023E-02
7	0.	0.	0.	1.384747E-02	1.418841E-02	1.554185E-02	7.590052E-03	1.166973E-02
8	0.	0.	0.	0.	1.135139E-02	1.106556E-02	4.893609E-03	6.282411E-03
9	0.	0.	0.	0.	0.	8.978191E-03	3.545846E-03	4.103049E-03
10	0.	0.	0.	0.	0.	0.	2.903710E-03	2.996650E-03
11	0.	0.	0.	0.	0.	0.	0.	2.463580E-03
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

GROUP= 9      GROUP=10      GROUP=11      GROUP=12      GROUP=13      GROUP=

1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.
4	5.190792E-02	8.156121E-02	1.449471E-01	2.619789E-01	2.437317E-01
5	6.552112E-02	9.138550E-02	1.146645E-01	7.937921E-02	-2.760734E-02
6	3.723014E-02	4.578918E-02	3.897015E-02	-3.348152E-03	-1.601502E-02
7	1.914634E-02	2.653696E-02	1.915628E-02	-1.080261E-02	-5.909508E-03
8	8.941808E-03	1.370924E-02	1.072432E-02	-1.034280E-02	-2.574619E-03
9	4.901658E-03	6.588669E-03	5.222332E-03	-8.952790E-03	-1.354402E-03
10	3.229399E-03	3.613857E-03	2.126729E-03	-6.875138E-03	-7.478729E-04
11	2.369306E-03	2.368754E-03	9.644884E-04	-4.734184E-03	-3.176694E-04
12	1.951396E-03	1.726809E-03	5.263146E-04	-3.304519E-03	-7.446673E-05
13	0.	1.415292E-03	3.218092E-04	-2.499498E-03	5.964780E-06
14	0.	0.	2.320815E-04	-2.005945E-03	2.870576E-05
15	0.	0.	0.	-1.734576E-03	3.542036E-05

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TABLE 2-3 (Continued)

P 3 CROSS SECTION TABLE ATOMIC NUMBER= 1.000									
	GROUP= 1	GROUP= 2	GROUP= 3	GROUP= 4	GROUP= 5	GROUP= 6	GROUP= 7	GROUP= 8	
16	0.	0.	0.	0.	3.643367E-05				
1	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	9.374183E-03	7.878328E-03	1.581210E-02	2.404337E-02	3.084160E-02	5.184897E-02	3.751772E-02	4.948581E-02	
5	0.	1.298749E-02	2.909097E-02	3.485217E-02	4.446874E-02	6.271627E-02	4.172298E-02	6.564675E-02	
6	0.	0.	2.229441E-02	2.288708E-02	2.565524E-02	2.897583E-02	1.596974E-02	2.905469E-02	
7	0.	0.	0.	1.773456E-02	1.718025E-02	1.712254E-02	7.504307E-03	1.109942E-02	
8	0.	0.	0.	0.	1.346257E-02	1.165489E-02	4.464637E-03	5.151399E-03	
9	0.	0.	0.	0.	0.	9.210277E-03	3.043796E-03	3.014123E-03	
10	0.	0.	0.	0.	0.	0.	2.403210E-03	2.019342E-03	
11	0.	0.	0.	0.	0.	0.	0.	1.574079E-03	
12	0.	0.	0.	0.	0.	0.	0.	0.	
13	0.	0.	0.	0.	0.	0.	0.	0.	
14	0.	0.	0.	0.	0.	0.	0.	0.	
15	0.	0.	0.	0.	0.	0.	0.	0.	
16	0.	0.	0.	0.	0.	0.	0.	0.	
P 4 CROSS SECTION TABLE ATOMIC NUMBER= 1.000									
	GROUP= 9	GROUP=10	GROUP=11	GROUP=12	GROUP=13	GROUP=			
1	0.	0.	0.	0.	0.				
2	0.	0.	0.	0.	0.				
3	0.	0.	0.	0.	0.				
4	6.923951E-02	1.048669E-01	1.707671E-01	2.050393E-01	1.268190E-01				
5	8.055177E-02	1.020912E-01	1.006793E-01	-1.020521E-02	-4.416451E-02				
6	4.014374E-02	4.050526E-02	1.271986E-02	-4.900291E-02	9.425842E-03				
7	1.739266E-02	1.843191E-02	-2.170333E-03	-3.265725E-02	8.716298E-03				
8	6.285920E-03	6.526317E-03	-5.863335E-03	-2.276973E-02	6.140751E-03				
9	2.680505E-03	1.192291E-03	-6.257109E-03	-1.646243E-02	4.507747E-03				
10	1.430705E-03	-1.473655E-04	-5.042098E-03	-1.067239E-02	3.387932E-03				
11	8.720465E-04	-5.221411E-04	-3.741723E-03	-6.231365E-03	2.286970E-03				
12	6.330660E-04	-5.959661E-04	-2.909704E-03	-3.893085E-03	1.391558E-03				
13	0.	-5.443957E-04	-2.372677E-03	-2.751005E-03	8.937846E-04				
14	0.	0.	-2.068406E-03	-2.107476E-03	6.422990E-04				
15	0.	0.	0.	-1.774885E-03	4.977106E-04				
16	0.	0.	0.	0.	4.218757E-04				

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TABLE 2-3 (Continued)

1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	1.193901E-02	1.006651E-02	2.003777E-02	3.029158E-02	3.854565E-02	6.340764E-02	4.667497E-02	6.084526E-02
5	0.	1.635323E-02	3.619491E-02	4.250414E-02	5.266015E-02	7.110060E-02	4.684511E-02	7.433940E-02
6	0.	0.	2.710010E-02	2.666583E-02	2.822962E-02	2.847924E-02	1.415982E-02	2.677221E-02
7	0.	0.	0.	2.011324E-02	1.785070E-02	1.504204E-02	5.159009E-03	6.869648E-03
8	0.	0.	0.	0.	1.351207E-02	9.326872E-03	2.416448E-03	1.747791E-03
9	0.	0.	0.	0.	0.	6.945040E-03	1.298278E-03	3.503159E-04
10	0.	0.	0.	0.	0.	0.	8.559280E-04	-1.433898E-04
11	0.	0.	0.	0.	0.	0.	0.	-3.026135E-04
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

GROUP= 9    GROUP=10    GROUP=11    GROUP=12    GROUP=13    GROUP=

1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.
4	8.339116E-02	1.200692E-01	1.726510E-01	1.158456E-01	4.856254E-02
5	8.601756E-02	9.316380E-02	5.363638E-02	-6.725891E-02	-2.306403E-02
6	3.383416E-02	2.015106E-02	-2.700946E-02	-4.926250E-02	1.549751E-02
7	9.365393E-03	2.399634E-04	-2.822666E-02	-1.969151E-02	4.742228E-03
8	1.637874E-04	-6.380887E-03	-2.325915E-02	-8.916493E-03	1.131832E-03
9	-1.536581E-03	-6.654566E-03	-1.634840E-02	-3.919229E-03	1.301735E-05
10	-1.690734E-03	-5.155034E-03	-1.011817E-02	-7.572003E-04	-4.169216E-04
11	-1.588977E-03	-4.040138E-03	-6.522416E-03	7.089223E-04	-5.812435E-04
12	-1.472165E-03	-3.297282E-03	-4.690418E-03	9.715221E-04	-5.437992E-04
13	0.	-2.872122E-03	-3.635575E-03	9.287366E-04	-4.342672E-04
14	0.	0.	-3.081612E-03	8.428991E-04	-3.500977E-04
15	0.	0.	0.	7.740143E-04	-2.915712E-04
16	0.	0.	0.	0.	-2.569209E-04

NOT REPRODUCIBLE

P 5 CROSS SECTION TABLE ATOMIC NUMBER= 1.000

	GROUP= 1	GROUP= 2	GROUP= 3	GROUP= 4	GROUP= 5	GROUP= 6	GROUP= 7	GROUP= 8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.

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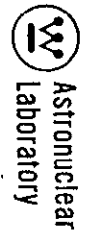


TABLE 2-3 (Continued)

4	1.442034E-02	1.220813E-02	2.405015E-02	3.609048E-02	4.546139E-02	7.274213E-02	5.472782E-02	7.028197E-02
5	0.	1.446810E-02	4.243363E-02	4.855048E-02	5.782732E-02	7.350283E-02	4.774398E-02	7.668270E-02
6	0.	0.	3.081198E-02	2.860041E-02	2.782898E-02	2.312685E-02	9.105444E-03	1.902049E-02
7	0.	0.	0.	2.074634E-02	1.601033E-02	9.463927E-03	9.338287E-04	-2.244323E-04
8	0.	0.	0.	0.	1.138675E-02	4.367081E-03	-8.300652E-04	-3.062569E-03
9	0.	0.	0.	0.	0.	2.505695E-03	-1.283655E-03	-3.106053E-03
10	0.	0.	0.	0.	0.	0.	-1.353445E-03	-2.799333E-03
11	0.	0.	0.	0.	0.	0.	0.	-2.537872E-03
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

GROUP# 9      GROUP#10      GROUP#11      GROUP#12      GROUP#13      GROUP#

1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.
4	9.379414E-02	1.264182E-01	1.532213E-01	4.948089E-02	1.559350E-02
5	8.126282E-02	6.640469E-02	-9.564578E-03	-7.119500E-02	-1.378804E-03
6	1.902924E-02	-1.019632E-02	-6.082517E-02	-1.646686E-02	-3.533337E-03
7	-3.168878E-03	-2.209447E-02	-4.325527E-02	7.004892E-03	-7.285013E-03
8	-7.519277E-03	-1.946694E-02	-2.930844E-02	1.035861E-02	-5.364664E-03
9	-6.169464E-03	-1.296170E-02	-1.689579E-02	9.965302E-03	-3.843863E-03
10	-4.843000E-03	-8.402711E-03	-8.308289E-03	7.955006E-03	-2.779818E-03
11	-3.929301E-03	-6.007895E-03	-4.433938E-03	5.469178E-03	-1.761398E-03
12	-3.404649E-03	-4.624972E-03	-2.780252E-03	3.737156E-03	-9.772475E-04
13	0.	-3.901790E-03	-1.936881E-03	2.771548E-03	-5.763488E-04
14	0.	0.	-1.536543E-03	2.189072E-03	-3.887040E-04
15	0.	0.	0.	1.874016E-03	-2.868114E-04
16	0.	0.	0.	0.	-2.359016E-04

4) COMPTON SCATTER is the group-averaged, total, Compton scatter cross section in units of barns/electron.

5) COMPTON ABSORPTION is the Compton absorption cross section in units of barns/electron. These data are directly usable as energy absorption data in energy flux calculations.

6) COMPTON SCAT-LOSS is the Compton scatter-transfer cross section for scatter-transfer below the lower energy bound of the last (lowest) energy group in units of barns/electron. The data are directly useable as energy absorption data in energy flux calculations.

7) COMPTON ABS. (E) is the Compton energy-absorption cross section in units of MeV-barns/electron. These data are energy-absorption cross sections for use in particle flux calculations.

8) COMPTON SCAT-LOSS (E) is the Compton scatter, energy-loss cross section for energy-loss due to scatter-transfer below the lower energy bounds of the last (lowest) energy group, in units of MeV-barns/electron. These data are for use as energy absorption cross sections in particle flux calculations.

The final printed output from a GAMLEG-W problem is the element data and the photon transport cross section data. The element data consisting of the photoelectric and pair-production cross section library data at the input energy points are printed. These data are followed by an edit of the input library data as well as calculated data in the multigroup structure. These group averaged data are tabulated by columns and contain the following quantities as a function of energy group:

1) PHOTO ELECTRIC ABSORPTION is the photoelectric absorption cross section in units of barns/atom.

2) PAIR PRODUCTION ABSORPTION is the pair-production absorption cross section in units of barns/atom. These data, at option, include the pair-production annihilation photons as absorbed energy or particles.

3) ENERGY ABS (PP+PE) is the energy-absorption cross section in units of barns/atom and includes, at option, the pair-production annihilation photon energy.



4) ENERGY ABS (TOTAL) is the total energy-absorption cross section in units of barns/atom. These data are useable as energy-absorption data for particle flux calculations.

5) PAIR PRODUCTION TRANSFER is the energy- or particle-transfer cross section from the group in units of MeV-barns/atom or barns/atom.

The photon transport cross section set (or array table) for the  $P_0$  data is the next set of printed output. These data are in units of barns/atom for the element. The atomic number printed before the table identifies the element data. The cross section table consists of a column of data for each group of a multigroup set with  $G$  groups. The group,  $g$ , is defined by table position (row) in each column as:

<u>Table Position</u>	<u>Cross Section Type</u>	<u>Description</u>
1	$\sigma_a$	The absorption cross section in units of barns/atom.
2	0.0	-----
3	$\sigma_t$	total collision cross section in units of barns/atom.
4	$\sigma_{gg}$	the self- or within-group particle or energy scatter-transfer cross section
5	$\sigma_{g-1 \rightarrow g}$	the scatter-transfer cross section from group $g-1$ to group $g$
6	$\sigma_{g-1 \rightarrow g}$	.
.	.	.
.	.	.
.	.	.
.	.	.
G+3	$\sigma_{g-G+1 \rightarrow G}$	the scatter-transfer cross section from group $g-G+1$ to Group $G$

The scatter-transfer cross section table positions contain zero except where a possible scatter-transfer into a group exists.

The  $P_\ell$  cross section data for  $\ell > 0$  contain zero entries in the  $\sigma_a$  and  $\sigma_t$  table positions for each group. The  $P_\ell$  scatter-transfer cross section table corresponds to the  $P_0$  data in format. NOTE: The  $P_\ell$ , for  $\ell > 0$ , cross section data from GAMLEG-W contains the  $(2\ell + 1)$  term. These  $P_\ell$  data are directly useable in the ANISN-W and DOT-IIW codes.

The sample problem output in Table 2-3 illustrates a single element GAMLEG-W problem. If a multiple element problem is run, the  $P_0$  data for all elements are printed followed by  $P_\ell$  data for all elements for order  $\ell = 1, 2, 3$ , etc. This output format is necessary due to the cyclic calculation of the data.

### 2.5.2 Tape Output Description

Magnetic tape output from a GAMLEG-W problem consists of 1) a multigroup, photon transport cross section tape in a format consistent with the ANISN-W, DOT-IIW, SATURN<sup>(5)</sup>, and APPROPOS<sup>(5)</sup> codes, and if a punched card library is input, 2) a library tape of pair-production and photoelectric cross section data in a form consistent with the GAMLEG-W, SCAP<sup>(6)</sup>, KAP-VI<sup>(6)</sup>, and MAP<sup>(4)</sup> codes. The multigroup, photon cross section output tape is written in the binary mode on 10 in the following format:

<u>Tape Record No.</u>	<u>Description</u>
1	A two-word record containing 1) the number of cross section sets on the tape (which is equal to the multiple of the input quantity, NMAT, times the number of Legendre ( $P_\ell$ ) expansion coefficients ( $\ell + 1$ ), 2) the tape identification word, IDT, which is GAMLEG-W input data.
2	A twelve-word binary record identifying the cross section data. The twelve words are: <ol style="list-style-type: none"> <li>1) The number of table positions, <math>IG-1 + 3</math>, where IG is GAMLEG-W input data.</li> <li>2) The number of energy groups, <math>IG-1</math>.</li> <li>3) The position of the total cross section in the cross section table (equal to 3).</li> </ol>

- 4) The set identification number NSET derived from the input variables, IZ, the element sequence number, m, in the problem, and the P<sub>ℓ</sub> order, ℓ, as follows:

$$\text{NSET} = m + (\ell - 1) * \text{IZ}$$

- 5-12) Eight blank words.

3

A binary record containing (IG-1 + 3) \* (IG-1) words of cross section data. These data are in the order of all table positions for group 1, all table positions for group 2, etc.

All even-numbered records on the tape are the set identification data; all odd-numbered sets greater than 1 are the cross section data. As stated earlier, the P<sub>0</sub> data for all elements are the first records on tape followed by the P<sub>1</sub> data for all elements, the P<sub>2</sub> data for all elements, etc.

The library data tape produced by GAMLEG-W consists of the punched card library used as input to a GAMLEG-W problem. This data tape is a binary tape produced in GAMLEG-W problems for use in the KAP VI, MAP, or SCAP codes. The tape format is:

<u>Tape Record No.</u>	<u>Description</u>
1	A one-word record containing the input variable, IZ, which is number of sets of photoelectric and pair-production data on the tape.
2	A twelve-word (48 characters) record containing an alphanumeric identification title of the library element cross section data.
3	A three-word record containing: <ol style="list-style-type: none"> <li>1) the number of energy points, IA, in the element library data,</li> <li>2) the atomic number (electrons/atom) of the element, and</li> <li>3) the atomic weight of the element.</li> </ol>

- 4 A record containing IA values of the energy corresponding to the pointwise, photoelectric and pair production data for the element. These data are in units of MeV.
5. A record containing IA values of the pointwise, pair-production cross section data corresponding to the energies in record 4. These data are in units of barns/atom.
- 6 A record containing IA values of photoelectric absorption cross section data corresponding to the energies in record 4. These data are in units of barns/atom.

Tape Records 2 - 6 are repeated for IZ sets of element data.

### 2.5.3 Punched Card Output

At user option, the  $P_{\ell}$  photon transport cross section data for all elements in a GAMLEG-W problem can be obtained on punched data cards. These punched card data consist of a title card for each set (which identifies its  $P_{\ell}$  order and the atomic number) as follows:

P (0) CROSS SECTION TABLE      ATOMIC NUMBER = XX.XXXX

This card is followed by the  $P_{\ell}$  photon transport cross section data in a (6E12.5) FORTRAN format for all table positions and groups.

## 2.6 CODE LOGIC

The general code logic used in the GAMLEG-W calculation of photon transport cross section data is presented in this section. A description of the subroutines in the GAMLEG-W code and their function in the overall code logic is described.

### 2.6.1 Description of Calculation Procedure

The GAMLEG-W code consists of main routine and 5 subroutines. These subroutines perform specific, repetitive functions in the calculation of photon transport cross sections. A description of the numerical techniques used in the GAMLEG-W code is described in Section 2.7. The general code logic in the GAMLEG-W code is shown in Figure 2-1. As shown, the sequence of calculations involves four principal operations:

- 1) Calculation of group-averaged Compton scatter data, group flux and source integrals, and group average energies;
- 2) Calculation of multigroup,  $P_\ell$  Compton scatter-transfer cross sections for order  $\ell$ ;
- 3) Calculation of group-averaged photoelectric and pair-production absorption data for elements; and
- 4) Calculation of the complete,  $P_\ell$  cross section table.

As shown in Figure 2-1, the code calculates all element data for each order  $\ell$  of  $P_\ell$ . This cyclic operation produces the photon transport cross section data for all elements,  $m$ , from 1 to  $M$  ( $M$  is the input variable  $IZ$ ). The complete set of element data for  $P_0$  data is followed by a complete set of  $P_1$  data, a complete set of  $P_2$  data and so on until all  $P_\ell$  cross section data of order  $\ell$  (input variable,  $NMAX$ , is equal to  $\ell + 1$ ) is calculated.

The code logic maximizes the capability of the code (i.e., number of elements, number of groups, order of  $P_\ell$ , order of numerical integration) with a minimum requirement of computer capability.

### 2.6.2 Description of Subroutines

Calculations performed in each of the five subroutines used by GAMLEG-W are described in the following paragraphs. These subroutines perform specific, repetitive functions

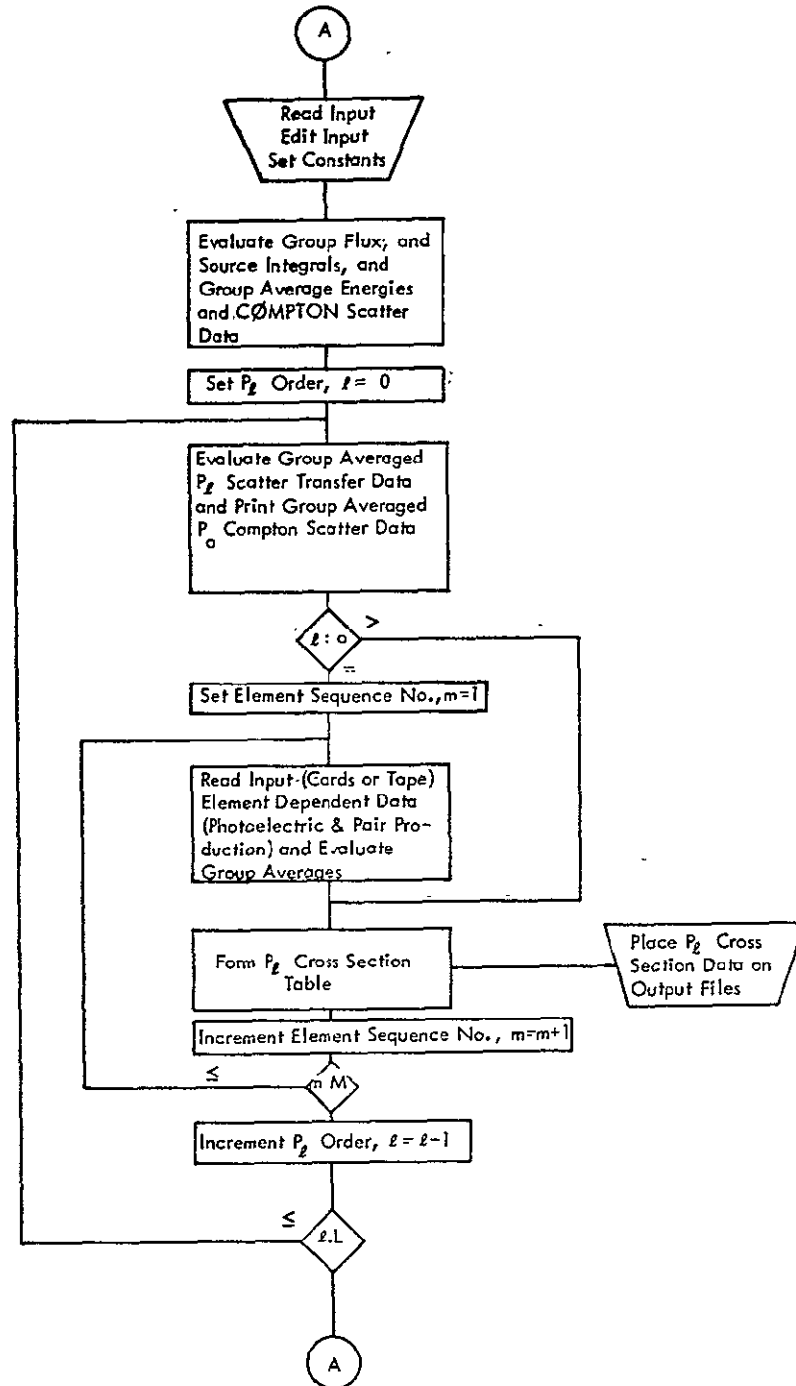


Figure 2-1. GAMLEG-W Code Logic

and are used only by the main routine during the four major steps of the code. The subroutines are as follows:

<u>Subroutine</u>	<u>Principal Operation</u>
AL	Performs a search of the tabular data to select the values of the dependent- and independent-variables bounding the desired value and calculates the interpolated value based on linear interpolation in the logarithm of the dependent and independent variables (log-log interpolation).
ARG	Calculates the $P_p$ scatter-transfer cross section for scatter from the incident energy to the scattered energy based on the differential form of the Klein Nishina equation for inelastic scattering of a photon with a free electron. A generalized, recursion relationship for Legendre polynomial coefficients is used. (7)
SIGMAS	Calculates the Compton cross section at an energy from the Klein Nishina equation for the inelastic scattering of a photon with a free electron.
SIGMAC	Calculates the Compton cross section at an energy from the Klein Nishina equation for the inelastic scattering of a photon with a free electron.
SIMP	Calculates the integral value of a set of equally-spaced tabulated data based on a Simpson's rule integration method. (8)

## 2.7 METHOD OF SOLUTION

The GAMLEG-W code is a revised version of the GAMLEG code. The revisions include revised procedures of: 1) Compton cross section weighting, 2) calculating scatter cross section data, 3) numerical integration, and 4) input and output of photon cross section data. The basic code logic of the original GAMLEG code was not altered; but the numerical techniques used to calculate group-averaged, photon cross section data for discrete ordinate photon transport were extensively revised.

The original GAMLEG code is described in Reference 1. In addition, a derivation by Evans<sup>(2)</sup> of the Klein-Nishina equations from the differential-scattering cross section for photons given by Evans is given in Reference 9. The numerical integration method in GAMLEG-W (using Simpson's rule) was adapted from Reference 8; detailed comparisons of the MUG<sup>(10)</sup> and GAMLEG-W constants and calculated results were made.

The GAMLEG-W calculation is divided into the calculation of group averages of the weighting functions, Compton scatter cross sections, absorption cross sections, and the formation of the photon transport cross section tables.

### 2.7.1 Group Averages of the Weighting Functions

The initial calculations performed by the GAMLEG-W code are the preparation of group energies and weighting functions into a form consistent with the calculation of group average cross sections. The input group energy bounds,  $E_g$ , and the input flux- and source-pointwise energies,  $E_i$ , are converted from the input data units, in MeV, to units of electron rest masses as follows:

$$\alpha_g = E_g / m_o c^2$$

$$\alpha_i = E_i / m_o c^2$$

where  $m_o c^2 = 0.510977205$  and,

$m_o$  = is the electron rest mass,

$c$  = is the velocity of light



The weighting functions used for performing group averages are obtained from GAMLEG-W input data as a function of the desired output form specified by the user as 1) energy transfer (input variable NPF = 0) or 2) particle transfer (input variable NPF = 1) and 3) the form of the input data (input variable KON = 2, -1, 0, 1, 2). The weighting function,  $f(\alpha_n)$ , is calculated as a function of the equally-spaced energy points within each group defined as:

$$\alpha_n = \left( \frac{\alpha_{g+1} - \alpha_g}{N} \right) \cdot (n-1) + \alpha_g$$

where  $\alpha_{g+1}$  is the upper energy bound of the group

$\alpha_g$  is the lower energy bound of the group

N is the order of numerical integration

$\alpha_n$  are the equally spaced energy values from  $n = 1$  to  $n = N + 1$

At each of the energy points,  $\alpha_n$ , the weighting function is calculated from the input flux or source data,  $I(\alpha_i)$ ,  $N(\alpha_i)$ ,  $S(\alpha_i)$ , and  $s(\alpha_i)$ : from log-log interpolation of the tabulated input data. The weighting function  $f(\alpha_n)$  is then defined from the input variables, NPF and KON, as:

If KON = 0 and NPF = 0 or 1 (Uniform or Flat Weighting)

$$f(\alpha_n) = 1.0$$

If KON = +1 or +2 (Source Weighting)

$$f(\alpha_n) = S(\alpha_n), \quad \text{KON} = 1 \text{ and } \text{NPF} = 0$$

$$f(\alpha_n) = S(\alpha_n) / \alpha_n \quad \text{KON} = 1 \text{ and } \text{NPF} = 1$$

$$f(\alpha_n) = s(\alpha_n), \quad \text{KON} = 2 \text{ and } \text{NPF} = 1$$

$$f(\alpha_n) = s(\alpha_n) * \alpha_n, \quad \text{KON} = 2 \text{ and } \text{NPF} = 0$$

If KON = -1 or -2 (Flux Weighting)

$$f(\alpha_n) = I(\alpha_n), \quad \text{KON} = 1 \text{ and NPF} = 0$$

$$f(\alpha_n) = I(\alpha_n) / \alpha_n, \quad \text{KON} = -1 \text{ and NPF} = 1$$

$$f(\alpha_n) = N(\alpha_n), \quad \text{KON} = -2 \text{ and NPF} = 1$$

$$f(\alpha_n) = N(\alpha_n) * \alpha_n, \quad \text{KON} = -2 \text{ and NPF} = 0$$

All numerical integrations in the GAMLEG-W code are performed with the SIMP subroutine<sup>(8)</sup> using Simpson's rule. The following integrals are computed by GAMLEG-W and are provided as printed output data:

- 1) Group integral weighting function,

$$fg = \int_{\alpha_g^L}^{\alpha_g^U} f(\alpha) d\alpha$$

- 2) Group average energy,

$$\bar{E}_g = m_0 c^2 \int_{\alpha_g^L}^{\alpha_g^U} \alpha f(\alpha) d\alpha$$

- 3) Group integral source,

$$s_g = \frac{\int_{\alpha_g^L}^{\alpha_g^U} S(\alpha) d\alpha}{\alpha_g^U - \alpha_g^L}$$

or,

$$s_g = \frac{\int_{\alpha_g^L}^{\alpha_g^U} s(\alpha) d\alpha}{\alpha_g^U - \alpha_g^L}$$

### 2.7.2 Compton Scatter Cross Section Calculation

The calculation of the Compton scatter cross section involves the determination of the group-averaged, Compton total scatter, Compton absorption, and Compton energy-scatter-transfer or particle-scatter-transfer cross sections.

These calculations are based on the Klein Nishina equation for the inelastic scattering of a photon with a free electron. All data are in units of barns/electron. The Klein Nishina equation for the Compton total cross section at energy,  $\alpha_n$ , is as follows:

#### Compton Total Scatter Cross Section:

$$\sigma_{cs}(\alpha_n) = \frac{C}{\alpha_n^2} \left\{ \ln(A_n) \left[ \alpha_n^{-2} - \frac{2}{\alpha_n} \right] + 4 + \frac{2\alpha_n(1+\alpha_n)}{A_n^2} \right\}$$

where:  $\sigma_{cs}(\alpha_n)$  is the Compton total scatter cross section at energy,  $\alpha_n$ ,

$C$  is the constant,  $\pi r_0^2$ , where  $r_0$  is the classical electron radius ( $r_0 = \frac{e^2}{m_0 c^2}$ ).

$$A_n = 1 + 2\alpha_n$$

#### Compton Absorption Cross Section:

$$\sigma_{ca}(\alpha_n) = \sigma_{cs}(\alpha_n) - C \left\{ \frac{A_n}{\alpha_n^3} + \frac{(A_n+1)(2\alpha_n-A_n)}{\alpha_n^2 A_n^2} + \frac{8\alpha_n^2}{3A_n^3} \right\}$$

where:  $\sigma_{ca}(\alpha_n)$  is the Compton absorption cross section at energy,  $\alpha_n$ , and

$C, A_n$  are defined above.

Compton Scatter-Transfer Cross Section to Energy,  $\alpha'_n$ :

$$\sigma_{cs}(\alpha_n \rightarrow \alpha'_n) = C * B * \left[ \frac{\alpha_n}{\alpha'_n} + \frac{\alpha'_n}{\alpha_n} - 1.0 + \mu^2 \right]$$

where:

$\mu$  is the cosine of the scattering angle,  $\theta$ ,

$$\mu = \cos \theta = 1 + \frac{1}{\alpha_n} - \frac{1}{\alpha'_n}$$

$\sigma_s(\alpha_n \rightarrow \alpha'_n)$  is the scatter-transfer cross section from energy,  $\alpha_n$ , to energy  $\alpha'_n$

C is defined above, and

B is the ratio of the scattered energy  $\alpha'_n$  to the initial energy,  $\alpha_n$ , for energy-scatter-transfer cross sections, or 1.0 for particle scatter transfer cross sections.

The group average Compton scatter cross sections calculated by GAMLEG-W

are:

Group Average Compton Scatter Cross Section,  $\sigma_g^{cs}$ :

$$\sigma_g^{cs} = \frac{\int_{\alpha_g^L}^{\alpha_g^U} f(\alpha) \cdot \sigma_{cs}(\alpha) d\alpha}{f_g}$$

Group Average Compton Absorption Cross Section,  $\sigma_g^{ca}$ :

$$\sigma_g^{ca} = \sigma_g^{cs} - \left\{ \frac{\int_{\alpha_g^L}^{\alpha_g^U} f(\alpha) \sigma_{ca}(\alpha) d\alpha}{f_g} \right\}$$

In addition to the above cross section data, the GAMLEG-W code calculates an energy-or particle-loss cross section for each group for scatter-transfer below the lowest energy group low energy bound as follows:

Group Average Compton Scatter-Loss Cross Section,  $\sigma_g^{cl}$ ;

$$\sigma_g^{cl} = \frac{\int_{\alpha_g^L}^{\alpha_g^U} f(\alpha) \int_{\alpha_0}^{\alpha^L} \sigma_{cs}(\alpha \rightarrow \alpha') d\alpha' d\alpha}{f_g}$$

where  $\sigma_g^{cl}$  is the Compton scatter loss

$\alpha_0$  is the lowest energy to which a photon can scatter,  $\alpha_0 = \frac{\alpha}{1+2\alpha}$ ,

$\alpha_g^L$  is the lower energy bound of the lowest energy group.

The Compton absorption and Compton scatter-loss sections above are usable as energy absorption data only when energy flux calculations are performed. The group-averaged Compton absorption and scatter-loss cross section data for use in energy absorption when particle flux cross sections are obtained in GAMLEG-W as follows:

Group Average Compton Energy Absorption Cross Section,  $\bar{E} \sigma_g^{ca}$ ;

$$\bar{E} \sigma_g^{ca} = \frac{m_0 c^2 \int_{\alpha_g^L}^{\alpha_g^U} \alpha f(\alpha) \sigma_{ca}(\alpha) d\alpha}{f_g}$$

Group Average Compton Energy Loss Cross Section,  $\bar{E} \sigma_g^{cl}$ ;

$$\bar{E} \sigma_g^{cl} = \frac{m_0 c^2 \int_{\alpha_g^L}^{\alpha_g^U} \alpha f(\alpha) \int_{\alpha_0}^{\alpha^L} \sigma_{cs}(\alpha \rightarrow \alpha') d\alpha' d\alpha}{f_g}$$

The Compton cross section data discussed above are printed output from GAMLEG-W.

Group average Compton scatter-transfer cross sections for use in multigroup photon transport calculations with anisotropic scattering are obtained by numerical integration of the Compton scatter-transfer cross section for the specified multigroup structure. These scatter-transfer cross section data are obtained for energy scatter-transfer or particle scatter-transfer according to the GAMLEG-W input data. The numerical integration of the scatter-transfer cross sections involves 1) the integration over the energy group to which a photon scatters, and 2) performing group averages of this scatter-transfer cross section in the energy group before scattering. The  $P_0$  group average scatter-transfer cross section for energy scatter-transfer is as follows:

Group Average Compton Energy Scatter-Transfer Cross Section From Group  $g$  to Group  $h$ ,  $\sigma_{g \rightarrow h}^{s0}$

$$\sigma_{g \rightarrow h}^{s0} = \frac{\int_{\alpha_g^L}^{\alpha_g^U} f(\alpha) \int_{\alpha_h^L}^{\alpha_h^U} \frac{\alpha'}{\alpha} \delta \sigma_{cs}(\alpha \rightarrow \alpha') d\alpha' d\alpha}{f_g}$$

where;

$$\delta = 1 \text{ if } \frac{\alpha}{1+2\alpha} \leq \alpha' \leq \alpha, \text{ or}$$

$$\delta = 0 \text{ for all other conditions.}$$

The general form of the higher order terms of the Legendre expansion of Compton scatter-transfer cross section for energy scatter-transfer is as follows:

Group Average Compton Energy Scatter-Transfer Cross Section from Group to Group h,  $\sigma_{g \rightarrow h}^{s_\ell}$

$$\sigma_{g \rightarrow h}^s = \frac{\int_{\alpha_S^L}^{\alpha_S^U} f(\alpha) \int_{\alpha_h^L}^{\alpha_h^U} \frac{\alpha'}{\alpha} (2\ell + 1) P_\ell(\mu) \sigma_{cs}(\alpha \rightarrow \alpha') d\alpha' d\alpha}{fg}$$

where  $\delta$  is defined above,

$\ell$  is the  $P_\ell$  order

$P_\ell(\mu)$  is the Legendre polynomial coefficient of order  $\ell$

$\mu$  is the cosine of the scattering angle,  $\theta$ , defined in Klein Nishina scattering as:

$$\mu = 1 + \frac{1}{\alpha} - \frac{1}{\alpha'}$$

The particle scatter-transfer cross sections are of the same general form except that the term  $\frac{\alpha'}{\alpha}$ , is set to 1.0 to generate all  $P_\ell$  scatter-transfer data.

Absorption Cross Sections

Photoelectric and pair-production cross sections for use as absorption or scatter-transfer cross section data are obtained from pointwise values of these cross sections supplied as GAMLEG-W input. Pointwise cross section and corresponding energy data supplied for each element are used to perform group averaging of the absorption cross section data over the weighting function. The value of the pair-production or photoelectric cross section at each energy point is obtained from an interpolation between the nearest two input point values. The interpolation technique assumes that the cross section intermediate to the two point values varies linearly on a logarithmic scale for both the cross section and energy (log-log scale). Use of this technique requires that both values of the input pointwise cross section data nearest to the energy point must be non-zero. If either or both values are zero then the interpolated

value is set to zero and execution is terminated with an error message. The calculation of the absorption cross section involves the computation of the pair-production absorption cross section, the photoelectric absorption cross section, and, at user option, the pair-production cross section for the generation of the pair of 0.511 MeV annihilation photons as scatter-transfer event. The GAMLEG-W code calculates the group average of these cross sections for energy or particle scatter-transfer cross section as follows:

Group Average Photoelectric Absorption Cross Section,  $\sigma_g^{pe}$

---

$$\sigma_g^{pe} = \frac{\int_{\alpha_g^L}^{\alpha_g^U} f(\alpha) \sigma_{pe}(\alpha) d\alpha}{f_g}$$

where  $\sigma_{pe}(\alpha)$  is the interpolated value of the photoelectric cross section

Group Average Pair Production Absorption Cross Section,  $\sigma_g^{pp, \alpha}$

---

$$\sigma_g^{pp, \alpha} = \frac{\int_{\alpha_g^L}^{\alpha_g^U} f(\alpha) \cdot [1.0 - \delta] \cdot \sigma_{pp}(\alpha) d\alpha}{f_g}$$

where  $\delta = 0.0$ ; if no pair of 0.511 MeV photons are produced (user option)

$\delta = 2.0$ ; if a pair of 0.511 MeV photons are produced and particle scatter-transfer data is requested.

$\delta = \frac{2.0}{\alpha}$ ; if a pair of 0.511 MeV photons are produced and energy-scatter-transfer data is requested.

$\sigma_{pp}(\alpha)$  is the interpolated value of the pair-production cross section



Group Average Pair Production Scatter-Transfer Cross Section,  $\sigma_{g \rightarrow h}^{pp, t}$

$$\sigma_{g \rightarrow h}^{pp, t} = \frac{\epsilon \int_{\alpha_g^L}^{\alpha_g^U} f(\alpha) \delta \sigma_{pp}(\alpha) d\alpha}{f_g}$$

where:

$\delta$  is defined above

$$\epsilon = 0.0 \text{ if } \alpha_h^U < 1.0 \text{ or } \alpha_h^L > 1.0$$

$$\epsilon = 1.0 \text{ if } \alpha_h^U > 1.0 \text{ and } \alpha_h^L < 1.0$$

In addition to the above calculation of absorption cross sections, the GAMLEG-W code calculates the energy-absorption photoelectric and pair-production data, and the total energy absorption data for use in the calculation of energy deposition in particle flux calculations. These data are group averaged quantities as follows:

Group Average Energy Absorption (Photoelectric and Pair Production) Cross Section,  $\bar{E} \sigma_g^{pe + pp, a}$

$$\bar{E} \sigma_g^{pe + pp, a} = \frac{m_0 c^2 \int_{\alpha_g^L}^{\alpha_g^U} f(\alpha) [\alpha - \delta] \sigma_{pp}(\alpha) d\alpha}{f_g} + (\text{cont'd.})$$

$$\frac{m_0 c^2 \int_{\alpha_s^L}^{\alpha_s^U} f(\alpha) d\alpha \sigma_{pe}(\alpha) d\alpha}{f_g}$$

where  $\delta = 0.0$  if no pair production is allowed  
 $\delta = 2.0$  if pair production is allowed

Group Average Energy Absorption (Total) Cross Section,  $\bar{E} \sigma_s^a$

$$\bar{E} \sigma_g^a = \bar{E} \sigma_g^{pe+pp,a} + Z \left( \bar{E} \sigma_g^c + \bar{E} \sigma_g^{cl} \right)$$

where,  $Z$  is the electrons/atom of the element

The above element-dependent cross section data are printed output from the GAMLEG-W code and is used in forming the  $P_0$  transport cross section table.

### Transport Cross Sections

The final output data from the GAMLEG-W code consist of a combination of the Compton scatter cross section data and absorption cross section data, as described previously. The multigroup data are prepared in units of barns per atom for each element. The  $P_0$  cross section table consists of the absorption, total, and scatter-transfer cross sections as follows:

Absorption Cross Section,  $\sigma_{gm}^a$

$$\sigma_{g,m}^a = \sigma_g^{pp,a} + \sigma_g^{pe} + Z_m^* \left[ \delta_1 \sigma_g^{ca} + \delta_2 \sigma_g^{cl} \right]$$

where;  $\sigma_{g,m}^a$  is the absorption cross section for element,  $m$ ,  
 $Z_m$  is the atomic number (electrons/atom) of the element,  $m$ ,  
 $\delta_1$  is 1 if energy scatter-transfer data is calculated, and 0 if particle scatter-transfer data is calculated  
 $G$  is the total number of groups  
 $\delta_2$  is 1 if the Compton scatter-loss below the lowest group is calculated, and 0 if Compton scatter-loss is ignored

$$\frac{\text{Total Cross Section, } \sigma_{gm}^t}{\sigma_{gm}^t} = \sigma_{gm}^a + Z_m^* \sum_{h=g}^G \sigma_{gh}^{cs}$$

$$\frac{\text{Scatter-Transfer Cross Sections, } \sigma_{hg,m}^{s0}}{\sigma_{hg,m}^s} = Z_m \sigma_{hg}^{cs} + \delta \sigma_{hg}^{ppt}$$

where  $\delta$  is 1 if  $h$  is the group which bounds 0.511 MeV or 0 otherwise.

The inclusion of pair-production as an isotropic, scatter-transfer cross section and Compton scatter-loss as an absorption are both options to the user.

The higher order scatter-transfer cross sections,  $P_\ell$  for  $\ell > 0$ , consist of the scatter-transfer cross sections in units of barns/atom in a similar fashion to the  $P_0$  scatter-transfer data. The absorption and total cross sections are zero.

## 2.8 REFERENCES

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2. R. D. Evans, The Atomic Nucleus, McGraw-Hill Book Company, Inc., 1955.
3. R. G. Soltesz and R. K. Disney, WANL-PR(LL)-034, Volume 4, "One-Dimensional, Discrete Ordinate Transport Technique," August 1970.
4. R. G. Soltesz, R. K. Disney, J. Jedruch, and S. L. Zeigler, WANL-PR(LL)-034, Volume 5, "Two Dimensional, Discrete Ordinate Transport Techniques," August 1970.
5. R. G. Soltesz, R. K. Disney, and S. L. Ziegler, WANL-PR(LL)-034, Volume 3, "Cross Section Generation and Data Processing Techniques," August 1970.
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### 3.0 APPROPOS CODE

In the analysis of nuclear reactor systems, an efficient technique for preparing multigroup, cross-section data in the required format for discrete ordinate transport as well as Monte Carlo computer codes is required. The APPROPOS code provides this needed technique. APPROPOS prepares multigroup, simultaneous, neutron-photon cross section data and neutron reaction cross section data for radiation transport codes. The APPROPOS code processes multigroup, neutron cross section data and multigroup, neutron reaction cross section data (e.g., radiative capture, fission, inelastic scatter, and elastic scatter) to provide spectral-weighted, neutron cross section data in a reduced number of energy groups. These data are then processed with input specified elemental atom densities, gamma ray production data due to neutron reactions, and photon cross section data to provide macroscopic, coupled, neutron-photon cross section data, neutron cross section data, and photon cross section data. Output data from the APPROPOS code are placed on punched cards and/or magnetic tape for use in the ANISN-W, DOT-IIW, or NAGS codes.

### 3.1 COMPUTER CODE SYNOPSIS

1. Name: APPROPOS<sup>(1)</sup>

2. Computer: The code is designed for the UNIVAC-1108 computer.

3. Nature of Physical Problem Solved: APPROPOS prepares multigroup, simultaneous, neutron-photon cross section data and neutron reaction cross section data for radiation transport codes.

4. Method of Solution: The APPROPOS code processes multigroup, neutron cross section data and multigroup, neutron reaction cross section data (e.g., radiative capture, fission, inelastic scatter, and elastic scatter) to provide spectral-weighted, neutron cross section data in a reduced number of energy groups. These data are then processed with input specified elemental atom densities, gamma ray production data due to neutron reactions, and photon cross section data to provide macroscopic, coupled, neutron-photon cross section data, neutron cross section data, and photon cross section data. Output data from the APPROPOS code are placed on punched cards and/or magnetic tape for use in the ANISN-W<sup>(2)</sup>, DOT-IIW<sup>(3)</sup>, or NAGS<sup>(1)</sup> codes.

5. Restrictions on the Complexity of the Problem: The APPROPOS computer code utilizes flexible dimensioning to facilitate efficient core data storage allocation. Because of the variable dimensioning technique, on any given data array, no sized restriction is imposed; only a size restriction on the length of the sum of all arrays is imposed. The amount of core data storage for a given problem may be exactly computed as indicated in the documentation. Because the code utilizes specific, user-supplied libraries of data, the structure and limitations of these libraries must be consistent with other input data parameters.

6. Typical Running Time: The APPROPOS code processes approximately 2 compositions per second of UNIVAC-1108 CPU time. Each composition, in this example, contains 16 neutron groups, 13 gamma ray groups, a  $P_1$  cross section scatter approximation, and approximately 6 elements per composition. The large amount input/output requires approximately a factor of 3-5 greater elapsed time for the majority of problems.

7. Unusual Features of the Code: Use of flexible dimensioning and the processing of the data in an efficient manner with regard to available core storage constitutes the major features of the code.

8. Related or Auxiliary Programs: Neutron and photon cross sections may be provided by the GAMBIT<sup>(4)</sup> and GAMLEG-W<sup>(1)</sup> codes, respectively. Photon production data may be generated with the POPOP4<sup>(5)</sup> code. Output data from the APPROPOS code are admissible to the one-dimensional ANISN-W, and the two-dimensional DOT-IIW discrete ordinate transport codes. A punched card library of photon production data and selected nuclear parameters is prepared for the NAGS<sup>(1)</sup> data processing code.

9. Status: The code is in production use at the Marshall Space Flight Center (MSFC). Users at MSFC load the code from a tape with control cards followed by user's input data.

10. References:

1. R. G. Soltész, R. K. Disney, and S. L. Zeigler, WANL-PR(LL)-034, Volume 3, "Cross Section Generation and Data Processing Techniques," August 1970.
2. R. G. Soltész and R. K. Disney, WANL-PR(LL)-034, Volume 4, "One-Dimensional, Discrete Ordinate Transport Technique," August 1970.
3. R. K. Disney, R. G. Soltész, J. Jedruch, and S. L. Zeigler, WANL-PR(LL)-034, Volume 5, "Two-Dimensional, Discrete Ordinate Transport Techniques," August 1970.
4. G. Collier and G. Gibson, WANL-TME-1752, "GAMBIT Program," April 1968.
5. W. E. Ford, III, and D. H. Wallace, USAEC Report CTC-12, "POPOP4-A Code for Converting Gamma-Ray Spectra to Secondary Gamma-Ray Production Cross Sections," May 1969.

11. Machine Requirements: The APPROPOS code is in production at MSFC on the UNIVAC-1108 computer with 65K core storage locations. The program requires approximately 30K decimal location for the program; the remaining 35K decimal locations are available for problem data storage. Up to 10 tape or disk devices are required in addition to input, output, and punch disks. However, no more than six data tapes are ever required; all other files may be assigned to disk storage.

12. Programming Language Used: The APPROPOS code is written in standard, USASI FORTRAN-IV.

13. Operating System or Monitor Under Which Program is Executed: The APPROPOS code is operational under the UNIVAC-1108, EXEC8 Monitor System at MSFC.

14. Other Programming or Operating Information or Restrictions: None.

15. Name and Establishment of Authors:

R. K. Disney and R. G. Soltesz

Westinghouse Astronuclear Laboratory

P. O. Box 10864

Pittsburgh, Pa. 15236



## 3.2 INPUT DATA DESCRIPTION

### 3.2.1 Input Format

The input data for the APPROPOS code are divided into the following four sets of data:

1. Overall problem storage allocation, problem descriptive title, and problem size specifications and options;
2. Fine-group to broad-group cross section weighting data;
3. Library data; and
4. Composition data.

All input data for the APPROPOS code are entered in a fixed, FORTRAN format for each card. With the exception of the library data, all input data are entered in 6 fields per card where each field contains 12 columns. Integer data must be entered as right adjusted\* within each field. Floating point data may be written with or without an exponent and with or without a decimal point.

### 3.2.2 Input Data Instructions

This section is to be used as a guide in preparing problem input data (Table 3-1) for the APPROPOS code. Other sections present a more detailed description of the data presented here. The quantity in slashes represents the condition requiring input of a particular array or variable. Arrays or variables which are not required should not be entered. If no condition is specified, the array or variable is required.

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\* "Right adjusted" means that the last significant digit of a number is at the extreme right of a field.

TABLE 3-1

## INPUT INSTRUCTIONS FOR THE APPROPOS CODE

Data Set 1 - Overall Problem Storage Allocation, Problem Title,  
Problem Size Specifications, and Options

<u>Card No.</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
1	(6X, 16)	7-12	MAXCOR	Maximum number of core locations available for APPROPOS data (i. e., MAXCOR = 35000 <sup>10</sup> on the UNIVAC-1108, EXEC 8 Computer with a 65K core memory storage available)
2	(18A4)	1-72	TITLE	Title card describing the overall APPROPOS problem
3	(6112)	----	----	<u>Neutron Broad-Group Structure Specifications (Output Group Structure):</u>
		1-12	NGN	Total number of neutron broad-groups
		13-24	NFG	Number of fast neutron broad-groups
		25-36	NIG	Number of neutron broad-groups with neutron, inelastic scatter gamma ray production data
		37-48	NCG	Number of neutron broad-groups with neutron, radiative capture gamma ray production data
		49-60	NTABN	Neutron broad-group table length of transport code cross section output data
		61-72	NPLN	$P_0$ scattering approximation for neutron cross section output data
4	(6112)	----	----	<u>Gamma Ray Group Structure Specifications (Output Group Structure):</u>
		1-12	NGG	Total number of gamma ray groups
		13-24	NTABG	Gamma ray table length of transport code cross section output data
		25-36	NPLG	$P_0$ scattering approximation for gamma ray cross section output data

TABLE 3-1 (Continued)

<u>Card No.</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
5	(6112)	----	----	<u>Library, Composition, Element, and Weighting Spectra Specifications:</u>
		1-12	NLE	Number of sets of element data in the gamma-ray production and nuclear parameter library if NAPL = 0 or 1 (if NAPL = 2, NLE = NAA)
		13-24	NAA	Number of different elements in the entire problem (NAA determines the total number of different elements in the gamma-ray transport cross section data to be read from tape)
		25-36	NME	Maximum number of elements or isotopes that will be entered in any given composition (Note: If an element is requested twice within a composition, it must be counted twice for NME)
		37-48	NMR	Total number of compositions in the problem
		49-60	NSP	Total number of spectra to be used in spectral-weighting of microscopic, fine-group data
		61-72	NAPL	Source of APPROPOS library data: NAPL = 0: Input from cards NAPL = 1: Input from cards and placed behind reaction rate data on Tape 10 NAPL = 2: Input from library Tape 10
6	(6112)	----	----	<u>Code Logic Specifications:</u>
		1-12	NOD	Transport code cross section output data option: NOD = 1: Neutron cross section data only NOD = 2: Gamma ray cross section data only NOD = 3: Neutron and gamma ray cross section data only. NOD = 4: Neutron, gamma ray, and coupled neutron-photon cross section data (for simultaneous analyses) Note: If NOD is negative, neutron and/or gamma ray energy-absorption data are placed in table position 1

TABLE 3-1 (Continued)

<u>Card No.</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
6 (cont'd.)		13-24	NLIB	<p>Library and Flux Spectra Input Option:</p> <p>NLIB = 0: Composition - independent reaction rate data input from cards with the library data; neutron transport cross sections in NGN groups are read from Tape 8 (not operational)</p> <p>NLIB = 1: Composition - dependent reaction rate data input from cards with the region data; neutron transport cross section sections for NGN groups are read from Tape 8 (not operational)</p> <p>NLIB = 2: Composition - dependent reaction rate data input from Tape 10; neutron transport cross sections for NGN groups are read from Tape 8 (not operational)</p> <p>NLIB = 3: Flux spectra tape from a previous APPROPOS problem is input on Tape 4</p> <p>NLIB = 4: Output flux tape from an ANISN-W problem is input on Tape 17</p> <p>NLIB = 5: Output flux tape from two ANISN-W problems are input on Tapes 17 and 18</p> <p>NLIB = 6: Fine-group flux spectra are input from cards (NSP sets)</p>
		25-36	NTRIG	<p>Output Data Option:</p> <p>NTRIG = 0: Library and composition data for NAGS, and transport cross sections for DOT-IIW and ANISN-W punched on cards</p> <p>NTRIG = 1: Library and composition data for NAGS punched on cards; transport cross sections for DOT-IIW and ANISN-W placed on Tape 14</p>

TABLE 3-1 (Continued)

<u>Card No.</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
6 (Cont'd.)		37-48	NPRIN	Output Data Print Option: NPRIN = 0: Input parameters from Data Set 1, spectral-weighting specifications, element identification list for the problem, library data, composition parameters, microscopic reaction rate data for each element in a composition, macroscopic neutron cross sections, macroscopic photon cross sections, simultaneous neutron-photon cross sections, and an edit of the contents of output Tape 14 NPRIN = 1: All the information for NPRIN = 0 as well as microscopic neutron and photon transport cross sections for each element in a composition NPRIN = 2: All the information for NPRIN = 0 and 1 as well as broad-group reaction rate data and transport cross sections by element, and microscopic photon cross sections as read from Tape 2
		49-60	NUP	Number of upscatter cross section positions in the final, coupled neutron-photon transport cross section data.
		61-72	NDOWN	Number of downscatter cross section positions in the final, coupled neutron-photon transport cross section data. $NDOWN = (NGN + NGG - 1)$ ; If $NOD \neq 4$ , $NDOWN = 0$ .

TABLE 3-1 (Continued)

Data Set 2 - Fine-Group to Broad-Group Cross Section Weighting Data

<u>Card No.</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
7	(6112)	----	----	<u>Fine-Group to Broad-Group Neutron Cross Section Weighting and Collapsing Specifications: /If NLIB ≥ 3 /</u>
		1-12	NMC	Number of sets of microscopic, element data to be read from Tape 8 and Tape 10 in the weighting and group-collapsing calculation (For example, if 15 different elements are to be weighted, and each element uses the $P_0$ , $P_1$ , and $P_2$ data, then NMC would equal $3 \times 15$ , or 45. If each element is to be weighted over two different spectra, as well, then $NMC = 90$ )
		13-24	NGF	Total number of fine-groups in the microscopic neutron cross section libraries (Tapes 8 and 10)
		25-36	NFF	Number of fast groups in the fine-group neutron cross section libraries
		37-48	IHTF	Position of $\Sigma_t$ or $\Sigma_{tr}$ (total or transport-corrected cross section) in the fine-group transport cross section library data
		49-60	IHSF	Position of $\Sigma_{gg}$ (within-group or self-scatter cross section) in the fine-group transport cross section library data
		61-72	IHMF	Number of table positions in the fine-group transport cross section library data. If IHMF is negative, then upscatter removal will be done using the fine-group spectral-weighting data

TABLE 3-1 (Continued)

<u>Card No.</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
8	(6112)	1-12	IHSB	Position of $\Sigma_{gg}$ (within-group or self-scatter cross section) in the broad-group structure before upscatter removal but after group-collapsing
		13-24	IHMB	Number of table positions in the broad-group structure before upscatter removal but after group-collapsing
		25-36	NRW	Transport cross section weighting option: NRW = 0: Linear weighting NRW = 1: Reciprocal weighting If an element is represented by $P_0$ data, linear weighting only is used and NRW is ignored
9	(6112)	----	----	<u>Fine-Group to Broad-Group Specifications;</u> <u>/If NLIB <math>\geq</math> 3/</u>
		1-12, 13-24, 25-36, etc.	IGF	Broad-group number as a function of fine-group number (for example, 1, 1, 1, 2 for four fine-groups provides two groups of broad-group data where the first three groups constitute the first broad-group). Enter NGF values
10	(6112)	1-12, 13-24, 25-36, etc.	IDS	Identification numbers for spectra input from Tape 4 or from Tapes 17 and/or 18. /NLIB = 3, 4, or 5/ Note that the tape ID numbers when NLIB = 3 are input in the same order as the spectra on Tape 4. When NLIB = 4 or 5, the tape ID numbers for Tape 17 precede the ID numbers for Tape 18 (if input); these ID numbers reflect the zone numbers that were used in the ANISN-W calculations. These ID numbers must be entered in the same sequence as appear on Tape 4. Enter NSP values

TABLE 3-1 (Continued)

<u>Card No.</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
11	(6I12)	1-12, 13-24, 25-36, etc.	IDS	Identification numbers for spectra input from cards/ NLIB = 6/ Enter NSP values
12	(6E12.5)	1-12, 13-24, 25-36 etc.	XNF	Enter NGF values of spectra for NSP sets of spectra. Each spectrum begins on a new card /NLIB = 6/



TABLE 3-1 (Continued)

## Data Set 3 - Library Data

<u>Card No.</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
13	(4I12)	----	----	<u>Microscopic Library Tape ID Numbers:</u> (Tapes 8 and 10) /NLIB <sub>≥3</sub> /
		1-12	IDF(1, n)	Identification number of the fine-group, macroscopic library, neutron transport, cross section elemental data from Tape 8
		13-24	IDF(2, n)	Identification number of the corresponding fine-group, microscopic library neutron reaction, cross section elemental data from Tape 10
		25-36	IDF(3, n)	Identification number of the spectrum over which the fine-group, microscopic library, neutron transport and neutron reaction cross section elemental data are weighted. The value of IDF(3, n) entered here must correspond to one of the IDS numbers entered on Card 10 or Card 11
		37-48	IDF(4, n)	Corresponding P <sub>ℓ</sub> scattering approximation of the fine-group, microscopic library, neutron transport, cross section elemental data specified for IDF(1, n). If a P <sub>0</sub> transport-corrected set of data is chosen in IDF(1, n), then IDF(4, n) = -1

Card 13 is repeated for NMC different sets of data.

Note: Because the fine-group library data tapes are read only once, the parameters, IDF(1, n) and IDF(2, n), must be entered in the sequential order in which they appear on Tapes 8 and 10, respectively. If a particular element or isotope is to be weighted over more than one spectra, that set of elemental data is repeatedly entered until all desired spectra are requested.

14	(E12.5)	1-12	CONST	Normalization constant for energy deposition data; e.g., CONST = 1.603 × 10 <sup>-13</sup> watt-sec/Mev
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TABLE 3-1 (Continued)

<u>Card No.</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
15	(6112)	1-12, 13-24, 25-36, etc.	LAL	GAM ID numbers for each different element in the problem in order of increasing GAM ID number (NAA values). These ID numbers are used to select the gamma-ray production data and selected nuclear data parameters
<p>If NAPL = 2, the remainder of the library data are obtained from Tape 10. However, if NAPL = 0 or 1, the following library data are required input from cards:</p>				
16	(14	1-4	ID	The GAM ID number for the element or isotope
	E12.4,	5-16	AMU	Corresponding atomic mass units of the element or isotope
	12X, E12.4,	29-40	GNA	$\Gamma(n, \alpha)$ ; the energy (in Mev) of the emitted alpha particles for this neutron reaction. GNA = 0.0 if the element or isotope does not undergo this reaction
	6X, 16,	46-52	NGAML	The corresponding ID number of this element or isotope on the GAMLEG-W photon transport cross section tape
	10X, A6)	63-68	LABEL	The corresponding name of the element or isotope
17	(7E10.4)	1-10, 11-20, 21-30, etc.	GA	$\Gamma(n, \gamma)$ ; the energy (in Mev) of the emitted photons for this neutron reaction. If NCG on Card 3 of Data Set 1 is 1, then NGG values of GA are entered in order of decreasing photon energy. If NCG >1, then NGG values for each of the NCG neutron broad-groups are entered in order of decreasing neutron energy on continuous cards

TABLE 3-1

<u>Card No.</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
18	(7E10.4)	1-10, 11-20, 21-30, etc.	GI	$\Gamma(n; n'\gamma)$ ; the energy (in Mev) of the emitted photons for this neutron reaction. NGG values of GI are entered in order of decreasing photon energy for the highest neutron energy broad-group. The pattern is repeated for the next highest neutron energy broad-group until NIG neutron energy broad-groups of data have been entered (NGG x NIG values). The data are entered on continuous cards. The code assumes that the first of the NIG groups corresponds to the first broad-group, etc.
19	(7E10.4)	1-10, 11-20, 21-30, etc.	SNA	$\sigma(n, \alpha)$ ; the microscopic cross section for this neutron reaction (NGN values). The data are entered in order of decreasing neutron energy
20	(7E10.4)	1-10, 11-20, 21-30, etc.	URHO	$\mu_a/\rho$ ; the microscopic, photon mass-energy absorption coefficients for this element or isotope (in $\text{cm}^2/\text{gm}$ ). The data are entered in order of decreasing photon energy (NGG values)
If NLIB = 0, Cards 21 to 24 are required.				
21	(6E12.5)	1-12, 13-24, 25-36, etc.	SA	$\sigma_c$ ; the microscopic capture cross section for this element or isotope which includes $\sigma(n, \gamma)$ , $\sigma(n, p, \gamma)$ , and $\sigma(n, \alpha, \gamma)$ reactions (in barns/atom). The data are entered in order of decreasing neutron energy (NGN values)
22	(6E12.5)	1-12, 13-24, 25-36, etc.	SF	$\sigma_f$ ; the fission cross section for fissionable isotopes (in barns/atom); non-fissionable elements or isotopes contain zeros for this cross section. The data are entered in order of decreasing neutron energy (NGN values)

TABLE 3-1 (Continued)

<u>Card No.</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
23	(6E12.5)	1-12, 13-24, 25-36, etc.	SE	$\sigma_{el, eff}$ ; the "effective" energy deposition cross section for this element or isotope (in barns/atom). See the Detailed User Information Section for a description of this cross section. The data are entered in order of decreasing neutron energy (NFG values)
24	(6E12.5)	1-12, 13-24, 25-36, etc.	SI	$\sigma_{n, n'}$ ; the total inelastic scattering cross section for this element or isotope (in barns/atom). The data are entered in order of decreasing neutron energy (NFG values)
Cards 16 to 24 are repeated for each element in the gamma-ray production and nuclear parameter library (NLE sets).				
25	(7E10.4)	1-10, 11-20, 21-30, etc.	GPF	$\Gamma (n; f)_{prompt}$ ; the spectrum of energy (in Mev) from the prompt fission of U-235 (NGG values). The data are entered in order of decreasing photon energy
26	(7E10.4)	1-10, 11-20, 21-30, etc.	GDF	$\Gamma (n; f)_{delayed}$ ; the spectrum of decay energy (in Mev) from the fission of U-235 for a particular reactor run time (NGG values). The data are entered in order of decreasing photon energy
27	(7E10.4)	1-10, 11-20, 21-30, etc.		Neutron dose rate conversion factors (NGN values). The data are entered in order of decreasing neutron energy
28	(7E10.4)	1-10, 11-20, 21-30, etc.	UGB	Upper lethargy bounds of the broad-group, neutron energy structure (NGN values). At 10.0 Mev, the lethargy is 0.0; at 0.0 Mev, the lethargy is infinite. The data are entered in order of decreasing neutron energy
29	(7E10.4)	1-10, 11-20, 21-30, etc.	DOSEG	Photon dose rate conversion factors (NGG values). The data are entered in order of decreasing photon energy

TABLE 3-1 (Continued)  
Data Set 4 - Composition Data

<u>Card No.</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
30	(6112)	1-12	IS	Left mesh boundary line number of the NAGS composition
		13-24	IF	Right mesh boundary line number of the NAGS composition
		25-36	JS	Bottom mesh boundary line number of the NAGS composition
		37-48	JF	Top mesh boundary line number of the NAGS composition
				Note: The parameters, IS, IF, JS, and JF, are only used in the NAGS code to process the data; these parameters are not required for the DOT-IIW or ANISN-W codes.
31	(3112)	49-60	NREG	Identification number of this composition for labeling the output cross section tape. To obtain a unique cross section output tape ID number for each cross section set, allow for $3*(NPL+1)$ ID numbers between each composition for $NOD = 3$ ; if $NOD = 1$ or $2$ , allow for $(NPLN+1)$ or $(NPLG+1)$ ID numbers, NPL is the maximum of either NPLG or NPLN
		61-72	NELE	Total number of elements or isotopes in this composition
		1-12	IND	IND = 1: First or intermediate composition IND = 4: Last composition to be input  Note: IND is only used in the NAGS code.
		13-24	NTID1	/If NLIB = 2/ Tape ID number for broad-group cross section data (not operational, enter NTID1 = 0)

TABLE 3-1 (Continued)

<u>Card No.</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
31 (Cont'd.)		25-36	NTID2	/If NLIB = 2/ Tape ID number for broad-group cross section data (not operational, enter NTID2 = 0)
	(7A6)	1-48	TITLE	Descriptive title for this composition; this title is placed on the output cross section tape
32	(I12,	1-12	NID (1, n)	The GAM ID number of an element or isotope in the composition
	E12.5,	13-24	ADEN(n)	The corresponding atom density of the element or isotope in the composition (in atoms/cc $\times 10^{24}$ )
	I12	25-36	NID (2, n)	The corresponding identification number of microscopic library broad-group element or isotope data on an internal scratch file. NID (2, n) = (IDF (1, m) $\times$ 100) + IDF (3, m) (For example, if zirconium is input, and its microscopic tape ID number is 3721, and the desired spectra is 12, then NID (2, n) = 372112) /NLIB $\geq$ 3/
	I12)	37-48	NID (3, n)	The corresponding $P_0$ neutron scattering approximation of the element or isotope. (If a $P_0$ transport-corrected set of data is chosen, then NID (3, n) = 0) /NLIB $\geq$ 3/

- Note: 1) Card 32 is repeated for each element or isotope in the composition (NELE elements or isotopes)  
 2) The set of Card 32 data for a composition is entered in increasing order of NID (2, n)  
 3) Cards 30 to 32 are repeated for each composition in the problem (NMR sets of data)

This concludes the required input data for an APPROPOS calculation.

### 3.3 DETAILED INPUT DATA INSTRUCTIONS

Presented in this section is a detailed description of selected portions of the input data instructions given in Section 3.2.2. The detailed notes in this section reflect the availability of the Master Library Tapes (described in Volume 2 of this report) with specific, well-defined identification numbers and parameters. However, APPROPOS is a generalized code; any equivalent set of self-consistent Master Library Tapes can be used provided they conform to the conventional requirements of record format, size, and content.

#### 3.3.1 Neutron and Gamma Ray Group Structure Specifications

One of the basic calculations within the APPROPOS code is the group-collapse of the fine-group neutron library data to an input-specified broad-group energy structure. This broad-group energy structure cannot be chosen arbitrarily, particularly if photon transport calculations are contemplated. Because the gamma ray production data and selected nuclear parameter data library are provided in 16 neutron energy groups and 13 gamma ray groups, the broad-group structure specifications on cards 3 and 4 of Data Set 1 must be specified as:

<u>Card 3</u>	<u>Card 4</u>
NGN = 16	NGG = 13
NFG = 11	NTABG = 16
NIG = 6	
NCG = 1	

When these parameters are input as specified above, the broad-group structure specifications are consistent with the data contained in Master Library No. 6. In addition, NPLG should be input greater than or equal to one. If NPLG is input as zero,  $P_0$  data for gamma ray calculations are used resulting in questionable results because of the implied assumption of isotropic scattering for gamma rays. If simultaneous calculations are anticipated, setting  $NPLN = NPLG$  results in efficient cross section generation in that the APPROPOS generates  $P_\ell$  simultaneous data for a particular composition where  $\ell$  represents NPLN or

NPLG, whichever is greater. For example, if NPLN is specified as 0 and NPLG is specified as 1, the code generates  $P_0$  and  $P_1$  simultaneous data where the  $P_1$  neutron table positions contain all zeros.

Finally, all energy-dependent data for the APPROPOS code are input from highest energy group to lowest energy group (or in order of increasing lethargy).

### 3.3.2 Weighing Spectra

Four methods of providing fine-group weighting spectra for the APPROPOS code are available. They are:

- 1) Spectra may be input from cards, (NLIB = 6);
- 2) Spectra may be input from tape from an ANISN-W fine-group calculation, (NLIB = 4);
- 3) Spectra may be input from two tapes from two separate, ANISN-W fine-group calculations, (NLIB = 5); and
- 4) Spectra may be input from tape from a previous APPROPOS calculation, (NLIB = 3).

These spectra are used to group-collapse the fine-group library data.

The ANISN-W, one-dimensional, discrete ordinates transport code computes the integrated flux for each region in the calculation. These fluxes (or spectra), as well as other data, are placed on tape 17 by ANISN-W in the same sequential order as the zone number data, i. e., 1, 2, 3, . . . , IZM. Therefore, when selecting the spectra from the ANISN-W calculation, the region numbers desired are input on card 10 of Data Set 2 in the IDS array. The user can input two ANISN-W output tapes, if desired, by setting NLIB = 5. With this option, region numbers (spectra) are selected from tape 17 first followed by the region numbers for the spectra on tape 18. However, the region numbers from tape 18 must be displaced by the number of zones contained in the data on tape 17. For example, if IZM = 5 for the tape 17 data, then the following spectra specifications could be input when NLIB=5 and NSP=7:



	<u>Spectra on Tapes 17 &amp; 18</u> (Zone Number)	<u>Spectra Requested</u> IDS, Card 10 of Data Set 2
Tape 17 -	{ 1 2 3 4 5 }	1 2 3  5
Tape 18 -	{ 1 2 3 }	6 7 8

Note that all the spectra from tape 17 need not be requested if they are not needed.

After the desired spectra are read from tape, the spectra are placed on tape 4 for subsequent calculations. The user can save this tape for use in subsequent APPROPOS calculations. Tape 4 spectral data may be input by setting NLIB = 3. Only the ID numbers requested from the previous and corresponding spectra calculation are available on tape 4.

The final method of providing fine-group weighting spectra allows the user to input the required information from cards. With this capability, only the imagination limits the flexibility of this option (NLIB = 6). A flat spectra, a 1/E spectra, higher moment weighting functions, and importance function weighting spectra are but a few of the possibilities. As with the other three options, the spectra are placed on tape 4 for subsequent calculations within the code so that the user may save this tape, if desired, for subsequent calculations.

### 3.3.3 Group-Collapsing and Upscatter-Removal

Frequently, as in parametric or scoping studies, the need to reduce the fine-group data into broad-group data is evident. In addition, upscatter-removal is a desirable capability. Both of these computations are performed by the APPROPOS code.

The technique of group-collapsing has two requirements as follows:

1) The actual pointwise spectrum in the region must not differ appreciably from the average region spectrum. If the spectrum varies rapidly with spatial position, multiple zones should be used to describe the material, and

2) The energy bounds of the broad-group data must correspond to the energy bounds of the fine-group data.

The first requirement must be satisfied external to the APPROPOS code when the weighting spectra are generated. Generally, rerunning the ANISN-W calculation with the group-collapsed and/or upscatter-removed cross sections provides the user with some insight as to whether he has met the first requirement.

The second requirement is inherently met by the APPROPOS code. By definition, the broad-group energy bounds must correspond to a fine-group energy bound. The only loophole here is that if the wrong fine-group boundary is specified, an inconsistency results. This inconsistency only applies to those calculations where the gamma ray library data are required, i. e., in coupled neutron-photon cross section calculations. If only neutron transport calculations are anticipated, the broad-group boundaries may be specified arbitrarily to suit the calculation. The fine-group to broad-group correspondence with respect to the Master Library Data is given in Table 3-2.

If the specified broad-group structure will not accommodate the complete, multigroup scattering matrix, the "extra" transfer coefficients are placed such that they transfer as far down (or up) as possible.

Upscatter removal is accomplished by zone by subtracting the reaction rate due to  $\sigma_{i \rightarrow i}$  from the reaction rate due to  $\sigma_{i \rightarrow j}$ , where  $j > i$ . Thus, the net transfer rate between groups  $j$  and  $i$  is preserved. As in group-collapsing, the first requirement above is equally important in upscatter removal. Subsequent ANISN-W calculations can verify the validity of the upscatter-removal for a particular geometrical configuration.

In the APPROPOS code, the flux-weighting, upscatter-removal, and group-collapse algorithms are identical to those available in the ANISN-W code.

### 3.3.4 Master Library Tape Data Specifications

The APPROPOS code uses five of the six Master Libraries described in Volume 2 of this report. These six tapes are as follows:

TABLE 3-2  
 FINE-GROUP TO BROAD-GROUP CORRESPONDENCE

<u>Fine-Group Number</u>	<u>Broad-Group* Number</u>	<u>Fine-Group Number</u>	<u>Broad-Group Number</u>
1	1	27	11
2	1	28	11
3	1	29	11
4	1	30	11
5	1	31	11
6	2	32	11
7	2	33	12
8	3	34	12
9	4	35	12
10	5	36	12
11	6	37	12
12	6	38	12
13	7	39	12
14	8	40	13
15	8	41	13
16	9	42	13
17	9	43	13
18	10	44	14
19	10	45	14
20	10	46	14
21	10	47	15
22	10	48	15
23	10	49	15
24	10	50	16
25	10	51	16
26	11	52	16

\*The broad-group numbers are entered on card 9 of Data Set 2 in the IGF array.

MSFC Master  
Library No.

Description

- |    |  |
|----|--|
| 1  | Microscopic, 52 group, Transport Corrected, Neutron Cross Section Sets for Use in the ANISN-W, DOT-IIW, and APPROPOS Codes.          |
| 2  | Microscopic, 52 group, $P_0$ Neutron Cross Section Sets for Use in the ANISN-W, DOT-IIW, and APPROPOS Codes.                         |
| 3  | Microscopic, 52 Group, Reaction Rate Cross Section Sets for Use in the APPROPOS Code.  |
| 4  | Microscopic, 13 Group, $P_0$ , Gamma Ray Cross Section Sets for Use in the ANISN-W, DOT-IIW, and APPROPOS Codes.                     |
| 5  | Pair-Production and Photo-Electric Gamma Ray Cross Sections for Use in the KAP-VI, SCAP, MAP, and GAMLEG-W Codes.                    |
| 6* | Gamma Ray Production Data Due to Thermal Neutron Capture and Inelastic Scatter, Selected Nuclear Parameters, and other Related Data. |

\*On cards or behind Master Library Tape No. 3.

Generally, Master Library No. 6 is behind Master Library No. 3 on a tape; all other Master Libraries are on tape as well. Section 3.4.1 describes the specific tape drives on which these Master Library Tapes are mounted.

The data specifications of these tapes, as related to the input data parameters, are defined below:

<u>Master Library Number</u>	<u>Parameter</u>	<u>Card No.</u>	<u>Data Set No.</u>	<u>Value</u>
1	NPLN	3	1	$\leq 3$
	NLIB	6	1	$\geq 3$
	NGF	7	2	52
	NFF	7	2	32
	IHTF	7	2	3

<u>Master Library Number</u>	<u>Parameter</u>	<u>Card No.</u>	<u>Data Set No.</u>	<u>Value</u>
1 (continued)	IHSF	7	2	13
	IHMF	7	2	34
	NRW	8	2	0
2	NPLN	3	1	0
	NLIB	6	1	$\geq 3$
	NGF	7	2	52
	NFF	7	2	32
	IHTF	7	2	3
	IHSF	7	2	13
	IHMF	7	2	34
	NRW	8	2	1
3	NLIB	6	1	$\geq 3$
	NGF	7	2	52
	NFF	7	2	32
4	NGG	4	1	13
	NTABG	4	1	16
	NPLG	4	1	$\leq 9$
5	Not Required			
6	NGN	3	1	16
	NFG	3	1	11
	NIG	3	1	6
	NCG	3	1	1
	NLE	5	1	38

The element or isotope identification numbers for Master Libraries Numbers 1, 2, and 3 are given in Section 3 of Volume 2 of this report; the GAM element or isotope identification numbers for Master Library Number 6 are given in Table 3-3.

TABLE 3-3  
ELEMENT IDENTIFICATION LIST FOR MASTER LIBRARY NUMBER 6

<u>Number</u>	<u>GAM Element ID Number*</u>	<u>Name</u>	<u>Atomic Mass Units</u>
1	1	HYDROGEN	1.0080
2	3	BERYLLIUM	9.0122
3	4	BORON (NATURAL)	10.8110
4	5	CARBON	12.0111
5	10	U-235	235.0439
6	12	U-238	238.0508
7	22	NITROGEN	14.0067
8	23	OXYGEN	15.9994
9	24	MAGNESIUM	24.3120
10	25	ALUMINUM	26.9815
11	26	SILICON	28.0860
12	27	CHROMIUM	51.9960
13	28	MANGANESE	54.9380
14	29	IRON	55.8470
15	30	COBALT	58.9332
16	31	NICKEL	58.7100
17	32	COPPER	63.5400
18	44	ZIRCONIUM	91.2200
19	51	MOLYBDENUM	95.9400
20	69	SILVER	107.8700
21	70	INDIUM	114.8200
22	71	CADMIUM	112.4000
23	119	GADOLINIUM	157.2500
24	126	LEAD	207.1900
25	127	NIObIUM	92.9060
26	128	TITANIUM	47.9000
27	129	TANTALUM	180.9480
28	130	LI-6	6.0151
29	131	LI-7	7.0160
30	133	BORON-10	10.0129
31	134	W-182	181.9483
32	135	W-183A	182.9503
33	136	W-183B	182.9503
34	137	W-184	183.9510
35	138	W-186	185.9544
36	139	SULFUR	32.0640
37	300	LITHIUM	6.9390
38	301	TUNGSTEN	183.8500

\*The GAM element ID number is required as input on card 15 of Data Set 3 as well as on Card 32 of Data Set 4.

### 3.3.5 Composition Data

Before proceeding, note the following definitions:

- 1) A REGION is defined as a geometric section of a reactor model,
- 2) A COMPOSITION is a homogeneous mixture of elements or isotopes associated with a region, and
- 3) The same composition may be used in more than one region.

The parameters, IS, IF, JS, and JF, on card 30 of Data Set 4 are actually used by the NAGS code to define a region. When a one-dimensional calculation is anticipated, IS and IF (or JS and JF) in the transverse direction to the calculation are input as 1 and 2, respectively. If the user hasn't defined the mesh description for subsequent analyses yet, the APPROPOS code can be run with these parameters input as zero. Later, the punched card output from the APPROPOS code can easily be modified, by hand, to insert these parameters required by the NAGS code.

The parameters, NID (1, n), ADEN (n), NID (2, n), and NID (3, n) on card 32 of Data Set 4, completely specify the composition. The atom densities of the constituent elements or mixtures are specified by NID (1, n) and ADEN (n). The spectral dependence of the element or isotope is specified by NID (2, n) and the  $P_0$  scattering approximation is specified by NID (3, n). Therefore, these four parameters provide considerable flexibility in preparing the data for a composition.

### 3.3.6 Core Storage Requirements

The core storage allocation for the APPROPOS code is actually redefined three times during a calculation. If any of these storage allocations exceed the available number of core data storage locations, MAXCOR, execution of that phase of the calculations cannot be done. The core storage requirements are defined as follows:

### Spectra Tape Generation (NLIB = 4 or 5)

$$\text{MAXR} = \left\{ \text{NGF} + [\text{IM} * (2 + \text{NGF})] + [\text{IZM} * (1 + \text{NGF})] + 1 \right\}$$

$$\text{MAXZ} = \left\{ \text{NGF} + [\text{IM} * (2 + \text{NGF})] + [\text{IZM} * (1 + \text{NGF})] + 1 \right\}$$

where:

MAXR = required locations to read the ANISN-W data from tape 17 (NLIB = 4 or 5),

MAXZ = required locations to read the ANISN-W data from tape 18 (NLIB = 5),

NGF = number of energy groups, IGM, in the respective ANISN-W calculation,

IZM = number of regions or zones in the respective ANISN-W calculation.

To execute this phase of the calculation,

IM = number of radial mesh intervals in the respective ANISN-W calculation.

MAXCOR  $\geq$  MAXR or MAXZ, whichever is greater

### Fine-Group to Broad-Group Calculation (NLIB $\geq$ 3)

$$\text{MAX2} = \left\{ [\text{NGF} * (5 + \text{NSP} + \text{IHMP})] + (\text{NMC} * 18) \right. \\ \left. + [\text{NGN} * (\text{IHMB} + \text{NSP} + 5)] + \text{NSP} + 1 \right\}$$

where: IHMP = |IHMF| and the other quantities are input parameters.

To execute this phase of the calculation,

MAXCOR  $\geq$  MAX2

### Remainder of Calculations (NLIB $\geq$ 3)

$$\text{MAX3} = \left\{ [\text{NME} * (4 + (4 * \text{IGM}))] + [\text{NTAB} * (3 * \text{NGN} + 3 * \text{NGG})] \right. \\ \left. + [\text{NLE} * (5 + \text{NGN} + (\text{NGG} * (\text{NIG} + \text{NCG} + 1))) \right] \\ \left. + (3 * \text{NGG}) + (2 * \text{NGN}) + (6 * \text{NMR}) + (2 * \text{NAA}) \right. \\ \left. + 1 + \text{MAX} \left( (\text{NREQ} * (\text{NPLG} + 1)), (\text{NREQ} + (\text{NTA} * \text{NGN} * \text{NME})) \right) \right\}$$

where: NTAB = NUP + NDOWN + 4 + NTYP

NREQ = (NTABG \* NGG \* NAA)

NTYP = 0 if NOD > 0



$$\begin{aligned} \text{NTYP} &= 1 \text{ if } \text{NOD} < 0 \\ \text{NTA} &= \text{IHMB}, \text{ if } \text{IHMF} > 0 \\ \text{NTA} &= \text{IHMB} - \text{IHSB} + \text{IHTF} + 1, \text{ if } \text{IHMF} < 0 \end{aligned}$$

To execute this phase of the calculation,

$$\text{MAXCOR} \geq \text{MAX3}$$

For the complete problem, MAXCOR must be greater than MAXR, MAXZ, MAX2, or MAX3, whichever is greatest.

### 3.3.7 Limitations

Only two major limitations exist for APPROPOS calculations. The first limitation is the amount of available core storage; the second limitation is the MASTER Library Data.

The first limitation of insufficient core storage space results from attempting to run too large a problem for the amount of data storage specified for MAXCOR on card 1 of Data Set 1. On the MSFC UNIVAC-1108 computer with the EXEC8 Monitor System, the maximum value of MAXCOR, or the amount of available problem data storage, is approximately 35,000, when used with  $65K_{10}$  core locations. Because the APPROPOS code is written in variable dimension, on any given data array no size restriction is imposed; a size restriction is only imposed on the length of the sum of all data arrays. For this reason, changing the code to use more core storage for data should it become available at MSFC, can be easily accomplished by changing only one FORTRAN card in the main program of the APPROPOS code.

The second limitation occurs when the detail provided by the Master Libraries is insufficient for the problem under analysis. This limitation must be realized by the user; no simple solution to this limitation is possible.

### 3.4 PROBLEM SETUP INFORMATION

This section describes the data deck setup for the APPROPOS code. Information on tape assignments, running time, error messages, and a sample problem card input is provided.

#### 3.4.1 Tape Assignments

The APPROPOS code has been placed on the MSFC, UNIVAC-1108 computer under the EXEC8 Monitor System. Under this system, the APPROPOS code may require up to ten tape or disk devices in addition to input, output, and punch disks. However, no more than six tapes are ever required; all other files may be assigned to disk storage. The tape assignments are as follows:

- Tape 1, Scratch, microscopic neutron cross section data (by  $P_\ell$  order)
- Tape 2, Input microscopic photon transport cross section library data (GAMLEG-W)
- Tape 3, Scratch, macroscopic neutron and photon cross section data
- Tape 4, Input fine-group neutron flux spectra data, NLIB = 3
- Tape 5, Input disk
- Tape 6, Output disk
- Tape 7, Punch disk
- Tape 8, Input fine-group microscopic neutron transport cross section library data, NLIB  $\geq$  3
- Tape 10, Input fine-group microscopic neutron reaction rate cross section library data, NLIB  $\geq$  3
- Tape 12, Scratch, microscopic broad-group cross section tape
- Tape 14, Output macroscopic transport cross section tape for the ANISN-W and DOT-IIW codes
- Tape 17, Input fine-group flux tape as written by the ANISN-W code, NLIB = 4 or 5
- Tape 18, Input fine-group flux tape as written by the ANISN-W code, NLIB = 5

When setting up the data deck and control cards for the APPROPOS code, assign the scratch files to disk devices (FASTRAND); no file is ever backspaced. For most calculations, a maximum of six tapes are required. Note that if NLIB = 4 or 5, the spectra from Tapes 17 and/or

18 are placed on Tape 4 and can be used for subsequent APPROPOS calculations, if desired. However, no noticeable reduction in running time will result.

The Master Library Tapes described in Volume 2 of this report are requested as follows:

<u>Tape File</u>	<u>Master Library Tape</u>
2	4; $P_{\ell}$ gamma ray transport cross section data
8	1 or 2; $P_{\ell}$ or $P_{0r}$ transport corrected neutron transport cross section data, respectively
10	3 and 6; reaction rate cross section data, gamma ray production data, and selected nuclear parameters

The tapes should never be requested with write access. The one exception is the initial APPROPOS calculation where Master Library 6 data are input from cards and written behind Master Library 3 data on Tape 10. For this one exception,  $NAPL = 1$  on Card 5 of Data Set 1; all subsequent calculations should be made with  $NAPL = 2$  and read access only for Tapes 2, 8, and 10.

#### 3.4.2 Running Time

The required running time for the APPROPOS code is primarily dependent on the number of compositions in the calculation. Approximately two compositions per second of UNIVAC-1108 Central Processor Unit (CPU) time are processed by the APPROPOS code when using the Master Library Tape data. The large amount of input/output requires a factor of 3-5 greater elapsed time for the majority of problems.

#### 3.4.3 Error Messages

A number of APPROPOS code generated error messages may be encountered in running problems. These messages are primarily due to incorrect problem input. The error messages are generally self-explanatory and are listed:

<u>Message</u>	<u>Description or Explanation</u>
"_____ locations needed to generate flux spectra tape (Tape 4)"	If execution is terminated after this message, too many spectra were requested, or else the value of MAXCOR was input incorrectly.
"Impossible to execute problem. Problem size must be reduced by___ locations. Sorry..."	The calculation is too large for the amount of available core storage, or else the value of MAXCOR was input incorrectly.
"Element___not in basic library"	One of the values of LAL on Card 15 of Data Set 3 does not exist in the gamma-ray production data and selected nuclear data parameter library (Master Library 6). The LAL data may be incorrectly input; the calculation should be rerun after the source of the error has been corrected.
"Number of sets of library data less than requested - check LAL input data"	The LAL data on Card 15 of Data Set 3 may be input incorrectly. Also, if NAPL = 2, NLE must equal NAA.
"GAM element___not in APPROPOS library"	One of the values of LAL on Card 15 of Data Set 3 does not exist in the gamma-ray production and selected nuclear data parameter library (Master Library 6). The LAL data may be incorrectly input; the calculation should be rerun after the source of the error has been corrected.
"End-of-file encountered on Tape 12, check input value of NID (J, 2) for J = ___"	The identification number, NID (2, n), of the element data within the composition on Card 32 of Data Set 4 is in error. The Jth element in the composition is in error.
"Element___not in APPROPOS Library"	The coupling between neutron and photon cross section data cannot be made for this element because LAL on Card 15 of Data Set 3 is input incorrectly.
"End-of-file encountered on Tape 4, check input value of IDS(N) for N = ___"	The identification numbers for spectra input from tape are input incorrectly; check the IDS data on Card 10 of Data Set 2. The Nth value is in error.

<u>Message</u>	<u>Description or Explanation</u>
"End-of-file encountered on Tape 8, check input value of IDF (1, M) for M = ___"	The requested neutron transport cross section data does not exist on the tape or else the value of IDF (1, n) on Card 13 of Data Set 3 was input incorrectly. The Mth card is in error.
"End-of-file encountered on Tape 10, check input value of IDF (2, M) for M = ___"	The requested neutron reaction rate cross section data does not exist on the tape or else the value of IDF (2, n) on Card 13 of Data Set 3 was input incorrectly. The Mth card is in error.
"Error-weighting spectra for element ___ is not available. Check IDF (3, M) value of ___"	In entering IDF (3, M) on Card 13 of Data Set 3, the value does not correspond to one of the IDS numbers entered on Cards 10 or 11 of Data Set 2.

#### 3.4.4 Sample Problem Input

A sample problem card input listing is shown in Table 3-4 to assist the user in preparing problem input data. In this calculation, a set of simultaneous, neutron-photon cross section data are generated with a  $P_1$  scattering approximation for one composition. This composition contains three elements: Carbon, Uranium-235, and Aluminum. The data are averaged over the first region spectrum in a typical ANISN-W calculation. The printout from this calculation is given in Section 3.5 in Table 3-5.

TABLE 3-4

SAMPLE PROBLEM CARD INPUT FOR THE APPROPOS CODE

25000						DATA 010
APPROPOS WITH X-SECTS FROM KRO215, P0,P1 FOR MSFC, PRODUCE 29 GROUP,P1						DATA 020
16	11	6	1	17		1DATA 030
13	16	1				DATA 040
3	3	6	1	1		2DATA 050
4	4	1	2	4		28DATA 060
6	52	32	3	14		34DATA 070
8	17	0				DATA 080
1	1	1	1	1		2DATA 090
2	3	4	5	6		6DATA 100
7	8	8	9	9		10DATA 110
10	10	10	10	10		10DATA 120
10	11	11	11	11		11DATA 130
11	11	12	12	12		12DATA 140
12	12	12	13	13		13DATA 150
13	14	14	14	15		15DATA 160
15	16	16	16			DATA 170
1						DATA 180
0120	0129	1	0			DATA 190
0121	0129	1	1			DATA 200
0620	0629	1	0			DATA 210
0621	0629	1	1			DATA 220
3520	3529	1	0			DATA 230
3521	3529	1	1			DATA 240
1.603-13						DATA 250
5	10	25				DATA 260
1	3	12	15	1		3DATA 270
4	0	0	REGION 1 C,U235,AL P1			DATA 280
25 0.0037		012001	1			DATA 290
5 0.06		062001	1			DATA 300
10 0.0041		352001	1			DATA 310

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### 3.5 DESCRIPTION OF OUTPUT

Computer output from an APPROPOS calculation consists of printed output, punched output, and tape output. The following sections describe, in detail, each form of output.

#### 3.5.1 Printed Output

The printed output from the sample problem input data presented in Section 3.4.4 is shown in Table 3-5. The first output section printed by the APPROPOS code is a description of the overall problem parameters contained in Data Sets 1 and 2. The code then lists the number of cross section sets to be weighted ( $NLIB \geq 3$ ) and the amount of core storage required for this calculation.

The next section lists the correspondence between the neutron fine-group and broad-group structures. Following this, the weighting spectra are printed out, first by fine-group, and then by broad-group.

The broad-group reaction rate data and corresponding transport cross sections by element are printed out if  $NPRIN = 2$ .

The code next prints the program title card and the amount of core storage required for the remainder of the calculations. The element identification list for the library is printed if  $NAPL = 1$ . This listing is followed by the element identification list for the problem as specified by the parameter, LAL.

If  $NPRIN = 2$ , the microscopic photon cross sections for each element are printed first for the  $P_0$  sets, then for the  $P_\ell$  sets, where  $\ell = 1, 2, 3, \dots, NPLG$ .

The library data on cards 25 to 29 in Data Set 3 are printed next. These data are followed by a printout of Master Library 6 data for each element in the problem corresponding to the library data on cards 16 to 20 in Data Set 3.

The next section lists the composition parameters input on cards 30 to 32 in Data Set 4. The broad-group capture, fission, inelastic scatter, and "effective energy deposition" cross

TABLE 3-5

SAMPLE PROBLEM COMPUTER PRINTOUT FOR THE APPROPOS CODE

APPROPOS INPUT DATA

NGN	NUMBER OF NEUTRON GROUPS . . . . .	16
NFG	NUMBER OF FAST GROUPS . . . . .	11
NIG	NUMBER OF INELASTIC NEUTRON GROUPS . . . . .	6
NCG	NUMBER OF CAPTURE GAMMA GROUPS . . . . .	1
NTABN	TABLE LENGTH OF NEUTRON DATA . . . . .	17
NPLN	PL SCATTERING FOR NEUTRONS . . . . .	1
NGG	NUMBER OF GAMMA RAY GROUPS . . . . .	13
NTABG	TABLE LENGTH OF GAMMA RAY DATA . . . . .	16
NPLG	PL SCATTERING FOR GAMMAS RAYS . . . . .	1
NLE	NUMBER OF LIBRARY ELEMENTS . . . . .	3
NAA	NUMBER OF DIFFERENT ELEMENTS IN PROB . . . . .	3
NME	MAXIMUM NUMBER OF ELEMENTS IN ANY COMP. . . . .	6
NMR	MAXIMUM NUMBER OF COMPOSITIONS . . . . .	1
NSP	NUMBER OF SPECTRA FOR WEIGHTING . . . . .	1
NAPL	APPRO LIB OP. 0/1/2=CARDS/TAPE GEN/TAPE . . . . .	2
NO1	1/2/3/4=NEUTRON/PHOTON/1+2/COUPLED+3 . . . . .	4
NLIB	LIBRARY OPTION 0/1/2/3/4/5/6/ . . . . .	4
NTRIG	0/1= PUNCH/MAG. TAPE OUTPUT+NAGS PUNCH . . . . .	1
NPRIN	PRINT OPTION . . . . .	2
NUP	NUMBER OF UPSCATTER IN FINAL PRINT . . . . .	4
NDOWN	NUMBER OF DOWN SCATTER IN FINAL PRINT . . . . .	28
NMC	NO. OF MICRO. SETS TO BE WEIGHTED . . . . .	6
NGF	NO. OF FINE GROUPS . . . . .	52
NFF	NO. OF FINE GROUPS-FAST . . . . .	32
IHTF	POS. OF SIGMA(TOTAL)-FINE GROUP . . . . .	3
IHSF	POS. OF SIGMA(G-G)-FINE GROUP . . . . .	14
IHMF	NO. OF TABLE POS. -FINE GROUP . . . . .	34
IHSB	POS. OF SIGMA(G-G)-BROAD GROUP(BUR) . . . . .	8
IHMB	NO. OF TABLE POS. -BROAD GROUP(BUR) . . . . .	17
NRW	WEIGHTING TECH. (0/1, LINEAR/RECIPROCAL) . . . . .	0

FLUX SPECTRA OBTAINED FROM ANISN TAPE FOR PROBLEM 1

(PROBLE.204 A, 52 G, RADIMSFC SE PROB )

2101 LOCATIONS NEEDED TO GENERATE FLUX SPECTRA TAPE (TAPE4)



TABLE 3-5 (Continued)

WEIGHTING SPECTRA TAPE 17

SPECTRA NO. REGION NO.

1	1
2	2
3	3
4	4

6 CROSS SECTION SETS WILL BE COLLAPSED

2558 LOCATIONS OF 25000 AVAILABLE WILL BE USED

TABLE 3-5 (Continued) .

SPECTRA WEIGHTING SPECIFICATIONS (BROAD GROUP NUMBER BY FINE GROUP)

FINE GROUP BROAD GROUP

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

TABLE 3-5 (Continued)

44	14
45	14
46	14
47	15
48	15
49	15
50	16
51	16
52	16

WEIGHTING SPECTRA-FINE

	1
1	1.11383E-05
2	3.91017E-05
3	1.00346E-04
4	1.60969E-04
5	2.26761E-04
6	4.11333E-04
7	1.18323E-03
8	1.14957E-03
9	1.67625E-03
10	2.44009E-03
11	1.63523E-03
12	1.55750E-03
13	1.46100E-03
14	1.39589E-03
15	1.69045E-03
16	1.62294E-03
17	7.58577E-04
18	2.28703E-04
19	2.16276E-04
20	2.09629E-04
21	1.95415E-04
22	1.87213E-04
23	1.74765E-04
24	1.69268E-04
25	1.58808E-04
26	1.47549E-04
27	1.41430E-04
28	1.35827E-04
29	1.33934E-04
30	1.29582E-04
31	1.28272E-04
32	1.25708E-04
33	7.59640E-05
34	8.88246E-05

TABLE 3-5 (Continued)

35	9.14286E-05
36	6.92359E-05
37	1.72743E-04
38	2.94161E-04
39	1.12514E-04
40	4.76510E-05
41	8.13828E-05
42	6.28045E-05
43	6.79655E-05
44	3.44265E-05
45	3.35973E-05
46	3.05139E-05
47	2.31235E-05
48	8.26265E-06
49	5.63280E-06
50	3.38833E-06
51	5.45498E-07
52	2.36363E-07

## WEIGHTING SPECTRA-BROAD

	1
1	5.38315E-04
2	1.59456E-03
3	1.18957E-03
4	1.67625E-03
5	2.44009E-03
6	3.19273E-03
7	1.46100E-03
8	3.08634E-03
9	2.38152E-03
10	1.53908E-03
11	9.42303E-04
12	9.04871E-04
13	2.59806E-04
14	9.90377E-05
15	3.70190E-05
16	4.17019E-06

TABLE 3-5 (Continued)

	1	129	A	LUMI	NUM
	1		2	3	4
1	1.61921E-02	0.		2.33777E-01	6.66551E-01
2	3.87503E-04	0.		2.56833E-01	2.51394E-01
3	4.16237E-04	0.		1.71108E-01	1.10068E-01
4	4.78944E-04	0.		1.36045E-01	0.
5	1.90831E-03	0.		6.88034E-02	0.
6	4.48167E-03	0.		1.62051E-02	0.
7	5.32298E-03	0.		9.15448E-04	0.
8	1.59918E-03	0.		2.16384E-04	0.
9	2.49826E-03	0.		2.56652E-05	0.
10	6.86391E-03	0.		3.52625E-06	0.
11	1.77476E-02	0.		5.02387E-07	0.
12	4.24946E-02	0.		0.	0.
13	8.20927E-02	0.		0.	0.
14	1.20773E-01	0.		0.	0.
15	1.75407E-01	0.		0.	0.
16	3.27869E-01	0.		0.	0.

TABLE 3-5 (Continued)

	1 12001 ALUMINUM								P0 CORE EDGE							
	1		2		3		4		5		6		7		8	
1	1.83600E-02	3.87503E-04	4.16237E-04	4.78944E-04	1.90831E-03	4.48167E-03	5.32298E-03	1.59918E-03								
2	0.	0.	0.	0.	0.	0.	0.	0.								
3	2.18306E+00	3.10225E+00	3.37416E+00	4.09855E+00	4.59892E+00	4.80555E+00	1.40339E+00	1.41563E+00								
4	0.	0.	0.	0.	0.	0.	0.	0.								
5	0.	0.	0.	0.	0.	0.	0.	0.								
6	0.	0.	0.	0.	0.	0.	0.	0.								
7	0.	0.	0.	0.	0.	0.	0.	0.								
8	1.41859E+00	2.69191E+00	2.82180E+00	3.71004E+00	4.34397E+00	4.76849E+00	1.25277E+00	1.37282E+00								
9	0.	4.29897E-01	3.11055E-01	4.56890E-01	3.88031E-01	2.53043E-01	3.25727E-02	1.45291E-01								
10	0.	0.	1.34850E-01	8.85779E-02	9.50549E-02	0.	0.	0.								
11	0.	0.	0.	1.38041E-01	1.03184E-02	0.	0.	0.								
12	0.	0.	0.	0.	4.33283E-02	0.	0.	0.								
13	0.	0.	0.	0.	0.	0.	0.	0.								
14	0.	0.	0.	0.	0.	0.	0.	0.								
15	0.	0.	0.	0.	0.	0.	0.	0.								
16	0.	0.	0.	0.	0.	0.	0.	0.								
17	0.	0.	0.	0.	0.	0.	0.	0.								
		9	10	11	12	13	14	15	16							
1	2.49826E-03	6.86391E-03	1.77476E-02	4.25945E-02	8.20927E-02	1.20774E+01	1.75407E+01	3.27869E+01								
2	0.	0.	0.	0.	0.	0.	0.	0.								
3	1.41250E+00	1.41687E+00	1.42775E+00	1.44259E+00	1.48209E+00	1.52077E+00	1.57541E+00	1.72787E+00								
4	0.	0.	0.	0.	0.	0.	0.	0.								
5	0.	0.	0.	0.	0.	0.	0.	0.								
6	0.	0.	0.	0.	0.	0.	0.	0.								
7	0.	0.	0.	0.	0.	0.	0.	0.								
8	1.36841E+00	1.36791E+00	1.35558E+00	1.40000E+00	1.40000E+00	1.40000E+00	1.40000E+00	1.40000E+00								
9	4.12023E-02	4.15944E-02	4.20931E-02	5.44219E-02	0.	0.	0.	0.								
10	0.	0.	0.	0.	0.	0.	0.	0.								
11	0.	0.	0.	0.	0.	0.	0.	0.								
12	0.	0.	0.	0.	0.	0.	0.	0.								
13	0.	0.	0.	0.	0.	0.	0.	0.								
14	0.	0.	0.	0.	0.	0.	0.	0.								
15	0.	0.	0.	0.	0.	0.	0.	0.								
16	0.	0.	0.	0.	0.	0.	0.	0.								
17	0.	0.	0.	0.	0.	0.	0.	0.								

TABLE 3-5 (Continued)

2		12101 ALUMINUM			P1		CORE EDGE		
	1	2	3	4	5	6	7	8	
1	0.	0.	0.	0.	0.	0.	0.	0.	
2	0.	0.	0.	0.	0.	0.	0.	0.	
3	0.	0.	0.	0.	0.	0.	0.	0.	
4	0.	0.	0.	0.	0.	0.	0.	0.	
5	0.	0.	0.	0.	0.	0.	0.	0.	
6	0.	0.	0.	0.	0.	0.	0.	0.	
7	0.	0.	0.	0.	0.	0.	0.	0.	
8	6.71847E-02	6.61602E-02	8.08015E-02	2.80794E-01	2.55192E-01	2.78901E-02	1.31357E-01	2.15701E-02	
9	0.	-6.71847E-02	-6.61602E-02	-8.08015E-02	-2.80794E-01	-2.55192E-01	-2.78901E-02	-1.31357E-01	
10	0.	0.	0.	0.	0.	0.	0.	0.	
11	0.	0.	0.	0.	0.	0.	0.	0.	
12	0.	0.	0.	0.	0.	0.	0.	0.	
13	0.	0.	0.	0.	0.	0.	0.	0.	
14	0.	0.	0.	0.	0.	0.	0.	0.	
15	0.	0.	0.	0.	0.	0.	0.	0.	
16	0.	0.	0.	0.	0.	0.	0.	0.	
17	0.	0.	0.	0.	0.	0.	0.	0.	
	9	10	11	12	13	14	15	16	
1	0.	0.	0.	0.	0.	0.	0.	0.	
2	0.	0.	0.	0.	0.	0.	0.	0.	
3	0.	0.	0.	0.	0.	0.	0.	0.	
4	0.	0.	0.	0.	0.	0.	0.	0.	
5	0.	0.	0.	0.	0.	0.	0.	0.	
6	0.	0.	0.	0.	0.	0.	0.	0.	
7	0.	0.	0.	0.	0.	0.	0.	0.	
8	4.02268E-02	3.99824E-02	5.17040E-02	0.	0.	0.	0.	0.	
9	-2.15701E-02	-4.02268E-02	-3.99824E-02	-5.17040E-02	0.	0.	0.	0.	
10	0.	0.	0.	0.	0.	0.	0.	0.	
11	0.	0.	0.	0.	0.	0.	0.	0.	
12	0.	0.	0.	0.	0.	0.	0.	0.	
13	0.	0.	0.	0.	0.	0.	0.	0.	
14	0.	0.	0.	0.	0.	0.	0.	0.	
15	0.	0.	0.	0.	0.	0.	0.	0.	
16	0.	0.	0.	0.	0.	0.	0.	0.	
17	0.	0.	0.	0.	0.	0.	0.	0.	

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TABLE 3-5 (Continued)

	3	629	C	ARBO	N 29	6 DE	G K
	1		2	3		4	
1	0.	0.		9.08066E-01		4.53210E-02	
2	0.	0.		5.05289E-01		0.	
3	0.	0.		3.75977E-01		0.	
4	0.	0.		2.60564E-01		0.	
5	0.	0.		1.26665E-01		0.	
6	3.53257E-07	0.		3.15495E-02		0.	
7	8.71029E-06	0.		6.29502E-03		0.	
8	1.42670E-05	0.		1.47794E-03		0.	
9	4.05360E-05	0.		1.76560E-04		0.	
10	1.09464E-04	0.		2.42593E-05		0.	
11	2.87078E-04	0.		3.45624E-06		0.	
12	6.37404E-04	0.		0.		0.	
13	1.23106E-03	0.		0.		0.	
14	1.81954E-03	0.		0.		0.	
15	2.68126E-03	0.		0.		0.	
16	5.03409E-03	0.		0.		0.	



TABLE 3-5 (Continued)

3 62001 CARBON, 296 DEG. K			P0 CORE EDGE					
	1	2	3	4	5	6	7	8
1	1.20477E-03	0.	0.	0.	0.	3.53257E-07	8.71029E-06	1.42670E-05
2	0.	0.	0.	0.	0.	0.	0.	0.
3	1.74822E+00	1.86523E+00	2.60744E+00	3.27284E+00	4.03317E+00	4.58288E+00	4.66794E+00	4.70013E+00
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	1.15181E+00	1.39772E+00	1.78404E+00	2.58174E+00	3.54330E+00	4.23843E+00	3.95458E+00	4.39925E+00
9	0.	5.73891E-01	4.67502E-01	8.23402E-01	6.91103E-01	4.89878E-01	3.44446E-01	7.13354E-01
10	0.	0.	1.26152E-02	0.	0.	0.	0.	0.
11	0.	0.	0.	6.73849E-03	0.	0.	0.	0.
12	0.	0.	0.	0.	1.82316E-03	0.	0.	0.
13	0.	0.	0.	0.	0.	1.30155E-04	0.	0.
14	0.	0.	0.	0.	0.	0.	1.35221E-06	0.
15	0.	0.	0.	0.	0.	0.	0.	3.61640E-06
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.
	9	10	11	12	13	14	13'	16
1	4.05360E-05	1.09464E-04	2.87078E-04	6.37404E-04	1.23106E-03	1.81954E-03	2.68126E-03	5.03410E-03
2	0.	0.	0.	0.	0.	0.	0.	0.
3	4.70988E+00	4.71009E+00	4.71027E+00	4.63861E+00	4.67729E+00	4.77439E+00	4.88181E+00	4.49787E+00
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	1.99973E-06	3.80962E-03	0.	0.	0.
6	0.	0.	0.	3.55670E-05	1.02857E-02	3.27081E-02	0.	0.
7	0.	0.	0.	5.56650E-02	1.51038E-01	1.54588E-01	1.34455E-01	0.
8	4.40621E+00	4.40208E+00	4.31294E+00	4.37024E+00	4.25701E+00	4.41158E+00	4.67185E+00	4.32186E+00
9	3.00859E-01	3.03628E-01	3.07905E-01	3.97040E-01	2.57816E-01	2.96708E-01	1.89898E-01	4.24068E-02
10	0.	0.	0.	0.	0.	8.35756E-03	5.80758E-02	2.00273E-02
11	0.	0.	0.	0.	0.	0.	1.37451E-03	8.59834E-03
12	0.	0.	0.	0.	0.	0.	0.	1.90785E-04
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.

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TABLE 3-5 (Continued)

4		62101 CARBON, 296 DEG. K			P1		CORE EDGE		
	1	2	3	4	5	6	7	8	
1	0.	0.	0.	0.	0.	0.	0.	0.	
2	0.	0.	0.	0.	0.	0.	0.	0.	
3	0.	0.	0.	0.	0.	0.	0.	0.	
4	0.	0.	0.	0.	0.	0.	0.	0.	
5	0.	0.	0.	0.	0.	0.	0.	0.	
6	0.	0.	0.	0.	0.	0.	0.	0.	
7	0.	0.	0.	0.	0.	0.	0.	0.	
8	8.29507E-01	3.39112E-01	5.64956E-01	4.92884E-01	3.71120E-01	2.84051E-01	5.80535E-01	1.56862E-01	
9	0.	-8.29507E-01	-3.39112E-01	-5.64956E-01	-4.92884E-01	-3.71120E-01	-2.84051E-01	-5.80535E-01	
10	0.	0.	0.	0.	0.	0.	0.	0.	
11	0.	0.	0.	0.	0.	0.	0.	0.	
12	0.	0.	0.	0.	0.	0.	0.	0.	
13	0.	0.	0.	0.	0.	0.	0.	0.	
14	0.	0.	0.	0.	0.	0.	0.	0.	
15	0.	0.	0.	0.	0.	0.	0.	0.	
16	0.	0.	0.	0.	0.	0.	0.	0.	
17	0.	0.	0.	0.	0.	0.	0.	0.	

	9	10	11	12	13	14	15	16
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	-2.14975E-06	-2.03047E-03	0.	0.	0.
6	0.	0.	0.	-3.69961E-05	-8.24900E-03	-2.04017E-02	0.	0.
7	0.	0.	0.	-2.84424E-02	-1.18461E-01	-1.29536E-01	-1.01726E-01	0.
8	2.77536E-01	2.74645E-01	3.52500E-01	2.38959E-01	3.23752E-01	2.89895E-01	1.68650E-01	1.24159E-01
9	-1.56862E-01	-2.77536E-01	-2.74645E-01	-3.52500E-01	-2.27580E-01	-2.45356E-01	-1.59517E-01	-3.08626E-02
10	0.	0.	0.	0.	0.	-9.95128E-03	-4.54741E-02	-1.18810E-02
11	0.	0.	0.	0.	0.	0.	-1.33449E-03	-4.47886E-03
12	0.	0.	0.	0.	0.	0.	0.	-9.33778E-05
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 3-5 (Continued)

	5	3529	U RAN1 UM-2	35
	1	2	3	4
1	2.36118E-02	1.27709E+00	3.49747E-02	1.91011E+00
2	5.25818E-02	1.28972E+00	3.33011E-02	1.75357E+00
3	9.21408E-02	1.23002E+00	2.30186E-02	1.53611E+00
4	1.56461E-01	1.18800E+00	1.62188E-02	1.63339E+00
5	3.05706E-01	1.39935E+00	1.15745E-02	1.32149E+00
6	7.72196E-01	2.26043E+00	3.78726E-03	8.47128E-02
7	1.34659E+00	4.18888E+00	8.32623E-04	0.
8	3.24444E+00	7.03134E+00	1.96378E-04	0.
9	8.85312E+00	1.77272E+01	2.33971E-05	0.
10	2.49493E+01	3.90708E+01	3.93705E-06	0.
11	1.94474E+01	2.73702E+01	5.07664E-07	0.
12	1.19968E+01	6.95689E+01	0.	0.
13	3.94741E+01	1.85749E+02	0.	0.
14	4.71458E+01	2.69343E+02	0.	0.
15	7.65981E+01	4.37799E+02	0.	0.
16	1.55404E+02	8.87860E+02	0.	0.

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TABLE 3-5 (Continued)

	5 352001 URANIUM-235								P0 CORE EDGE							
	1		2		3		4		5		6		7		8	
1	1.30071E+00	1.34231E+00	1.32216E+00	1.34446E+00	1.70506E+00	3.03262E+00	5.53547E+00	1.02758E+01								
2	3.84581E+00	3.41445E+00	3.13771E+00	2.96691E+00	3.43988E+00	5.51238E+00	1.02005E+01	1.71158E+01								
3	8.18786E+00	7.12190E+00	6.78324E+00	7.68654E+00	1.04388E+01	1.33022E+01	1.60357E+01	2.07762E+01								
4	0.	0.	0.	0.	0.	0.	0.	0.								
5	0.	0.	0.	0.	0.	0.	0.	0.								
6	0.	0.	0.	0.	0.	0.	0.	0.								
7	0.	0.	0.	0.	0.	0.	0.	0.								
8	4.97725E+00	4.20662E+00	4.28206E+00	5.27002E+00	8.37999E+00	1.02239E+01	1.04143E+01	1.04644E+01								
9	0.	3.45864E-01	3.96096E-01	7.16801E-01	8.87079E-01	3.62629E-01	4.52774E-02	8.59256E-02								
10	0.	0.	4.78045E-01	6.90159E-01	3.57038E-01	1.67535E-01	8.60490E-03	3.57317E-04								
11	0.	0.	0.	6.47037E-01	4.30785E-01	9.91356E-02	1.13768E-02	2.46053E-03								
12	0.	0.	0.	0.	3.84366E-01	5.46842E-02	3.95334E-03	5.92024E-03								
13	0.	0.	0.	0.	0.	5.34368E-02	1.07732E-03	2.04172E-03								
14	0.	0.	0.	0.	0.	0.	1.00289E-03	1.70636E-04								
15	0.	0.	0.	0.	0.	0.	0.	1.57937E-04								
16	0.	0.	0.	0.	0.	0.	0.	0.								
17	0.	0.	0.	0.	0.	0.	0.	0.								
	9		10		11		12		13		14		15		16	
1	2.65803E+01	6.39701E+01	4.68176E+01	8.15658E+01	2.25223E+02	3.16489E+02	5.14397E+02	1.04326E+03								
2	4.31482E+01	9.49766E+01	6.66190E+01	1.69331E+02	4.52113E+02	6.55581E+02	1.06560E+03	2.16105E+03								
3	3.70808E+01	7.67021E+01	5.84916E+01	9.25658E+01	2.36223E+02	3.27489E+02	5.25397E+02	1.05426E+03								
4	0.	0.	0.	0.	0.	0.	0.	0.								
5	0.	0.	0.	0.	0.	0.	0.	0.								
6	0.	0.	0.	0.	0.	0.	0.	0.								
7	0.	0.	0.	0.	0.	0.	0.	0.								
8	1.04641E+01	1.26870E+01	1.16740E+01	1.10000E+01	1.10000E+01	1.10000E+01	1.10000E+01	1.10000E+01								
9	3.60005E-02	3.63432E-02	4.50450E-02	0.	0.	0.	0.	0.								
10	0.	0.	0.	0.	0.	0.	0.	0.								
11	6.11900E-06	0.	0.	0.	0.	0.	0.	0.								
12	6.46137E-05	3.32348E-07	0.	0.	0.	0.	0.	0.								
13	1.62111E-04	0.	8.13478E-07	0.	0.	0.	0.	0.								
14	5.50465E-05	0.	0.	0.	0.	0.	0.	0.								
15	1.93950E-06	0.	0.	0.	0.	0.	0.	0.								
16	1.79013E-06	0.	0.	0.	0.	0.	0.	0.								
17	0.	0.	0.	0.	0.	0.	0.	0.								

TABLE 3-5 (Continued)

6		352101 URANIUM-235			P1		CORE EDGE		
	1	2	3	4	5	6	7	8	
1	0.	0.	0.	0.	0.	0.	0.	0.	
2	0.	0.	0.	0.	0.	0.	0.	0.	
3	0.	0.	0.	0.	0.	0.	0.	0.	
4	0.	0.	0.	0.	0.	0.	0.	0.	
5	0.	0.	0.	0.	0.	0.	0.	0.	
6	0.	0.	0.	0.	0.	0.	0.	0.	
7	0.	0.	0.	0.	0.	0.	0.	0.	
8	2.11312E+00	7.08545E-01	1.08981E+00	7.39779E-01	1.80775E-01	8.45475E-02	6.67588E-02	1.82056E-02	
9	0.	-2.11312E+00	-7.08545E-01	-1.08981E+00	-7.39779E-01	-1.80775E-01	-8.45475E-02	-6.67588E-02	
10	0.	0.	0.	0.	0.	0.	0.	0.	
11	0.	0.	0.	0.	0.	0.	0.	0.	
12	0.	0.	0.	0.	0.	0.	0.	0.	
13	0.	0.	0.	0.	0.	0.	0.	0.	
14	0.	0.	0.	0.	0.	0.	0.	0.	
15	0.	0.	0.	0.	0.	0.	0.	0.	
16	0.	0.	0.	0.	0.	0.	0.	0.	
17	0.	0.	0.	0.	0.	0.	0.	0.	
	9	10	11	12	13	14	15	16	
1	0.	0.	0.	0.	0.	0.	0.	0.	
2	0.	0.	0.	0.	0.	0.	0.	0.	
3	0.	0.	0.	0.	0.	0.	0.	0.	
4	0.	0.	0.	0.	0.	0.	0.	0.	
5	0.	0.	0.	0.	0.	0.	0.	0.	
6	0.	0.	0.	0.	0.	0.	0.	0.	
7	0.	0.	0.	0.	0.	0.	0.	0.	
8	3.39547E-02	3.80481E-02	0.	0.	0.	0.	0.	0.	
9	-1.82056E-02	-3.39547E-02	-3.80481E-02	0.	0.	0.	0.	0.	
10	0.	0.	0.	0.	0.	0.	0.	0.	
11	0.	0.	0.	0.	0.	0.	0.	0.	
12	0.	0.	0.	0.	0.	0.	0.	0.	
13	0.	0.	0.	0.	0.	0.	0.	0.	
14	0.	0.	0.	0.	0.	0.	0.	0.	
15	0.	0.	0.	0.	0.	0.	0.	0.	
16	0.	0.	0.	0.	0.	0.	0.	0.	
17	0.	0.	0.	0.	0.	0.	0.	0.	

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TABLE 3-5 (Continued)

APPROPOS WITH X-SECTS FROM KR0215, P0,P1 FOR MSFC, PRODUCE 29 GROUP,P1

6255 LOCATIONS WILL BE USED FOR THIS PROBLEM

TABLE 3-5 (Continued)

ELEMENT IDENTIFICATION LIST FOR PROBLEM

NUMBER	ELEMENT ID	NAME	ATOMIC MASS UNITS
1	5	CARBON	12.0111
2	10	U-235	235.0439
3	25	ALUMIN	26.9815

TABLE 3-5 (Continued)

MICROSCOPIC PHOTON CROSS SECTIONS-P(L),L= 0

ELEMENT NAME... CARBON  
 ELEMENT NO.... 1  
 GAMLEG ID NO... 6  
 GAM ID NO..... 5

	1	2	3	4	5	6	7	8
1	3.00633E-01	3.07243E-01	3.18600E-01	3.35288E-01	3.60436E-01	3.92105E-01	4.20779E-01	4.43018E-01
2	0.	0.	0.	0.	0.	0.	0.	0.
3	4.30988E-01	4.47215E-01	4.74532E-01	5.14727E-01	5.76790E-01	6.58895E-01	7.37553E-01	8.02757E-01
4	8.14973E-03	6.81599E-03	1.38495E-02	2.12423E-02	2.75752E-02	4.78619E-02	3.37703E-02	4.53176E-02
5	0.	1.14829E-02	2.61730E-02	3.22717E-02	4.29045E-02	6.42020E-02	4.32456E-02	6.72628E-02
6	0.	0.	2.07329E-02	2.25494E-02	2.72047E-02	3.50015E-02	2.13203E-02	3.75150E-02
7	0.	0.	0.	1.80965E-02	1.94897E-02	2.30775E-02	1.21944E-02	1.92533E-02
8	0.	0.	0.	0.	1.58710E-02	1.69998E-02	8.28946E-03	1.13412E-02
9	0.	0.	0.	0.	0.	1.40610E-02	6.23283E-03	7.84599E-03
10	0.	0.	0.	0.	0.	0.	5.21259E-03	5.96644E-03
11	0.	0.	0.	0.	0.	0.	0.	5.01951E-03
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
	9	10	11	12	13			
1	4.69588E-01	5.04815E-01	5.45584E-01	5.84779E-01	6.18374E-01			
2	0.	0.	0.	0.	0.			
3	8.86373E-01	1.01335E+00	1.20217E+00	1.58528E+00	2.17113E+00			
4	6.53424E-02	1.06415E-01	2.05493E-01	5.44608E-01	1.55276E+00			
5	8.89412E-02	1.34776E-01	2.03004E-01	3.47794E-01	4.55894E-01			
6	5.62371E-02	7.94106E-02	9.88245E-02	1.47856E-01	1.03294E-01			
7	3.25766E-02	5.23370E-02	6.25340E-02	8.74643E-02	5.12630E-02			
8	1.74800E-02	3.17816E-02	4.35040E-02	6.26236E-02	3.03778E-02			
9	1.06126E-02	1.79343E-02	2.79126E-02	4.84576E-02	2.09117E-02			
10	7.46892E-03	1.12356E-02	1.65975E-02	3.58606E-02	1.52059E-02			
11	5.74080E-03	8.04190E-03	1.07101E-02	2.59584E-02	1.00353E-02			
12	4.85638E-03	6.24455E-03	7.78091E-03	2.03239E-02	6.03297E-03			
13	0.	5.30978E-03	6.09449E-03	1.73100E-02	3.87313E-03			
14	0.	0.	5.20430E-03	1.54944E-02	2.79142E-03			
15	0.	0.	0.	1.45149E-02	2.17026E-03			
16	0.	0.	0.	0.	1.84409E-03			



TABLE 3-5 (Continued)

MICROSCOPIC PHOTON CROSS SECTIONS-P(L),L= 0

ELEMENT NAME... ALUMIN  
 ELEMENT NO..... 3  
 GAMLEG ID NO... 11  
 GAM ID NO..... 25

	1	2	3	4	5	6	7	8
1	7.86496E-01	7.89909E-01	7.99520E-01	8.16765E-01	8.46857E-01	8.90884E-01	9.35942E-01	9.74688E-01
2	0.	0.	0.	0.	0.	0.	0.	0.
3	1.08912E+00	1.11358E+00	1.15808E+00	1.22633E+00	1.33553E+00	1.48622E+00	1.63625E+00	1.76513E+00
4	1.76577E-02	1.47680E-02	3.00073E-02	4.60249E-02	5.97462E-02	1.03701E-01	7.31689E-02	9.81881E-02
5	0.	2.48796E-02	5.67081E-02	6.99221E-02	9.29598E-02	1.39104E-01	9.36989E-02	1.45736E-01
6	0.	0.	4.49212E-02	4.88571E-02	5.89435E-02	7.58365E-02	4.61940E-02	8.12824E-02
7	0.	0.	0.	3.92090E-02	4.22278E-02	5.00012E-02	2.64212E-02	4.17156E-02
8	0.	0.	0.	0.	3.43872E-02	3.68330E-02	1.79605E-02	2.45726E-02
9	0.	0.	0.	0.	0.	3.04655E-02	1.35045E-02	1.69997E-02
10	0.	0.	0.	0.	0.	0.	1.12940E-02	1.29273E-02
11	0.	0.	0.	0.	0.	0.	0.	1.08756E-02
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13
1	1.02510E+00	1.09529E+00	1.18210E+00	1.27029E+00	1.39568E+00
2	0.	0.	0.	0.	0.
3	1.93603E+00	2.19956E+00	2.60469E+00	3.43804E+00	4.75998E+00
4	1.41575E-01	2.30566E-01	4.45235E-01	1.17998E+00	3.36430E+00
5	1.92706E-01	2.92014E-01	4.39841E-01	7.53554E-01	9.87770E-01
6	1.21847E-01	1.72056E-01	2.14120E-01	3.22792E-01	2.23803E-01
7	7.05826E-02	1.13397E-01	1.35490E-01	1.97408E-01	1.11070E-01
8	3.78734E-02	6.88600E-02	9.42587E-02	1.46689E-01	6.58185E-02
9	2.29940E-02	3.88575E-02	6.04773E-02	1.18958E-01	4.53086E-02
10	1.61827E-02	2.43439E-02	3.59614E-02	9.49947E-02	3.29461E-02
11	1.24384E-02	1.74241E-02	2.32051E-02	7.61487E-02	2.17431E-02
12	1.05222E-02	1.35299E-02	1.68586E-02	6.48166E-02	1.30714E-02
13	0.	1.15045E-02	1.32047E-02	5.82074E-02	8.39178E-03
14	0.	0.	1.12760E-02	5.39725E-02	6.04807E-03
15	0.	0.	0.	5.16333E-02	4.70223E-03
16	0.	0.	0.	0.	3.99553E-03

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TABLE 3-5 (Continued)

MICROSCOPIC PHOTON CROSS SECTIONS-P(L),L= 0

ELEMENT NAME... U-235  
 ELEMENT NO..... 2  
 GAMLEG ID NO... 49  
 GAM ID NO..... 10

	1	2	3	4	5	6	7	8
1	1.52449E+01	1.47085E+01	1.40156E+01	1.32008E+01	1.22284E+01	1.13870E+01	1.09453E+01	1.09028E+01
2	0.	0.	0.	0.	0.	0.	0.	0.
3	1.87667E+01	1.84162E+01	1.80285E+01	1.76442E+01	1.72846E+01	1.71742E+01	1.73532E+01	1.77750E+01
4	1.24963E-01	1.04512E-01	2.12359E-01	3.25715E-01	4.22819E-01	7.33883E-01	5.17811E-01	6.94870E-01
5	0.	1.76071E-01	4.01319E-01	4.94833E-01	6.57870E-01	9.84431E-01	6.63100E-01	1.03136E+00
6	0.	0.	3.17904E-01	3.45758E-01	4.17139E-01	5.36689E-01	3.26911E-01	5.75230E-01
7	0.	0.	0.	2.77479E-01	2.98843E-01	3.53855E-01	1.86981E-01	2.95218E-01
8	0.	0.	0.	0.	2.43355E-01	2.60664E-01	1.27105E-01	1.73898E-01
9	0.	0.	0.	0.	0.	2.15602E-01	9.55700E-02	1.20305E-01
10	0.	0.	0.	0.	0.	0.	7.99265E-02	9.14854E-02
11	0.	0.	0.	0.	0.	0.	0.	7.69653E-02
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13
1	1.13025E+01	1.26927E+01	1.70514E+01	4.17161E+01	2.64441E+02
2	0.	0.	0.	0.	0.
3	1.87954E+01	2.08922E+01	2.71190E+01	5.70571E+01	2.88250E+02
4	1.00192E+00	1.63170E+00	3.15090E+00	8.35066E+00	2.38089E+01
5	1.36377E+00	2.06656E+00	3.11272E+00	5.33284E+00	6.99037E+00
6	8.62302E-01	1.21763E+00	1.51531E+00	2.66913E+00	1.58384E+00
7	4.99507E-01	8.02500E-01	9.58855E-01	2.44334E+00	7.86032E-01
8	2.68027E-01	4.87317E-01	6.67061E-01	2.31636E+00	4.65792E-01
9	1.62727E-01	2.74992E-01	4.27993E-01	2.29375E+00	3.20646E-01
10	1.14523E-01	1.72280E-01	2.54496E-01	2.24627E+00	2.33157E-01
11	8.80257E-02	1.23309E-01	1.64221E-01	2.13676E+00	1.53874E-01
12	7.44645E-02	9.57498E-02	1.19307E-01	2.00363E+00	9.25056E-02
13	0.	8.14166E-02	9.34489E-02	1.88743E+00	5.93880E-02
14	0.	0.	7.97993E-02	1.79905E+00	4.28017E-02
15	0.	0.	0.	1.74554E+00	3.32773E-02
16	0.	0.	0.	0.	2.82760E-02

TABLE 3-5 (Continued)

MICROSCOPIC PHOTON CROSS SECTIONS-P(L)<sub>0</sub>L = 1

ELEMENT NAME... CARBON  
 ELEMENT NO..... 1  
 GAMLEG ID NO.... 6  
 GAM ID NO..... 5

	1	2	3	4	5	6	7	8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	2.43915E-02	2.04163E-02	4.13994E-02	6.34068E-02	8.21477E-02	1.41834E-01	1.00492E-01	1.34471E-01
5	0.	3.42718E-02	7.78924E-02	9.55924E-02	1.26249E-01	1.87146E-01	1.25817E-01	1.96049E-01
6	0.	0.	6.13719E-02	6.61383E-02	7.88677E-02	9.95532E-02	5.98073E-02	1.05696E-01
7	0.	0.	0.	5.27884E-02	5.59497E-02	6.46478E-02	3.33528E-02	5.22424E-02
8	0.	0.	0.	0.	4.53064E-02	4.71275E-02	2.23198E-02	2.99787E-02
9	0.	0.	0.	0.	0.	3.87531E-02	1.66027E-02	2.04059E-02
10	0.	0.	0.	0.	0.	0.	1.38013E-02	1.53457E-02
11	0.	0.	0.	0.	0.	0.	0.	1.28295E-02
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13
1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.
4	1.92936E-01	3.10513E-01	5.83509E-01	1.36510E+00	1.75459E+00
5	2.56255E-01	3.78177E-01	5.38415E-01	7.20567E-01	1.47854E-01
6	1.56699E-01	2.12252E-01	2.38234E-01	2.31762E-01	-9.25163E-02
7	8.75841E-02	1.34899E-01	1.42307E-01	1.11042E-01	-5.93675E-02
8	4.51808E-02	7.87716E-02	9.47978E-02	6.83427E-02	-3.93911E-02
9	2.66866E-02	4.25842E-02	5.80121E-02	4.59528E-02	-2.87346E-02
10	1.84635E-02	2.58883E-02	3.27603E-02	2.79569E-02	-2.17363E-02
11	1.40263E-02	1.81861E-02	2.03827E-02	1.54127E-02	-1.49268E-02
12	1.17872E-02	1.39414E-02	1.44747E-02	9.30765E-03	-9.33645E-03
13	0.	1.17686E-02	1.11612E-02	6.45319E-03	-6.15244E-03
14	0.	0.	9.44656E-03	4.88326E-03	-4.50370E-03
15	0.	0.	0.	4.08539E-03	-3.53812E-03
16	0.	0.	0.	0.	-3.02382E-03

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TABLE 3-5 (Continued)

MICROSCOPIC PHOTON CROSS SECTIONS-P(L),L= 1

ELEMENT NAME... ALUMIN  
 ELEMENT NO..... 3  
 GAMLEG ID NO... 11  
 GAM ID NO..... 25

	1	2	3	4	5	6	7	8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	5.28483E-02	4.42353E-02	8.96987E-02	1.37381E-01	1.77987E-01	3.07306E-01	2.17733E-01	2.91354E-01
5	0.	7.42556E-02	1.68767E-01	2.07117E-01	2.73539E-01	4.05484E-01	2.72603E-01	4.24774E-01
6	0.	0.	1.32972E-01	1.43300E-01	1.70923E-01	2.15699E-01	1.29582E-01	2.29007E-01
7	0.	0.	0.	1.14375E-01	1.21224E-01	1.40070E-01	7.22645E-02	1.13192E-01
8	0.	0.	0.	0.	9.81638E-02	1.02110E-01	4.83595E-02	6.49537E-02
9	0.	0.	0.	0.	0.	8.39651E-02	3.59724E-02	4.42127E-02
10	0.	0.	0.	0.	0.	0.	2.99028E-02	3.32491E-02
11	0.	0.	0.	0.	0.	0.	0.	2.77972E-02
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13
1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.
4	4.18029E-01	6.72778E-01	1.26427E+00	2.95773E+00	3.80161E+00
5	5.55220E-01	8.19383E-01	1.16657E+00	1.56123E+00	3.20350E-01
6	3.39515E-01	4.59880E-01	5.16174E-01	5.02152E-01	-2.00452E-01
7	1.89766E-01	2.92282E-01	3.08331E-01	2.40591E-01	-1.28630E-01
8	9.78916E-02	1.70672E-01	2.05395E-01	1.48076E-01	-8.53475E-02
9	5.78211E-02	9.22658E-02	1.25693E-01	9.95643E-02	-6.22584E-02
10	4.00043E-02	5.60914E-02	7.09807E-02	6.05732E-02	-4.70954E-02
11	3.03903E-02	3.94033E-02	4.41626E-02	3.33941E-02	-3.23414E-02
12	2.95389E-02	3.02063E-02	3.13618E-02	2.01666E-02	-2.02290E-02
13	0.	2.54986E-02	2.41827E-02	1.39819E-02	-1.33303E-02
14	0.	0.	2.04675E-02	1.05804E-02	-9.75802E-03
15	0.	0.	0.	8.85168E-03	-7.66593E-03
16	0.	0.	0.	0.	-6.55161E-03

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TABLE 3-5 (Continued)

MICROSCOPIC PHOTON CROSS SECTIONS-P(L),L= 1

ELEMENT NAME... U-235  
 ELEMENT NO..... 2  
 GAMLEG ID NO.... 49  
 GAM ID NO..... 10

	1	2	3	4	5	6	7	8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	3.74003E-01	3.13050E-01	6.34790E-01	9.72238E-01	1.25960E+00	2.17478E+00	1.54088E+00	2.06189E+00
5	0.	5.25501E-01	1.19435E+00	1.46575E+00	1.93582E+00	2.86958E+00	1.92919E+00	3.00609E+00
6	0.	0.	9.41035E-01	1.01412E+00	1.20961E+00	1.52648E+00	9.17045E-01	1.62067E+00
7	0.	0.	0.	8.09422E-01	8.57895E-01	9.91266E-01	5.11410E-01	8.01050E-01
8	0.	0.	0.	0.	6.94698E-01	7.22622E-01	3.42237E-01	4.59673E-01
9	0.	0.	0.	0.	0.	5.94215E-01	2.54574E-01	3.12890E-01
10	0.	0.	0.	0.	0.	0.	2.11620E-01	2.35301E-01
11	0.	0.	0.	0.	0.	0.	0.	1.96719E-01
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13
1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.
4	2.95836E+00	4.76120E+00	8.94713E+00	2.09316E+01	2.69037E+01
5	3.92925E+00	5.79871E+00	8.25569E+00	1.10487E+01	2.26709E+00
6	2.40272E+00	3.25453E+00	3.65292E+00	3.55369E+00	-1.41858E+00
7	1.34296E+00	2.06846E+00	2.18203E+00	1.70265E+00	-9.10301E-01
8	6.92772E-01	1.20783E+00	1.45357E+00	1.04792E+00	-6.03997E-01
9	4.09195E-01	6.52958E-01	8.89519E-01	7.04609E-01	-4.40598E-01
10	2.83107E-01	3.96954E-01	5.02325E-01	4.28672E-01	-3.33291E-01
11	2.15070E-01	2.78854E-01	3.12535E-01	2.36328E-01	-2.28878E-01
12	1.80737E-01	2.13768E-01	2.21945E-01	1.42717E-01	-1.43159E-01
13	0.	1.80452E-01	1.71139E-01	9.89489E-02	-9.43374E-02
14	0.	0.	1.44847E-01	7.48766E-02	-6.90567E-02
15	0.	0.	0.	6.26427E-02	-5.42512E-02
16	0.	0.	0.	0.	-4.63652E-02

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TABLE 3-5 (Continued)

LIBRARY-DATA-WILL BEGIN FOR NAGS INPUT

NUMBER OF DIFFERENT ELEMENTS 3

PROMPT FISSION GAMMA SPECTRUM

3.00000E-03	1.50000E-02	4.00000E-02	1.11000E-01	2.52000E-01	5.59000E-01
3.63000E-01	5.03000E-01	7.08000E-01	9.47000E-01	1.38900E+00	2.05300E+00
1.23500E+00					

DELAYED FISSION GAMMA SPECTRUM

0.	0.	0.	4.27000E-02	2.30200E-01	5.87000E-01
3.69000E-01	5.00000E-01	5.87000E-01	8.51000E-01	1.00900E+00	1.15200E+00
2.67000E-01					

GAMMA RAY DOSE CONVERSION FACTORS

1.06300E-06	1.08300E-06	1.11600E-06	1.16600E-06	1.24000E-06	1.33200E-06
1.41700E-06	1.50400E-06	1.56400E-06	1.67300E-06	1.80300E-06	2.11200E-06
3.51600E-06					

NEUTRON DOSE CONVERSION FACTORS

1.20000E-04	1.05000E-04	8.80000E-05	6.35000E-05	3.25000E-05	1.03000E-05
1.15000E-06	1.73000E-07	2.10000E-08	9.00000E-09	1.90000E-08	5.62000E-08
1.00000E-07	1.00000E-07	1.00000E-07	1.00000E-07		

UPPER LETHARGY

0.	1.25000E+00	2.00000E+00	2.50000E+00	3.25000E+00	4.50000E+00
6.50000E+00	7.50000E+00	9.75000E+00	1.17500E+01	1.37500E+01	1.55000E+01
1.73000E+01	1.82000E+01	1.89000E+01	2.00000E+01		

TABLE 3-5 (Continued)

CROSS SECTIONS AND CONSTANTS FOR CARBON

ELEMENT ID NUMBER . . . . . 5  
 ATOMIC MASS UNITS . . . . . 1.20111E+01  
 Q(N,ALPHA) . . . . . 0.  
 NGAML (GAMLEG DATA TAPE ID NO.) . . . . . 6  
 ELEMENT . . . . . CARBON

Q(N,NPRIME,GAMMA)

0.	0.	0.	0.	4.26700E+00	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

NEUTRON RADIATIVE CAPTURE GAMMA SPECTRUM

0.	0.	0.	0.	3.37500E+00	1.19100E+00
0.	0.	0.	0.	3.74400E-01	0.
0.					

MICROSCOPIC ELASTIC CROSS SECTIONS

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

SIGMA(N,ALPHA)

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

MICROSCOPIC GAMMA RAY ABSORPTION COEFFICIENTS

1.55200E-02	1.58500E-02	1.64200E-02	1.72500E-02	1.84800E-02	2.00200E-02
2.13400E-02	2.24300E-02	2.37100E-02	2.53900E-02	2.73900E-02	3.20800E-02
5.33700E-02					

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TABLE 3-5 (Continued)

CROSS SECTIONS AND CONSTANTS FOR U-235

ELEMENT ID NUMBER . . . . . 10  
 ATOMIC MASS UNITS . . . . . 2.35044E+02  
 Q(N,ALPHA) . . . . . 0.  
 NGAML(GAMLEG DATA TAPE ID NO.) . . . . . 49  
 ELEMENT . . . . . U-235

Q(N,NPRIME,GAMMA)

0.	0.	0.	0.	3.66200E-03	3.74900E-02
7.23400E-02	1.49400E-01	2.81100E-01	5.65700E-01	8.55300E-01	9.39200E-01
2.38300E-01					
0.	0.	0.	0.	0.	0.
8.00600E-04	6.07200E-02	3.01900E-02	1.70600E-01	4.84300E-01	8.12500E-01
2.60400E-01					
0.	0.	0.	0.	0.	0.
0.	0.	0.	2.04600E-02	1.68200E-01	5.02200E-01
2.16600E-01					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	2.31100E-02	1.81300E-01
2.00500E-01					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	9.48200E-02
1.67900E-01					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	9.47400E-02
1.67800E-01					

NEUTRON RADIATIVE CAPTURE GAMMA SPECTRUM

0.	0.	8.49300E-02	5.18200E-02	2.08100E-01	4.59700E-01
3.21900E-01	4.57600E-01	5.74400E-01	7.87000E-01	1.15900E+00	1.69400E+00
6.09500E-01					

MICROSCOPIC ELASTIC CROSS SECTIONS

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

SIGMA(N,ALPHA)

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

MICROSCOPIC GAMMA RAY ABSORPTION COEFFICIENTS

4.27900E-02	4.15600E-02	3.99400E-02	3.80400E-02	3.57000E-02	3.35100E-02
3.23200E-02	3.19600E-02	3.19200E-02	3.46500E-02	4.39500E-02	1.07800E-01
4.42700E-01					



TABLE 3-5 (Continued)

CROSS SECTIONS AND CONSTANTS FOR ALUMIN

ELEMENT ID NUMBER . . . . . 25  
 ATOMIC MASS UNITS . . . . . 2.69815E+01  
 Q(N,ALPHA) . . . . . 0.  
 NGAML(GAMLEG DATA TAPE ID NO.) . . . . . 11  
 ELEMENT . . . . . ALUMIN

Q(N,NPRIME,GAMMA)  
 1.46900E-01 4.82800E-02 2.41400E-01 3.49300E-01 4.52900E-01 3.90400E-01  
 2.65100E-01 4.93700E-01 4.44000E-01 3.84100E-01 2.91200E-01 6.12800E-02  
 1.50700E-02  
 0.  
 0. 3.12600E-01 2.06700E-01 2.83300E-01 5.54600E-01 2.10900E-02  
 2.24100E-02  
 0.  
 0. 0. 0. 1.82400E-01 2.35000E-01 2.03700E-01  
 5.01300E-02  
 0.  
 0. 0. 0. 0. 0. 0.  
 0.  
 0. 0. 0. 0. 0. 0.  
 0.  
 0. 0. 0. 0. 0. 0.  
 0.  
 0. 0. 0. 0. 0. 0.  
 0.  
 0. 0. 0. 0. 0. 0.  
 0.  
 0. 0. 0. 0. 0. 0.  
 0.

NEUTRON RADIATIVE CAPTURE GAMMA SPECTRUM  
 1.74900E+00 9.86300E-02 4.56900E-01 4.09700E-01 1.13100E+00 8.83500E-01  
 3.84200E-01 2.03900E-01 1.75100E-01 2.07000E+00 6.87500E-02 3.83700E-02  
 5.64400E-02

MICROSCOPIC ELASTIC CROSS SECTIONS  
 0. 0. 0. 0. 0. 0.  
 0. 0. 0. 0. 0. 0.

SIGMA(N,ALPHA)  
 1.57200E-02 0. 0. 0. 0. 0.  
 0. 0. 0. 0. 0. 0.  
 0. 0. 0. 0. 0. 0.

MICROSCOPIC GAMMA RAY ABSORPTION COEFFICIENTS  
 1.84300E-02 1.85200E-02 1.87400E-02 1.91200E-02 1.97400E-02 2.06200E-02  
 2.14800E-02 2.22200E-02 2.32100E-02 2.46100E-02 2.64400E-02 3.10200E-02  
 5.20400E-02

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TABLE 3-5 (Continued)

COMPOSITION TITLE( REGION 1 C,U235,AL P1 )	
COMP. DEPENDENT DATA FOR COMP. NO.....(NREG)■	1
LEFT BOUNDARY MESH LINE NO.....(IS)■	1
RIGHT BOUNDARY MESH LINE NO.....(IF)■	3
BOTTOM BOUNDARY MESH LINE NO.....(JS)■	12
TOP BOUNDARY MESH LINE NO.....(JF)■	15
NO. OF ELEMENTS(+/-NEW INPUT DATA/USE PREVIOUS COMP. DATA).....(IEL)■	3
COMP. SEQUENCE(1/4-FIRST OR INTERMEDIATE/LAST).....(IND)■	4
GAMBIT-ANISN OUTPUT TAPE ID. NO./IF NLIB.EQ.2/.....(NTID1)■	0
GAMBIT-APPROPOS OUTPUT TAPE ID. NO./IF NLIB.EQ.2/.....(NTID2)■	0

TABLE 3-5 (Continued)

COMPOSITION TITLE( REGION 1 C,U235,AL P1 )

ELEMENT DEPENDENT DATA FOR COMP. NO.....(NREG)= 1  
 GAM ELEMENT ID. NO.....NID(1)= 29  
 TAPE ELEMENT ID. NO.....NID(2)= 12001  
 P(L) SCATTERING APPROXIMATION.....NID(3)= 1  
 ATOM DENSITY (ATOMS/CM\*\*3).....(ADEN)= 3.70000E-03

GROUP NUMBER	MICROSCOPIC CAPTURE CROSS SECTION	MICROSCOPIC FISSION CROSS SECTION	MICROSCOPIC INELASTIC CROSS SECTION	MICROSCOPIC ELASTIC CROSS SECTION
1	1.61921E-02	0.	6.66551E-01	2.33777E-01
2	3.87503E-04	0.	2.51394E-01	2.56833E-01
3	4.16237E-04	0.	1.10068E-01	1.71108E-01
4	4.78944E-04	0.	0.	1.36045E-01
5	1.90831E-03	0.	0.	6.88034E-02
6	4.48167E-03	0.	0.	1.62051E-02
7	5.32298E-03	0.	0.	9.15448E-04
8	1.59918E-03	0.	0.	2.16384E-04
9	2.49826E-03	0.	0.	2.56652E-05
10	6.86391E-03	0.	0.	3.52625E-06
11	1.77476E-02	0.	0.	5.02387E-07
12	4.25946E-02	0.	0.	0.
13	8.20927E-02	0.	0.	0.
14	1.20773E-01	0.	0.	0.
15	1.75407E-01	0.	0.	0.
16	3.27869E-01	0.	0.	0.

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TABLE 3-5 (Continued)

COMPOSITION TITLE( REGION 1 C,U235,AL P1

ELEMENT DEPENDENT DATA FOR COMP. NO.....(NREG)= 1  
 GAM ELEMENT ID. NO.....NID(1)= 5  
 TAPE ELEMENT ID. NO.....NID(2)= 62001  
 P(L) SCATTERING APPROXIMATION.....NID(3)= 1  
 ATOM DENSITY (ATOMS/CM\*\*3).....(ADEN)= 6.00000E-02

GROUP NUMBER	MICROSCOPIC CAPTURE CROSS SECTION	MICROSCOPIC FISSION CROSS SECTION	MICROSCOPIC INELASTIC CROSS SECTION	MICROSCOPIC ELASTIC CROSS SECTION
1	0.	0.	4.53210E-02	9.08066E-01
2	0.	0.	0.	5.05289E-01
3	0.	0.	0.	3.75977E-01
4	0.	0.	0.	2.80564E-01
5	0.	0.	0.	1.26665E-01
6	3.53257E-07	0.	0.	3.15495E-02
7	8.71029E-06	0.	0.	6.28502E-03
8	1.42670E-05	0.	0.	1.47794E-03
9	4.05360E-05	0.	0.	1.76560E-04
10	1.09464E-04	0.	0.	2.42593E-05
11	2.87078E-04	0.	0.	3.65624E-06
12	6.37404E-04	0.	0.	0.
13	1.23106E-03	0.	0.	0.
14	1.81954E-03	0.	0.	0.
15	2.68126E-03	0.	0.	0.
16	5.03409E-03	0.	0.	0.

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TABLE 3-5 (Continued)

COMPOSITION TITLE( REGION 1 C,U235,AL P1 )

ELEMENT DEPENDENT DATA FOR COMP. NO.....(NREG)= 1  
 GAM ELEMENT ID. NO.....NID(1)= 10  
 TAPE ELEMENT ID. NO.....NID(2)=35201  
 P(L) SCATTERING APPROXIMATION.....NID(3)= 1  
 ATOM DENSITY (ATOMS/CM\*\*3).....(ADEN)= 4.10000E-03

GROUP NUMBER	MICROSCOPIC CAPTURE CROSS SECTION	MICROSCOPIC FISSION CROSS SECTION	MICROSCOPIC INELASTIC CROSS SECTION	MICROSCOPIC ELASTIC CROSS SECTION
1	2.36118E-02	1.27709E+00	1.91011E+00	3.49747E-02
2	5.25818E-02	1.28972E+00	1.75357E+00	3.33011E-02
3	9.21408E-02	1.23002E+00	1.53611E+00	2.30186E-02
4	1.56461E-01	1.18800E+00	1.63339E+00	1.62188E-02
5	3.05706E-01	1.39935E+00	1.32149E+00	1.15745E-02
6	7.72196E-01	2.26043E+00	8.47128E-02	3.78726E-03
7	1.34659E+00	4.18888E+00	0.	8.32623E-04
8	3.24444E+00	7.03134E+00	0.	1.96378E-04
9	8.85312E+00	1.77272E+01	0.	2.33971E-05
10	2.49493E+01	3.90208E+01	0.	3.93205E-06
11	1.94474E+01	2.73702E+01	0.	5.07664E-07
12	1.19968E+01	6.95689E+01	0.	0.
13	3.94741E+01	1.85749E+02	0.	0.
14	4.71458E+01	2.69343E+02	0.	0.
15	7.65981E+01	4.37799E+02	0.	0.
16	1.55404E+02	8.87860E+02	0.	0.

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TABLE 3-5 (Continued)

MICROSCOPIC NEUTRON CROSS SECTIONS FOR COMP. ELEMENT NO. 1

P(10) TRANSPORT CROSS SECTION SET

	1	2	3	4	5	6	7	8
1	1.83600E-02	3.87503E-04	4.16237E-04	4.78944E-04	1.90831E-03	4.48167E-03	5.32298E-03	1.59918E-03
2	0.	0.	0.	0.	0.	0.	0.	0.
3	2.18306E+00	3.10225E+00	3.37416E+00	4.09855E+00	4.59892E+00	4.80555E+00	1.40339E+00	1.41563E+00
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	1.41859E+00	2.69191E+00	2.82180E+00	3.71004E+00	4.34397E+00	4.76849E+00	1.25277E+00	1.37282E+00
9	0.	4.29897E-01	3.11055E-01	4.56890E-01	3.88031E-01	2.53043E-01	3.25727E-02	1.45291E-01
10	0.	0.	1.34850E-01	8.85779E-02	9.50549E-02	0.	0.	0.
11	0.	0.	0.	1.38041E-01	1.03184E-02	0.	0.	0.
12	0.	0.	0.	0.	4.33283E-02	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13	14	15	16
1	2.49826E-03	6.86391E-03	1.77476E-02	4.25945E-02	8.20927E-02	1.20774E-01	1.75407E-01	3.27869E-01
2	0.	0.	0.	0.	0.	0.	0.	0.
3	1.41250E+00	1.41687E+00	1.42775E+00	1.44259E+00	1.48209E+00	1.52077E+00	1.57541E+00	1.72787E+00
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	1.36841E+00	1.36791E+00	1.35558E+00	1.40000E+00	1.40000E+00	1.40000E+00	1.40000E+00	1.40000E+00
9	4.12023E-02	4.15944E-02	4.20931E-02	5.44219E-02	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 3-5 (Continued)

MICROSCOPIC NEUTRON CROSS SECTIONS FOR COMP. ELEMENT NO. 2

P(0) TRANSPORT CROSS SECTION SET

	1	2	3	4	5	6	7	8
1	1.20477E-03	0.	0.	0.	0.	3.53257E-07	8.71029E-06	1.42670E-05
2	0.	0.	0.	0.	0.	0.	0.	0.
3	1.74822E+00	1.86523E+00	2.60744E+00	3.27284E+00	4.03317E+00	4.58288E+00	4.66794E+00	4.70013E+00
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	1.15181E+00	1.39772E+00	1.78404E+00	2.58174E+00	3.54330E+00	4.23843E+00	3.95458E+00	4.39925E+00
9	0.	5.73891E-01	4.67502E-01	8.23402E-01	6.91103E-01	4.89878E-01	3.44446E-01	7.13354E-01
10	0.	0.	1.26152E-02	0.	0.	0.	0.	0.
11	0.	0.	0.	6.73849E-03	0.	0.	0.	0.
12	0.	0.	0.	0.	1.82316E-03	0.	0.	0.
13	0.	0.	0.	0.	0.	1.30155E-04	0.	0.
14	0.	0.	0.	0.	0.	0.	1.35221E-06	0.
15	0.	0.	0.	0.	0.	0.	0.	3.61640E-06
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13	14	15	16
1	4.05360E-05	1.09464E-04	2.87078E-04	6.37404E-04	1.23106E-03	1.81954E-03	2.68126E-03	5.03410E-03
2	0.	0.	0.	0.	0.	0.	0.	0.
3	4.70988E+00	4.71009E+00	4.71027E+00	4.63861E+00	4.67729E+00	4.77439E+00	4.88181E+00	4.49787E+00
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	1.99973E-06	3.80962E-03	0.	0.	0.
6	0.	0.	0.	3.55670E-05	1.02857E-02	3.27081E-02	0.	0.
7	0.	0.	0.	5.56650E-02	1.51038E-01	1.54588E-01	1.34455E-01	0.
8	4.40621E+00	4.40208E+00	4.31294E+00	4.37024E+00	4.25701E+00	4.41158E+00	4.67185E+00	4.32186E+00
9	3.00859E-01	3.03628E-01	3.07905E-01	3.97040E-01	2.57816E-01	2.96708E-01	1.89898E-01	4.24068E-02
10	0.	0.	0.	0.	0.	8.35756E-03	5.80758E-02	2.00273E-02
11	0.	0.	0.	0.	0.	0.	1.37451E-03	8.59834E-03
12	0.	0.	0.	0.	0.	0.	0.	1.90785E-04
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.

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TABLE 3-5 (Continued)

MICROSCOPIC NEUTRON CROSS SECTIONS FOR COMP. ELEMENT NO. 3

P(10) TRANSPORT CROSS SECTION SET

	1	2	3	4	5	6	7	8
1	1.30071E+00	1.34231E+00	1.32216E+00	1.34446E+00	1.70506E+00	3.03262E+00	5.53547E+00	1.02758E+01
2	3.84581E+00	3.41445E+00	3.13771E+00	2.96691E+00	3.43988E+00	5.51238E+00	1.02005E+01	1.71158E+01
3	8.18786E+00	7.12190E+00	6.78324E+00	7.68654E+00	1.04588E+01	1.33022E+01	1.60357E+01	2.07762E+01
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	4.97725E+00	4.20662E+00	4.28206E+00	5.27002E+00	8.37999E+00	1.02239E+01	1.04143E+01	1.04644E+01
9	0.	3.45864E-01	3.96096E-01	7.16801E-01	8.87079E-01	3.62629E-01	4.52774E-02	8.59256E-02
10	0.	0.	4.78045E-01	6.90159E-01	3.57038E-01	1.67535E-01	8.60490E-03	3.57317E-04
11	0.	0.	0.	6.47037E-01	4.30785E-01	9.91356E-02	1.13768E-02	2.46053E-03
12	0.	0.	0.	0.	3.84366E-01	5.46842E-02	3.95334E-03	5.92024E-03
13	0.	0.	0.	0.	0.	5.34368E-02	1.07732E-03	2.04172E-03
14	0.	0.	0.	0.	0.	0.	1.00289E-03	1.70636E-04
15	0.	0.	0.	0.	0.	0.	0.	1.57937E-04
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13	14	15	16
1	2.65803E+01	6.39701E+01	4.68176E+01	8.15658E+01	2.25223E+02	3.16489E+02	5.14397E+02	1.04326E+03
2	4.31482E+01	9.49766E+01	6.66190E+01	1.69331E+02	4.52113E+02	6.55581E+02	1.06560E+03	2.16105E+03
3	3.70808E+01	7.67021E+01	5.84916E+01	9.25658E+01	2.36223E+02	3.27489E+02	5.25397E+02	1.05426E+03
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	1.04641E+01	1.26870E+01	1.16740E+01	1.10000E+01	1.10000E+01	1.10000E+01	1.10000E+01	1.10000E+01
9	3.60005E-02	3.63432E-02	4.50450E-02	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	6.11900E-06	0.	0.	0.	0.	0.	0.	0.
12	6.46137E-05	3.32348E-07	0.	0.	0.	0.	0.	0.
13	1.52111E-04	0.	8.13478E-07	0.	0.	0.	0.	0.
14	5.50465E-05	0.	0.	0.	0.	0.	0.	0.
15	1.93950E-06	0.	0.	0.	0.	0.	0.	0.
16	1.79013E-06	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.



TABLE 3-5 (Continued)

MACROSCOPIC NEUTRON CROSS SECTIONS FOR COMP. NO. 1

P(0) TRANSPORT CROSS SECTION SET

	1	2	3	4	5	6	7	8
1	5.47311E-03	5.50490E-03	5.42239E-03	5.51406E-03	6.99780E-03	1.24503E-02	2.27157E-02	4.21375E-02
2	1.57678E-02	1.39993E-02	1.28646E-02	1.21643E-02	1.41035E-02	2.26007E-02	4.18219E-02	7.01747E-02
3	1.46541E-01	1.52592E-01	1.96742E-01	2.43050E-01	3.01888E-01	3.47292E-01	3.51015E-01	3.72428E-01
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	9.47643E-02	1.11071E-01	1.35039E-01	1.90239E-01	2.63028E-01	3.13867E-01	2.84609E-01	3.11939E-01
9	0.	3.74421E-02	3.08250E-02	5.40335E-02	4.65389E-02	3.18157E-02	2.09729E-02	4.36911E-02
10	0.	0.	3.21584E-03	3.15739E-03	1.81556E-03	6.86894E-04	3.52801E-05	1.46500E-06
11	0.	0.	0.	3.56791E-03	1.80440E-03	4.06456E-04	4.66451E-05	1.00882E-05
12	0.	0.	0.	0.	1.84560E-03	2.24205E-04	1.62087E-05	2.42730E-05
13	0.	0.	0.	0.	0.	2.26900E-04	4.41700E-06	8.37107E-06
14	0.	0.	0.	0.	0.	0.	4.19297E-06	6.99607E-07
15	0.	0.	0.	0.	0.	0.	0.	8.64527E-07
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13	14	15	16
1	1.08991E-01	2.62309E-01	1.92035E-01	3.34616E-01	9.23793E-01	1.29816E+00	2.10984E+00	4.27890E+00
2	1.76908E-01	3.89404E-01	2.73138E-01	6.94257E-01	1.85366E+00	2.68788E+00	4.36897E+00	8.86031E+00
3	4.39850E-01	6.02327E-01	5.27714E-01	6.63174E-01	1.25464E+00	1.63479E+00	2.45287E+00	4.59875E+00
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	1.19984E-07	2.28577E-04	0.	0.	0.
6	0.	0.	0.	2.13402E-06	6.17142E-04	1.96248E-03	0.	0.
7	0.	0.	0.	3.33990E-03	9.06228E-03	9.27530E-03	8.06727E-03	0.
8	3.12339E-01	3.21202E-01	3.11656E-01	3.12494E-01	3.05701E-01	3.14975E-01	3.30591E-01	3.09592E-01
9	1.83516E-02	1.85206E-02	1.88148E-02	2.40238E-02	1.54690E-02	1.78025E-02	1.13939E-02	2.54441E-03
10	0.	0.	0.	0.	0.	5.01454E-04	3.48455E-03	1.20164E-03
11	2.50879E-08	0.	0.	0.	0.	0.	8.24703E-05	5.15900E-04
12	2.64916E-07	1.36263E-09	0.	0.	0.	0.	0.	1.14471E-05
13	6.23654E-07	0.	3.33526E-09	0.	0.	0.	0.	0.
14	2.25691E-07	0.	0.	0.	0.	0.	0.	0.
15	7.95196E-09	0.	0.	0.	0.	0.	0.	0.
16	7.33954E-09	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.

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TABLE 3-5 (Continued)

MICROSCOPIC PHOTON CROSS SECTIONS FOR COMP. ELEMENT NO. 1

P(0) TRANSPORT CROSS SECTION SET

	1	2	3	4	5	6	7	8
1	7.86496E-01	7.89909E-01	7.99520E-01	8.16765E-01	8.46857E-01	8.90884E-01	9.35942E-01	9.74688E-01
2	0.	0.	0.	0.	0.	0.	0.	0.
3	1.08912E+00	1.11358E+00	1.15808E+00	1.22633E+00	1.33553E+00	1.48622E+00	1.63625E+00	1.76513E+00
4	1.76577E-02	1.47680E-02	3.00073E-02	4.60249E-02	5.97462E-02	1.03701E-01	7.31689E-02	9.81881E-02
5	0.	2.48796E-02	5.67081E-02	6.99221E-02	9.29598E-02	1.39104E-01	9.36989E-02	1.45736E-01
6	0.	0.	4.49212E-02	4.88571E-02	5.89435E-02	7.58365E-02	4.61940E-02	8.12824E-02
7	0.	0.	0.	3.92090E-02	4.22278E-02	5.00012E-02	2.64212E-02	4.17156E-02
8	0.	0.	0.	0.	3.43872E-02	3.68330E-02	1.79605E-02	2.45726E-02
9	0.	0.	0.	0.	0.	3.04655E-02	1.35045E-02	1.69997E-02
10	0.	0.	0.	0.	0.	0.	1.12940E-02	1.29273E-02
11	0.	0.	0.	0.	0.	0.	0.	1.08756E-02
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13
1	1.02510E+00	1.09529E+00	1.18210E+00	1.27029E+00	1.39568E+00
2	0.	0.	0.	0.	0.
3	1.93603E+00	2.19956E+00	2.60469E+00	3.43804E+00	4.75998E+00
4	1.41575E-01	2.30566E-01	4.45235E-01	1.17998E+00	3.36430E+00
5	1.92706E-01	2.92014E-01	4.39841E-01	7.53554E-01	9.87770E-01
6	1.21847E-01	1.72056E-01	2.14120E-01	3.22792E-01	2.23803E-01
7	7.05826E-02	1.13397E-01	1.35490E-01	1.97408E-01	1.11070E-01
8	3.78734E-02	6.88600E-02	9.42587E-02	1.46689E-01	6.58185E-02
9	2.29940E-02	3.88575E-02	6.04773E-02	1.18958E-01	4.53086E-02
10	1.61827E-02	2.43439E-02	3.59614E-02	9.49947E-02	3.29461E-02
11	1.24384E-02	1.74241E-02	2.32051E-02	7.61487E-02	2.17431E-02
12	1.05222E-02	1.35299E-02	1.68586E-02	6.48166E-02	1.30714E-02
13	0.	1.15045E-02	1.32047E-02	5.82074E-02	8.39178E-03
14	0.	0.	1.12760E-02	5.39725E-02	6.04807E-03
15	0.	0.	0.	5.16333E-02	4.70223E-03
16	0.	0.	0.	0.	3.99553E-03

TABLE 3-5 (Continued)

MICROSCOPIC PHOTON CROSS SECTIONS FOR COMP. ELEMENT NO. 2

P(0) TRANSPORT CROSS SECTION SET

	1	2	3	4	5	6	7	8
1	3.00633E-01	3.07243E-01	3.18600E-01	3.35288E-01	3.60436E-01	3.92105E-01	4.20779E-01	4.43018E-01
2	0.	0.	0.	0.	0.	0.	0.	0.
3	4.30988E-01	4.47215E-01	4.74532E-01	5.14727E-01	5.76790E-01	6.58895E-01	7.37553E-01	8.02757E-01
4	8.14973E-03	6.81599E-03	1.38495E-02	2.12423E-02	2.75752E-02	4.78619E-02	3.37703E-02	4.53176E-02
5	0.	1.14829E-02	2.61730E-02	3.22717E-02	4.29045E-02	6.42020E-02	4.32456E-02	6.72628E-02
6	0.	0.	2.07329E-02	2.25494E-02	2.72047E-02	3.50015E-02	2.13203E-02	3.75150E-02
7	0.	0.	0.	1.80965E-02	1.94897E-02	2.30775E-02	1.21944E-02	1.92533E-02
8	0.	0.	0.	0.	1.58710E-02	1.69998E-02	8.28946E-03	1.13412E-02
9	0.	0.	0.	0.	0.	1.40610E-02	6.23283E-03	7.84599E-03
10	0.	0.	0.	0.	0.	0.	5.21259E-03	5.96644E-03
11	0.	0.	0.	0.	0.	0.	0.	5.01951E-03
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13
1	4.69588E-01	5.04815E-01	5.45584E-01	5.84779E-01	6.18374E-01
2	0.	0.	0.	0.	0.
3	8.86373E-01	1.01335E+00	1.20217E+00	1.58528E+00	2.17113E+00
4	6.53424E-02	1.06415E-01	2.05493E-01	5.44608E-01	1.55276E+00
5	8.89412E-02	1.34776E-01	2.03004E-01	3.47794E-01	4.55894E-01
6	5.62371E-02	7.94106E-02	9.88245E-02	1.47856E-01	1.03294E-01
7	3.25766E-02	5.23370E-02	6.25340E-02	8.74643E-02	5.12630E-02
8	1.74800E-02	3.17816E-02	4.35040E-02	6.26236E-02	3.03778E-02
9	1.06126E-02	1.79343E-02	2.79126E-02	4.84576E-02	2.09117E-02
10	7.46892E-03	1.12356E-02	1.65975E-02	3.58606E-02	1.52059E-02
11	5.74080E-03	8.04190E-03	1.07101E-02	2.59584E-02	1.00353E-02
12	4.85638E-03	6.24455E-03	7.78091E-03	2.03239E-02	6.03297E-03
13	0.	5.30978E-03	6.09449E-03	1.73100E-02	3.87313E-03
14	0.	0.	5.20430E-03	1.54944E-02	2.79142E-03
15	0.	0.	0.	1.45149E-02	2.17026E-03
16	0.	0.	0.	0.	1.84409E-03

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TABLE 3-5 (Continued)

MICROSCOPIC PHOTON CROSS SECTIONS FOR COMP. ELEMENT NO. 3

P(0) TRANSPORT CROSS SECTION SET

	1	2	3	4	5	6	7	8
1	1.52449E+01	1.47085E+01	1.40156E+01	1.32008E+01	1.22284E+01	1.13870E+01	1.09453E+01	1.09028E+01
2	0.	0.	0.	0.	0.	0.	0.	0.
3	1.87667E+01	1.84162E+01	1.80285E+01	1.76442E+01	1.72846E+01	1.71742E+01	1.73532E+01	1.77750E+01
4	1.24963E-01	1.04512E-01	2.12359E-01	3.25715E-01	4.22819E-01	7.33883E-01	5.17811E-01	6.94870E-01
5	0.	1.76071E-01	4.01319E-01	4.94833E-01	6.57870E-01	9.84431E-01	6.63100E-01	1.03136E+00
6	0.	0.	3.17904E-01	3.45758E-01	4.17139E-01	5.36689E-01	3.26911E-01	5.75230E-01
7	0.	0.	0.	2.77479E-01	2.98843E-01	3.53855E-01	1.86981E-01	2.95218E-01
8	0.	0.	0.	0.	2.43355E-01	2.60864E-01	1.27105E-01	1.73898E-01
9	0.	0.	0.	0.	0.	2.15602E-01	9.55700E-02	1.20305E-01
10	0.	0.	0.	0.	0.	0.	7.99265E-02	9.14854E-02
11	0.	0.	0.	0.	0.	0.	0.	7.69658E-02
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13
1	1.13025E+01	1.26927E+01	1.70514E+01	4.17161E+01	2.64441E+02
2	0.	0.	0.	0.	0.
3	1.87954E+01	2.08922E+01	2.71190E+01	5.70571E+01	2.88250E+02
4	1.80192E+00	1.63170E+00	3.15090E+00	8.35066E+00	2.38089E+01
5	1.36377E+00	2.06656E+00	3.11272E+00	5.33284E+00	6.99037E+00
6	8.62302E-01	1.21763E+00	1.51531E+00	2.66913E+00	1.58384E+00
7	4.99507E-01	8.02500E-01	9.58855E-01	2.44334E+00	7.86032E-01
8	2.68027E-01	4.87317E-01	6.67061E-01	2.31636E+00	4.65792E-01
9	1.62727E-01	2.74992E-01	4.27993E-01	2.29375E+00	3.20646E-01
10	1.14523E-01	1.72280E-01	2.54496E-01	2.24627E+00	2.33157E-01
11	8.80257E-02	1.23309E-01	1.64221E-01	2.13676E+00	1.53874E-01
12	7.44645E-02	9.57498E-02	1.19307E-01	2.00363E+00	9.25056E-02
13	0.	8.14166E-02	9.34489E-02	1.88743E+00	5.93880E-02
14	0.	0.	7.97993E-02	1.79905E+00	4.28017E-02
15	0.	0.	0.	1.74554E+00	3.32773E-02
16	0.	0.	0.	0.	2.82760E-02

TABLE 3-5 (Continued)

MACROSCOPIC PHOTON CROSS SECTIONS FOR COMP. NO. 1

P(0) TRANSPORT CROSS SECTION SET

	1	2	3	4	5	6	7	8
1	8.34522E-02	8.16620E-02	7.95381E-02	7.72627E-02	7.48961E-02	7.35093E-02	7.35854E-02	7.48891E-02
2	0.	0.	0.	0.	0.	0.	0.	0.
3	1.06832E-01	1.06459E-01	1.06674E-01	1.07762E-01	1.10416E-01	1.15447E-01	1.21456E-01	1.27574E-01
4	1.06666E-03	8.92099E-04	1.81267E-03	2.78026E-03	3.60913E-03	6.26433E-03	4.41996E-03	5.93132E-03
5	0.	1.50292E-03	3.42561E-03	4.22383E-03	5.61549E-03	8.40298E-03	5.66013E-03	8.80357E-03
6	0.	0.	2.71359E-03	2.95134E-03	3.56064E-03	4.58111E-03	2.79047E-03	4.91008E-03
7	0.	0.	0.	2.36853E-03	2.55088E-03	3.02046E-03	1.59605E-03	2.51994E-03
8	0.	0.	0.	0.	2.07725E-03	2.22500E-03	1.08495E-03	1.48437E-03
9	0.	0.	0.	0.	0.	1.84035E-03	8.15773E-04	1.02691E-03
10	0.	0.	0.	0.	0.	0.	6.82242E-04	7.80908E-04
11	0.	0.	0.	0.	0.	0.	0.	6.56970E-04
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13
1	7.83084E-02	8.63814E-02	1.07020E-01	2.10823E-01	1.12648E+00
2	0.	0.	0.	0.	0.
3	1.37407E-01	1.54598E-01	1.92955E-01	3.41772E-01	1.32971E+00
4	8.55223E-03	1.39279E-02	2.68956E-02	7.12802E-02	2.03230E-01
5	1.16409E-02	1.76399E-02	2.65698E-02	4.55204E-02	5.96689E-02
6	7.36050E-03	1.03935E-02	1.29345E-02	2.10091E-02	1.35194E-02
7	4.26373E-03	6.85004E-03	8.18466E-03	1.59959E-02	6.70947E-03
8	2.24784E-03	4.15968E-03	5.69395E-03	1.37972E-02	3.97594E-03
9	1.38901E-03	2.34729E-03	3.65329E-03	1.27520E-02	2.73699E-03
10	9.77557E-04	1.47056E-03	2.17234E-03	1.17128E-02	1.99020E-03
11	7.51376E-04	1.05255E-03	1.40177E-03	1.06000E-02	1.31345E-03
12	6.35620E-04	8.17307E-04	1.01839E-03	9.67414E-03	7.89616E-04
13	0.	6.94961E-04	7.97667E-04	8.99243E-03	5.06928E-04
14	0.	0.	6.81157E-04	8.50545E-03	3.65350E-04
15	0.	0.	0.	8.21863E-03	2.84051E-04
16	0.	0.	0.	0.	2.41361E-04

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TABLE 3-5 (Continued)

COUPLED MACROSCOPIC NEUTRON-PHOTON CROSS SECTIONS FOR COMP. NO. 1

P(10) TRANSPORT CROSS SECTION SET

TAPE IDENTIFICATION NO. 1

	1	2	3	4	5	6	7	8
1	5.47311E-03	5.50490E-03	5.42239E-03	5.51406E-03	6.99780E-03	1.24503E-02	2.27157E-02	4.21375E-02
2	1.57678E-02	1.39993E-02	1.28646E-02	1.21643E-02	1.41035E-02	2.26007E-02	4.18219E-02	7.01747E-02
3	1.46541E-01	1.52592E-01	1.96742E-01	2.43050E-01	3.01888E-01	3.47292E-01	3.51015E-01	3.72428E-01
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	9.47643E-02	1.11071E-01	1.35039E-01	1.90239E-01	2.63028E-01	3.13867E-01	2.84609E-01	3.11939E-01
9	0.	3.74421E-02	3.08250E-02	5.40335E-02	4.65389E-02	3.18157E-02	2.09729E-02	4.76911E-02
10	0.	0.	3.21584E-03	3.15739E-03	1.81556E-03	6.86894E-04	3.52801E-05	1.46500E-06
11	0.	0.	0.	3.56791E-03	1.80440E-03	4.06456E-04	4.66451E-05	1.00882E-05
12	0.	0.	0.	0.	1.84560E-03	2.24205E-04	1.62087E-05	2.42730E-05
13	0.	0.	0.	0.	0.	2.26900E-04	4.41700E-06	8.37107E-06
14	0.	0.	0.	0.	0.	0.	4.19297E-06	6.99607E-07
15	0.	0.	0.	0.	0.	0.	0.	8.64527E-07
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.	0.	0.	0.
26	0.	0.	0.	0.	0.	0.	0.	0.
27	0.	0.	0.	0.	0.	0.	0.	0.
28	0.	0.	0.	0.	0.	0.	0.	0.
29	0.	0.	0.	0.	0.	0.	0.	0.
30	0.	0.	0.	0.	0.	0.	0.	0.
31	0.	0.	0.	0.	0.	0.	0.	0.
32	0.	0.	0.	0.	0.	0.	0.	0.
33	0.	0.	0.	0.	0.	0.	0.	0.
34	0.	0.	0.	0.	0.	0.	0.	0.
35	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 3-5 (Continued)

36	0.	0.	0.	0.	0.	0.	0.	0.
	<sup>9</sup>	<sup>10</sup>	<sup>11</sup>	<sup>12</sup>	<sup>13</sup>	<sup>14</sup>	<sup>15</sup>	<sup>16</sup>
1	1.08991E-01	2.62309E-01	1.92035E-01	3.34616E-01	9.23793E-01	1.29816E+00	2.10984E+00	4.27890E+00
2	1.76908E-01	3.89404E-01	2.73138E-01	6.94257E-01	1.85366E+00	2.68788E+00	4.36897E+00	8.86031E+00
3	4.39850E-01	6.02327E-01	5.27714E-01	6.63174E-01	1.25464E+00	1.63479E+00	2.45287E+00	4.59875E+00
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	1.19984E-07	2.28577E-04	0.	0.	0.
6	0.	0.	0.	2.13402E-06	6.17142E-04	1.96248E-03	0.	0.
7	0.	0.	0.	3.33990E-03	9.06228E-03	9.27530E-03	8.06727E-03	0.
8	3.12339E-01	3.21202E-01	3.11656E-01	3.12494E-01	3.05701E-01	3.14975E-01	3.30591E-01	3.09592E-01
9	1.83516E-02	1.85206E-02	1.88148E-02	2.40238E-02	1.54690E-02	1.78025E-02	1.13939E-02	2.54441E-03
10	0.	0.	0.	0.	0.	5.01454E-04	3.48455E-03	1.20164E-03
11	2.50879E-08	0.	0.	0.	0.	0.	8.24703E-05	5.15900E-04
12	2.64916E-07	1.36263E-09	0.	0.	0.	0.	0.	1.14471E-05
13	6.23654E-07	0.	3.33526E-09	0.	0.	0.	0.	0.
14	2.25691E-07	0.	0.	0.	0.	0.	0.	0.
15	7.95196E-09	0.	0.	0.	0.	0.	0.	0.
16	7.33954E-09	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.	0.	0.	0.
26	0.	0.	0.	0.	0.	0.	0.	0.
27	0.	0.	0.	0.	0.	0.	0.	0.
28	0.	0.	0.	0.	0.	0.	0.	0.
29	0.	0.	0.	0.	0.	0.	0.	0.
30	0.	0.	0.	0.	0.	0.	0.	0.
31	0.	0.	0.	0.	0.	0.	0.	0.
32	0.	0.	0.	0.	0.	0.	0.	0.
33	0.	0.	0.	0.	0.	0.	0.	0.
34	0.	0.	0.	0.	0.	0.	0.	0.
35	0.	0.	0.	0.	0.	0.	0.	0.
36	0.	0.	0.	0.	0.	0.	0.	0.
	<sup>17</sup>	<sup>18</sup>	<sup>19</sup>	<sup>20</sup>	<sup>21</sup>	<sup>22</sup>	<sup>23</sup>	<sup>24</sup>
1	8.34522E-02	8.16620E-02	7.95381E-02	7.72627E-02	7.48961E-02	7.35093E-02	7.35854E-02	7.48891E-02
2	0.	0.	0.	0.	0.	0.	0.	0.
3	1.06832E-01	1.06459E-01	1.06674E-01	1.07762E-01	1.10416E-01	1.15447E-01	1.21456E-01	1.27574E-01
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 3-5 (Continued)

7	0.	0.	0.	0.	0.	0.	0.	0.
8	1.06666E-03	8.92099E-04	1.81267E-03	2.78026E-03	3.60913E-03	6.26433E-03	4.41996E-03	5.93132E-03
9	1.30424E-02	1.50292E-03	3.42561E-03	4.22383E-03	5.61549E-03	8.40298E-03	5.66013E-03	8.80357E-03
10	6.52004E-03	5.47230E-02	2.71359E-03	2.95134E-03	3.56064E-03	4.58111E-03	2.79047E-03	4.91008E-03
11	4.09448E-03	2.69887E-02	2.00277E-01	2.36853E-03	2.55088E-03	3.02046E-03	1.59605E-03	2.51994E-03
12	2.81596E-03	1.66087E-02	9.87681E-02	5.93017E-01	2.07725E-03	2.22500E-03	1.08495E-03	1.48437E-03
13	1.13134E-03	1.14535E-02	6.07932E-02	2.92428E-01	1.89030E+00	1.84035E-03	8.15773E-04	1.02691E-03
14	4.51503E-04	4.29403E-03	4.43471E-02	1.79932E-01	9.32169E-01	4.46603E+00	6.82242E-04	7.60905E-04
15	5.24374E-04	1.68974E-03	1.56588E-02	1.25565E-01	5.73596E-01	2.20218E+00	2.87021E+00	6.56970E-04
16	2.34212E-04	2.40228E-03	1.12905E-02	4.64537E-02	4.01503E-01	1.35492E+00	1.41527E+00	3.94296E+00
17	9.68343E-05	1.09114E-03	1.50987E-02	2.14066E-02	1.48082E-01	9.47518E-01	8.70747E-01	1.94420E+00
18	8.59698E-05	4.33011E-04	5.99426E-03	2.99009E-02	7.08365E-02	3.49673E-01	6.09685E-01	1.13614E+00
19	5.68055E-05	2.59559E-04	2.28560E-03	1.30559E-02	9.84828E-02	1.65334E-01	2.24684E-01	8.37970E-01
20	2.95613E-05	1.40652E-04	1.16488E-03	5.12269E-03	4.26193E-02	2.30397E-01	1.07835E-01	3.08629E-01
21	1.77118E-05	8.67564E-05	6.47175E-04	2.93387E-03	1.66789E-02	9.99903E-02	1.50047E-01	1.49054E-01
22	1.78228E-05	7.32368E-05	3.39170E-04	1.59531E-03	9.45446E-03	3.91587E-02	6.48908E-02	2.07279E-01
23	1.83713E-05	7.57981E-05	2.50123E-04	9.49672E-04	5.14658E-03	2.22379E-02	2.53867E-02	8.95114E-02
24	4.82782E-04	7.94595E-05	2.34512E-04	7.82610E-04	3.03536E-03	1.20909E-02	1.43564E-02	3.50033E-02
25	0.	2.03520E-04	2.30480E-04	7.95329E-04	2.48420E-03	7.15741E-03	7.80950E-03	1.97564E-02
26	0.	0.	8.40388E-04	8.24505E-04	2.51213E-03	5.87840E-03	4.60591E-03	1.07477E-02
27	0.	0.	0.	1.69581E-03	2.59630E-03	5.95440E-03	3.77260E-03	6.32954E-03
28	0.	0.	0.	0.	1.53615E-02	6.16027E-03	3.81373E-03	5.17932E-03
29	0.	0.	0.	0.	0.	7.35441E-03	3.94643E-03	5.23140E-03
30	0.	0.	0.	0.	0.	0.	5.10732E-03	5.73710E-03
31	0.	0.	0.	0.	0.	0.	0.	7.65591E-03
32	0.	0.	0.	0.	0.	0.	0.	0.
33	0.	0.	0.	0.	0.	0.	0.	0.
34	0.	0.	0.	0.	0.	0.	0.	0.
35	0.	0.	0.	0.	0.	0.	0.	0.
36	0.	0.	0.	0.	0.	0.	0.	0.

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	25	26	27	28	29
1	7.83084E-02	8.63814E-02	1.07020E-01	2.10823E-01	1.12648E+00
2	0.	0.	0.	0.	0.
3	1.37407E-01	1.54598E-01	1.92955E-01	3.41772E-01	1.32971E+00
4	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.
8	8.55223E-03	1.39279E-02	2.68956E-02	7.12802E-02	2.03230E-01
9	1.16409E-02	1.76399E-02	2.95698E-02	4.55204E-02	5.96689E-02
10	7.36050E-03	1.03935E-02	1.29345E-02	2.10091E-02	1.35194E-02
11	4.26373E-03	6.85004E-03	8.18466E-03	1.59959E-02	6.70947E-03
12	2.28784E-03	4.15968E-03	5.69395E-03	1.37972E-02	3.97594E-03
13	1.38901E-03	2.34729E-03	3.65329E-03	1.27520E-02	2.73699E-03
14	9.77557E-04	1.47056E-03	2.17234E-03	1.17128E-02	1.99020E-03
15	7.51376E-04	1.05255E-03	1.40177E-03	1.06000E-02	1.31345E-03



TABLE 3-5 (Continued)

16	6.35620E-04	8.17307E-04	1.01839E-03	9.67414E-03	7.89616E-04
17	5.08029E+00	6.94961E-04	7.97667E-04	8.99243E-03	5.06928E-04
18	2.50500E+00	7.04908E+00	6.81157E-04	8.50545E-03	3.65350E-04
19	1.54119E+00	3.47587E+00	9.46792E+00	8.21863E-03	2.84051E-04
20	1.07925E+00	2.13859E+00	4.66845E+00	1.27463E+01	2.41361E-04
21	3.97657E-01	1.49731E+00	2.87223E+00	6.28493E+00	5.85604E+00
22	1.91133E-01	5.51885E-01	2.01388E+00	3.86677E+00	2.88751E+00
23	2.65942E-01	2.64654E-01	7.41021E-01	2.71501E+00	1.77651E+00
24	1.14974E-01	3.68210E-01	3.61521E-01	9.97499E-01	1.24254E+00
25	4.49747E-02	1.59267E-01	5.02205E-01	4.94730E-01	4.58408E-01
26	2.54156E-02	6.23147E-02	2.16361E-01	6.86037E-01	2.17153E-01
27	1.38232E-02	3.52654E-02	8.45488E-02	2.94433E-01	3.02646E-01
28	8.15104E-03	1.91894E-02	4.75846E-02	1.14930E-01	1.31292E-01
29	6.67647E-03	1.13168E-02	2.58946E-02	6.43973E-02	5.14085E-02
30	6.74806E-03	9.26622E-03	1.52113E-02	3.50999E-02	2.91621E-02
31	7.38120E-03	9.57110E-03	1.25786E-02	2.10254E-02	1.59091E-02
32	1.01433E-02	1.11703E-02	1.36863E-02	1.79118E-02	1.02915E-02
33	0.	1.49922E-02	1.69281E-02	2.00489E-02	9.04976E-03
34	0.	0.	2.00889E-02	2.32392E-02	9.18962E-03
35	0.	0.	0.	2.44544E-02	9.96689E-03
36	0.	0.	0.	0.	9.83039E-03



TABLE 3-5 (Continued)

MICROSCOPIC NEUTRON CROSS SECTIONS FOR COMP. ELEMENT NO. 1

P(1) TRANSPORT CROSS SECTION SET

	1	2	3	4	5	6	7	8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	6.71847E-02	6.61602E-02	8.08015E-02	2.80794E-01	2.55192E-01	2.78901E-02	1.31357E-01	2.15701E-02
9	0.	-6.71847E-02	-6.61602E-02	-8.08015E-02	-2.80794E-01	-2.55192E-01	-2.78901E-02	-1.31357E-01
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13	14	15	16
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	4.02268E-02	3.99824E-02	5.17040E-02	0.	0.	0.	0.	0.
9	-2.15701E-02	-4.02268E-02	-3.99824E-02	-5.17040E-02	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 3-5 (Continued)

MICROSCOPIC NEUTRON CROSS SECTIONS FOR COMP. ELEMENT NO. 2

P(1) TRANSPORT CROSS SECTION SET

	1	2	3	4	5	6	7	8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	8.29507E-01	3.39112E-01	5.64956E-01	4.92884E-01	3.71120E-01	2.84051E-01	5.80535E-01	1.56862E-01
9	0.	-8.29507E-01	-3.39112E-01	-5.64956E-01	-4.92884E-01	-3.71120E-01	-2.84051E-01	-5.80535E-01
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.
	9	10	11	12	13	14	15	16
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	-2.14975E-06	-2.03047E-03	0.	0.	0.
6	0.	0.	0.	-3.69961E-05	-8.24900E-03	-2.04017E-02	0.	0.
7	0.	0.	0.	-2.84424E-02	-1.18461E-01	-1.29536E-01	-1.01726E-01	0.
8	2.77536E-01	2.74645E-01	3.52500E-01	2.38959E-01	3.23752E-01	2.89895E-01	1.68650E-01	1.24159E-01
9	-1.56862E-01	-2.77536E-01	-2.74645E-01	-3.52500E-01	-2.27580E-01	-2.45356E-01	-1.59517E-01	-3.08626E-02
10	0.	0.	0.	0.	0.	-9.95128E-03	-4.54741E-02	-1.18810E-02
11	0.	0.	0.	0.	0.	0.	-1.33449E-03	-4.47886E-03
12	0.	0.	0.	0.	0.	0.	0.	-9.33778E-05
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.

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TABLE 3-5 (Continued)

MICROSCOPIC NEUTRON CROSS SECTIONS FOR COMP. ELEMENT NO. 3

P(1) TRANSPORT CROSS SECTION SET

	1	2	3	4	5	6	7	8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	2.11312E+00	7.08545E-01	1.08981E+00	7.39779E-01	1.80775E-01	8.45475E-02	6.67588E-02	1.82056E-02
9	0.	-2.11312E+00	-7.08545E-01	-1.08981E+00	-7.39779E-01	-1.80775E-01	-8.45475E-02	-6.67588E-02
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13	14	15	16
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	3.39547E-02	3.80481E-02	0.	0.	0.	0.	0.	0.
9	-1.82056E-02	-3.39547E-02	-3.80481E-02	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 3-5 (Continued)

MACROSCOPIC NEUTRON CROSS SECTIONS FOR COMP. NO. 2

P(1) TRANSPORT CROSS SECTION SET

	1	2	3	4	5	6	7	8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	5.86828E-02	2.34966E-02	3.86645E-02	3.36451E-02	2.39526E-02	1.74929E-02	3.55919E-02	9.56620E-03
9	0.	-5.86828E-02	-2.34966E-02	-3.86645E-02	-3.36451E-02	-2.39526E-02	-1.74929E-02	-3.55919E-02
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13	14	15	16
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	-1.28985E-07	-1.21828E-04	0.	0.	0.
6	0.	0.	0.	-2.21977E-06	-4.94940E-04	-1.22410E-03	0.	0.
7	0.	0.	0.	-1.70655E-03	-7.10765E-03	-7.77215E-03	-6.10358E-03	0.
8	1.69402E-02	1.67826E-02	2.13413E-02	1.43375E-02	1.94251E-02	1.73937E-02	1.01190E-02	7.44951E-03
9	-9.56620E-03	-1.69402E-02	-1.67826E-02	-2.13413E-02	-1.36548E-02	-1.47214E-02	-9.57100E-03	-1.85176E-03
10	0.	0.	0.	0.	0.	-5.97077E-04	-2.72845E-03	-7.12858E-04
11	0.	0.	0.	0.	0.	0.	-8.00694E-05	-2.68732E-04
12	0.	0.	0.	0.	0.	0.	0.	-5.60267E-06
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.

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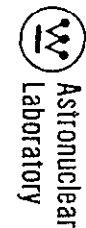


TABLE 3-5 (Continued)

MICROSCOPIC PHOTON CROSS SECTIONS FOR COMP. ELEMENT NO. 1

P(1) TRANSPORT CROSS SECTION SET

	1	2	3	4	5	6	7	8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	5.28483E-02	4.42353E-02	8.96987E-02	1.37381E-01	1.77987E-01	3.07306E-01	2.17733E-01	2.91354E-01
5	0.	7.42556E-02	1.68767E-01	2.07117E-01	2.73539E-01	4.05484E-01	2.72603E-01	4.24774E-01
6	0.	0.	1.32972E-01	1.43300E-01	1.70923E-01	2.15699E-01	1.29582E-01	2.29007E-01
7	0.	0.	0.	1.14375E-01	1.21224E-01	1.40070E-01	7.22645E-02	1.13192E-01
8	0.	0.	0.	0.	9.81638E-02	1.02110E-01	4.83595E-02	6.49537E-02
9	0.	0.	0.	0.	0.	8.39651E-02	3.59724E-02	4.42127E-02
10	0.	0.	0.	0.	0.	0.	2.99028E-02	3.32491E-02
11	0.	0.	0.	0.	0.	0.	0.	2.77972E-02
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13
1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.
4	4.18029E-01	6.72778E-01	1.26427E+00	2.95773E+00	3.80161E+00
5	5.55220E-01	8.19383E-01	1.16657E+00	1.56123E+00	3.20350E-01
6	3.39515E-01	4.59880E-01	5.16174E-01	5.02152E-01	-2.00452E-01
7	1.89766E-01	2.92282E-01	3.08331E-01	2.40591E-01	-1.28630E-01
8	9.78916E-02	1.70672E-01	2.05395E-01	1.48076E-01	-8.53475E-02
9	5.78211E-02	9.22658E-02	1.25693E-01	9.95643E-02	-6.22584E-02
10	4.00043E-02	5.60914E-02	7.09807E-02	6.05732E-02	-4.70954E-02
11	3.03903E-02	3.94033E-02	4.41626E-02	3.33941E-02	-3.23414E-02
12	2.55389E-02	3.02063E-02	3.13618E-02	2.01666E-02	-2.02290E-02
13	0.	2.54986E-02	2.41827E-02	1.39819E-02	-1.33303E-02
14	0.	0.	2.04675E-02	1.05804E-02	-9.75802E-03
15	0.	0.	0.	8.85168E-03	-7.66593E-03
16	0.	0.	0.	0.	-6.55161E-03

TABLE 3-5 (Continued)

MICROSCOPIC PHOTON CROSS SECTIONS FOR COMP. ELEMENT NO. 2

P(1) TRANSPORT CROSS SECTION SET

	1	2	3	4	5	6	7	8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	2.43915E-02	2.04163E+02	4.13994E-02	6.34068E-02	8.21477E-02	1.41834E-01	1.00492E-01	1.34471E-01
5	0.	3.42718E-02	7.78924E-02	9.55924E-02	1.26249E-01	1.87146E-01	1.25817E-01	1.96049E-01
6	0.	0.	6.13719E-02	6.61383E-02	7.88877E-02	9.95532E-02	5.98073E-02	1.05696E-01
7	0.	0.	0.	5.27884E-02	5.59497E-02	6.46476E-02	3.33528E-02	5.22424E-02
8	0.	0.	0.	0.	4.53064E-02	4.71275E-02	2.23198E-02	2.99787E-02
9	0.	0.	0.	0.	0.	3.87531E-02	1.66027E-02	2.04059E-02
10	0.	0.	0.	0.	0.	0.	1.38013E-02	1.53457E-02
11	0.	0.	0.	0.	0.	0.	0.	1.28295E-02
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13
1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.
4	1.92936E-01	3.10513E-01	5.83509E-01	1.36510E+00	1.75459E+00
5	2.56255E-01	3.78177E-01	5.38415E-01	7.20567E-01	1.47854E-01
6	1.56699E-01	2.12252E-01	2.38234E-01	2.31762E-01	-9.25163E-02
7	8.75841E-02	1.34899E-01	1.42307E-01	1.11042E-01	-5.93675E-02
8	4.51808E-02	7.87716E-02	9.47978E-02	6.83427E-02	-3.93911E-02
9	2.66866E-02	4.25842E-02	5.80121E-02	4.59528E-02	-2.87346E-02
10	1.84635E-02	2.58883E-02	3.27603E-02	2.79569E-02	-2.17363E-02
11	1.40263E-02	1.81861E-02	2.03827E-02	1.54127E-02	-1.49268E-02
12	1.17872E-02	1.39414E-02	1.44747E-02	9.30765E-03	-9.33645E-03
13	0.	1.17686E-02	1.11612E-02	6.45319E-03	-6.15244E-03
14	0.	0.	9.44656E-03	4.88326E-03	-4.50370E-03
15	0.	0.	0.	4.08539E-03	-3.53812E-03
16	0.	0.	0.	0.	-3.02382E-03

TABLE 3-5 (Continued)

MICROSCOPIC PHOTON CROSS SECTIONS FOR COMP. ELEMENT NO. 3

P(1) TRANSPORT CROSS SECTION SET

	1	2	3	4	5	6	7	8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	3.74003E-01	3.13050E-01	6.34790E-01	9.72238E-01	1.25960E+00	2.17478E+00	1.54088E+00	2.06189E+00
5	0.	5.25501E-01	1.19435E+00	1.46575E+00	1.93582E+00	2.86958E+00	1.92919E+00	3.00609E+00
6	0.	0.	9.41035E-01	1.01412E+00	1.20961E+00	1.52648E+00	9.17045E-01	1.62067E+00
7	0.	0.	0.	8.09422E-01	8.57895E-01	9.91266E-01	5.11410E-01	8.01050E-01
8	0.	0.	0.	0.	6.94698E-01	7.22622E-01	3.42237E-01	4.59673E-01
9	0.	0.	0.	0.	0.	5.94215E-01	2.54574E-01	3.12890E-01
10	0.	0.	0.	0.	0.	0.	2.11620E-01	2.35301E-01
11	0.	0.	0.	0.	0.	0.	0.	1.96719E-01
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13
1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.
4	2.95836E+00	4.76120E+00	8.94713E+00	2.09316E+01	2.69037E+01
5	3.92925E+00	5.79871E+00	8.25569E+00	1.10487E+01	2.26709E+00
6	2.40272E+00	3.25453E+00	3.65292E+00	3.55369E+00	-1.41858E+00
7	1.34296E+00	2.06846E+00	2.18203E+00	1.70265E+00	-9.10301E-01
8	6.92772E-01	1.20783E+00	1.45357E+00	1.04792E+00	-6.03997E-01
9	4.09195E-01	6.52958E-01	8.89519E-01	7.04609E-01	-4.40598E-01
10	2.83107E-01	3.96954E-01	5.02325E-01	4.28672E-01	-3.33291E-01
11	2.15070E-01	2.78854E-01	3.12535E-01	2.36328E-01	-2.28878E-01
12	1.80737E-01	2.13768E-01	2.21945E-01	1.42717E-01	-1.43159E-01
13	0.	1.80452E-01	1.71139E-01	9.89489E-02	-9.43374E-02
14	0.	0.	1.44847E-01	7.48766E-02	-6.90567E-02
15	0.	0.	0.	6.26427E-02	-5.42512E-02
16	0.	0.	0.	0.	-4.63652E-02



TABLE 3-5 (Continued)

MACROSCOPIC PHOTON CROSS SECTIONS FOR COMP. NO. 2

P(1) TRANSPORT CROSS SECTION SET

	1	2	3	4	5	6	7	8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	3.19244E-03	2.67215E-03	5.41849E-03	8.29890E-03	1.07518E-02	1.85637E-02	1.31527E-02	1.76000E-02
5	0.	4.48561E-03	1.01948E-02	1.25115E-02	1.65239E-02	2.44943E-02	1.64673E-02	2.56596E-02
6	0.	0.	8.03255E-03	8.65640E-03	1.03251E-02	1.30299E-02	7.82778E-03	1.38338E-02
7	0.	0.	0.	6.90912E-03	7.32288E-03	8.46132E-03	4.36533E-03	6.83766E-03
8	0.	0.	0.	0.	5.92985E-03	6.16821E-03	2.92129E-03	3.92371E-03
9	0.	0.	0.	0.	0.	5.07214E-03	2.17301E-03	2.67079E-03
10	0.	0.	0.	0.	0.	0.	1.80636E-03	2.00850E-03
11	0.	0.	0.	0.	0.	0.	0.	1.67917E-03
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.

	9	10	11	12	13
1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.
4	2.52522E-02	4.06410E-02	7.63716E-02	1.78669E-01	2.29646E-01
5	3.35396E-02	4.94970E-02	7.04695E-02	9.43103E-02	1.93516E-02
6	2.05093E-02	2.77803E-02	3.11809E-02	3.03338E-02	-1.21088E-02
7	1.14633E-02	1.76561E-02	1.86256E-02	1.45336E-02	-7.77021E-03
8	5.91341E-03	1.03099E-02	1.24075E-02	8.94492E-03	-5.15564E-03
9	3.49284E-03	5.57356E-03	7.59282E-03	6.01445E-03	-3.76088E-03
10	2.41677E-03	3.38835E-03	4.28778E-03	3.65909E-03	-2.84493E-03
11	1.83581E-03	2.38026E-03	2.66776E-03	2.01726E-03	-1.95367E-03
12	1.54275E-03	1.82470E-03	1.89449E-03	1.21822E-03	-1.22199E-03
13	0.	1.54031E-03	1.46082E-03	8.44615E-04	-8.05251E-04
14	0.	0.	1.23640E-03	6.39137E-04	-5.89459E-04
15	0.	0.	0.	5.34710E-04	-4.63081E-04
16	0.	0.	0.	0.	-3.95768E-04

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TABLE 3-5 (Continued)

COUPLED MACROSCOPIC NEUTRON-PHOTON CROSS SECTIONS FOR COMP. NO. 1

P(1) TRANSPORT CROSS SECTION SET

TAPE IDENTIFICATION NO. 2

	1	2	3	4	5	6	7	8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	5.86828E-02	2.34966E-02	3.86645E-02	3.36451E-02	2.39526E-02	1.74929E-02	3.55919E-02	9.56620E-03
9	0.	-5.86828E-02	-2.34966E-02	-3.86645E-02	-3.36451E-02	-2.39526E-02	-1.74929E-02	-3.55919E-02
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.	0.	0.	0.
26	0.	0.	0.	0.	0.	0.	0.	0.
27	0.	0.	0.	0.	0.	0.	0.	0.
28	0.	0.	0.	0.	0.	0.	0.	0.
29	0.	0.	0.	0.	0.	0.	0.	0.
30	0.	0.	0.	0.	0.	0.	0.	0.
31	0.	0.	0.	0.	0.	0.	0.	0.
32	0.	0.	0.	0.	0.	0.	0.	0.
33	0.	0.	0.	0.	0.	0.	0.	0.
34	0.	0.	0.	0.	0.	0.	0.	0.
35	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 3-5 (Continued)

	9	10	11	12	13	14	15	16
36	0.	0.	0.	0.	0.	0.	0.	0.
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	-1.28985E-07	-1.21828E-04	0.	0.	0.
6	0.	0.	0.	-2.21977E-06	-4.94940E-04	-1.22410E-03	0.	0.
7	0.	0.	0.	-1.70655E-03	-7.10765E-03	-7.77215E-03	-6.10358E-03	0.
8	1.69402E-02	1.67826E-02	2.13413E-02	1.43375E-02	1.94251E-02	1.73937E-02	1.01190E-02	7.44951E-03
9	-9.56620E-03	-1.69402E-02	-1.67826E-02	-2.13413E-02	-1.36548E-02	-1.47214E-02	-9.57100E-03	-1.45174E-03
10	0.	0.	0.	0.	0.	-5.97077E-04	-2.72845E-03	-7.12808E-04
11	0.	0.	0.	0.	0.	0.	-8.00694E-05	-2.64732E-04
12	0.	0.	0.	0.	0.	0.	0.	-5.60267E-06
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.	0.	0.	0.
26	0.	0.	0.	0.	0.	0.	0.	0.
27	0.	0.	0.	0.	0.	0.	0.	0.
28	0.	0.	0.	0.	0.	0.	0.	0.
29	0.	0.	0.	0.	0.	0.	0.	0.
30	0.	0.	0.	0.	0.	0.	0.	0.
31	0.	0.	0.	0.	0.	0.	0.	0.
32	0.	0.	0.	0.	0.	0.	0.	0.
33	0.	0.	0.	0.	0.	0.	0.	0.
34	0.	0.	0.	0.	0.	0.	0.	0.
35	0.	0.	0.	0.	0.	0.	0.	0.
36	0.	0.	0.	0.	0.	0.	0.	0.
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.

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TABLE 3-5 (Continued)

7	0.	0.	0.	0.	0.	0.	0.	0.
8	3.19244E-03	2.67215E-03	5.41849E-03	8.29890E-03	1.07518E-02	1.85637E-02	1.31527E-02	1.76000E-02
9	0.	4.48561E-03	1.01948E-02	1.25115E-02	1.65239E-02	2.44943E-02	1.64673E-02	2.56540E-02
10	0.	0.	8.03255E-03	8.65640E-03	1.03251E-02	1.30299E-02	7.82778E-03	1.38330E-02
11	0.	0.	0.	6.90912E-03	7.32288E-03	8.46132E-03	4.36533E-03	6.83760E-03
12	0.	0.	0.	0.	5.92985E-03	6.16821E-03	2.92129E-03	3.92371E-03
13	0.	0.	0.	0.	0.	5.07214E-03	2.17301E-03	2.67070E-03
14	0.	0.	0.	0.	0.	0.	1.80636E-03	2.00850E-03
15	0.	0.	0.	0.	0.	0.	0.	1.67917E-03
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.	0.	0.	0.
26	0.	0.	0.	0.	0.	0.	0.	0.
27	0.	0.	0.	0.	0.	0.	0.	0.
28	0.	0.	0.	0.	0.	0.	0.	0.
29	0.	0.	0.	0.	0.	0.	0.	0.
30	0.	0.	0.	0.	0.	0.	0.	0.
31	0.	0.	0.	0.	0.	0.	0.	0.
32	0.	0.	0.	0.	0.	0.	0.	0.
33	0.	0.	0.	0.	0.	0.	0.	0.
34	0.	0.	0.	0.	0.	0.	0.	0.
35	0.	0.	0.	0.	0.	0.	0.	0.
36	0.	0.	0.	0.	0.	0.	0.	0.

	25	26	27	28	29
1	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.
8	2.52522E-02	4.06410E-02	7.63716E-02	1.78669E-01	2.29646E-01
9	3.35396E-02	4.94970E-02	7.04695E-02	9.43103E-02	1.93516E-02
10	2.05093E-02	2.77803E-02	3.11809E-02	3.03338E-02	-1.21088E-02
11	1.14633E-02	1.76561E-02	1.86256E-02	1.45336E-02	-7.77021E-03
12	5.91341E-03	1.03099E-02	1.24075E-02	8.94492E-03	-5.15564E-03
13	3.49284E-03	5.57356E-03	7.59282E-03	6.01445E-03	-3.76088E-03
14	2.41657E-03	3.38835E-03	4.28778E-03	3.65909E-03	-2.84493E-03
15	1.83581E-03	2.38026E-03	2.66776E-03	2.01726E-03	-1.98367E-03

TABLE 3-5 (Continued)

16	1.54275E-03	1.82470E-03	1.89449E-03	1.21822E-03	-1.22199E-03
17	0.	1.54031E-03	1.46082E-03	8.44615E-04	-8.05251E-04
18	0.	0.	1.23640E-03	6.39137E-04	-5.89459E-04
19	0.	0.	0.	5.34710E-04	-4.63081E-04
20	0.	0.	0.	0.	-3.95768E-04
21	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.
26	0.	0.	0.	0.	0.
27	0.	0.	0.	0.	0.
28	0.	0.	0.	0.	0.
29	0.	0.	0.	0.	0.
30	0.	0.	0.	0.	0.
31	0.	0.	0.	0.	0.
32	0.	0.	0.	0.	0.
33	0.	0.	0.	0.	0.
34	0.	0.	0.	0.	0.
35	0.	0.	0.	0.	0.
36	0.	0.	0.	0.	0.

TABLE 3-5 (Continued)

P(0) NEUTRON TRANSPORT CROSS SECTIONS FOR REGION 1

TAPE IDENTIFICATION NO. 3

5.47311E-03	1.57678E-02	1.46541E-01	0.	0.	0.
0.	9.47643E-02	0.	0.	0.	0.
0.	0.	0.	0.	0.	5.50490E-03
1.39993E-02	1.52592E-01	0.	0.	0.	0.
1.11071E-01	3.74421E-02	0.	0.	0.	0.
0.	0.	0.	0.	5.42239E-03	1.28646E-02
1.96742E-01	0.	0.	0.	0.	1.35039E-01
3.08250E-02	3.21584E-03	0.	0.	0.	0.
0.	0.	0.	5.51406E-03	1.21643E-02	2.43050E-01
0.	0.	0.	0.	1.90239E-01	5.40335E-02
3.15739E-03	3.56791E-03	0.	0.	0.	0.
0.	0.	6.99780E-03	1.41035E-02	3.01888E-01	0.
0.	0.	0.	2.63028E-01	4.65389E-02	1.81556E-03
1.80440E-03	1.84560E-03	0.	0.	0.	0.
0.	1.24503E-02	2.26007E-02	3.47292E-01	0.	0.
0.	0.	3.13867E-01	3.18157E-02	6.86894E-04	4.06456E-04
2.24205E-04	2.26900E-04	0.	0.	0.	0.
2.27157E-02	4.18219E-02	3.51015E-01	0.	0.	0.
0.	2.84609E-01	2.09729E-02	3.52801E-05	4.66451E-05	1.62087E-05
4.41700E-06	4.19297E-06	0.	0.	0.	4.21375E-02
7.01747E-02	3.72428E-01	0.	0.	0.	0.
3.11939E-01	4.36911E-02	1.46500E-06	1.00882E-05	2.42730E-05	8.37107E-06
6.99607E-07	8.64527E-07	0.	0.	1.08991E-01	1.76908E-01
4.39850E-01	0.	0.	0.	0.	3.12339E-01
1.83516E-02	0.	2.50879E-08	2.64916E-07	6.23654E-07	2.25691E-07
7.95196E-09	7.33954E-09	0.	2.62309E-01	3.89404E-01	6.02327E-01
0.	0.	0.	0.	3.21202E-01	1.85206E-02
0.	0.	1.36263E-09	0.	0.	0.
0.	0.	1.92035E-01	2.73138E-01	5.27714E-01	0.
0.	0.	0.	3.11656E-01	1.88148E-02	0.
0.	0.	3.33526E-09	0.	0.	0.
0.	3.34616E-01	6.94257E-01	6.63174E-01	0.	1.19984E-07
2.13402E-06	3.33990E-03	3.12494E-01	2.40238E-02	0.	0.
0.	0.	0.	0.	0.	0.
9.23793E-01	1.85366E+00	1.25464E+00	0.	2.28577E-04	6.17142E-04
9.06228E-03	3.05701E-01	1.54690E-02	0.	0.	0.
0.	0.	0.	0.	0.	1.29816E+00
2.68788E+00	1.63479E+00	0.	0.	1.96248E-03	9.27530E-03
3.14975E-01	1.78025E-02	5.01454E-04	0.	0.	0.
0.	0.	0.	0.	2.10984E+00	4.36897E+00
2.45287E+00	0.	0.	0.	8.06727E-03	3.30591E-01

TABLE 3-5 (Continued)

1.13939E-02	3.48455E-03	8.24703E-05	0.	0.	0.
0.	0.	0.	4.27890E+00	8.86031E+00	4.59875E+00
0.	0.	0.	0.	3.09592E-01	2.54441E-03
1.20164E-03	5.15900E-04	1.14471E-05	0.	0.	0.
0.	0.				

TABLE 3-5 (Continued)

P(1) NEUTRON TRANSPORT CROSS SECTIONS FOR REGION 1

TAPE IDENTIFICATION NO.

0.	0.	0.	0.	0.	0.
0.	5.86828E-02	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
2.34966E-02	5.86828E-02	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	3.86645E-02
-2.34966E-02	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	3.36451E-02	-3.86645E-02
0.	0.	0.	0.	0.	0.
0.	0.	0.	2.39526E-02	-3.36451E-02	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	1.74929E-02	-2.39526E-02	0.	0.
0.	0.	0.	0.	0.	0.
0.	3.55919E-02	-1.74929E-02	0.	0.	0.
0.	0.	0.	0.	0.	0.
9.56620E-03	-3.55919E-02	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	1.69402E-02
-9.56620E-03	0.	0.	0.	0.	0.
0.	0.	0.	0.	1.67826E-02	-1.69402E-02
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	2.13413E-02	-1.67826E-02	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	-1.28985E-07
-2.21977E-06	-1.70655E-03	1.43375E-02	-2.13413E-02	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	-1.21828E-04	-4.94940E-04
-7.10765E-03	1.94251E-02	-1.36548E-02	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	-1.22410E-03	-7.77215E-03
1.73937E-02	-1.47214E-02	-5.97077E-04	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	-6.10358E-03	1.01190E-02



TABLE 3-5 (Continued)

-9.57100E-03	-2.72845E-03	-8.00694E-05	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	7.44951E-03	-1.85176E-03
-7.12858E-04	-2.68732E-04	-5.60267E-06	0.	0.	0.
0.	0.				

TABLE 3-5 (Continued)

P(0) PHOTON TRANSPORT CROSS SECTIONS FOR REGION 1

TAPE IDENTIFICATION NO. 5

8.34522E-02	0.	1.06832E-01	1.06666E-03	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	8.16620E-02	0.
1.06459E-01	8.92099E-04	1.50292E-03	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	7.95381E-02	0.	1.06674E-01	1.81267E-03
3.42561E-03	2.71359E-03	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
7.72627E-02	0.	1.07762E-01	2.78026E-03	4.22383E-03	2.95134E-03
2.36853E-03	0.	0.	0.	0.	0.
0.	0.	0.	0.	7.48961E-02	0.
1.10416E-01	3.60913E-03	5.61549E-03	3.56064E-03	2.55088E-03	2.07725E-03
0.	0.	0.	0.	0.	0.
0.	0.	7.35093E-02	0.	1.15447E-01	6.26433E-03
8.40298E-03	4.58111E-03	3.02046E-03	2.22500E-03	1.84035E-03	0.
0.	0.	0.	0.	0.	0.
7.35854E-02	0.	1.21456E-01	4.41996E-03	5.66013E-03	2.79047E-03
1.59605E-03	1.08495E-03	8.15773E-04	6.82242E-04	0.	0.
0.	0.	0.	0.	7.48891E-02	0.
1.27574E-01	5.93132E-03	8.80357E-03	4.91008E-03	2.51994E-03	1.48437E-03
1.02691E-03	7.80908E-04	6.56970E-04	0.	0.	0.
0.	0.	7.83084E-02	0.	1.37407E-01	8.55223E-03
1.16409E-02	7.36050E-03	4.26373E-03	2.28784E-03	1.38901E-03	9.77557E-04
7.51376E-04	6.35620E-04	0.	0.	0.	0.
8.63814E-02	0.	1.54598E-01	1.39279E-02	1.76399E-02	1.03935E-02
6.85004E-03	4.15968E-03	2.34729E-03	1.47056E-03	1.05255E-03	8.17207E-04
6.94961E-04	0.	0.	0.	1.07020E-01	0.
1.92955E-01	2.68956E-02	2.65698E-02	1.29345E-02	8.18466E-03	5.69395E-03
3.65329E-03	2.17234E-03	1.40177E-03	1.01839E-03	7.97667E-04	6.81157E-04
0.	0.	2.10823E-01	0.	3.41772E-01	7.12802E-02
4.55204E-02	2.10091E-02	1.59959E-02	1.37972E-02	1.27520E-02	1.17128E-02
1.06000E-02	9.67414E-03	8.99243E-03	8.50545E-03	8.21863E-03	0.
1.12648E+00	0.	1.32971E+00	2.03230E-01	5.96689E-02	1.35194E-02
6.70947E-03	3.97594E-03	2.73699E-03	1.99020E-03	1.31345E-03	7.89616E-04
5.06928E-04	3.65350E-04	2.84051E-04	2.41361E-04		

TABLE 3-5 (Continued)

P(1) PHOTON TRANSPORT CROSS SECTIONS FOR REGION 1

TAPE IDENTIFICATION NO. 6

0.	0.	0.	3.19244E-03	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	2.67215E-03	4.48561E-03	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	5.41849E-03
1.01948E-02	8.03255E-03	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	8.29890E-03	1.25115E-02	8.65640E-03
6.90912E-03	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	1.07518E-02	1.65239E-02	1.03251E-02	7.32288E-03	5.92985E-03
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	1.85637E-02
2.44943E-02	1.30299E-02	8.46132E-03	6.16821E-03	5.07214E-03	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	1.31527E-02	1.64673E-02	7.82778E-03
4.36533E-03	2.92129E-03	2.17301E-03	1.80636E-03	0.	0.
0.	0.	0.	0.	0.	0.
0.	1.76000E-02	2.56596E-02	1.38338E-02	6.83766E-03	3.92371E-03
2.67079E-03	2.00850E-03	1.67917E-03	0.	0.	0.
0.	0.	0.	0.	0.	2.52622E-02
3.35396E-02	2.05093E-02	1.14633E-02	5.91341E-03	3.49284E-03	2.41657E-03
1.83581E-03	1.54275E-03	0.	0.	0.	0.
0.	0.	0.	4.06410E-02	4.94970E-02	2.77803E-02
1.76561E-02	1.03099E-02	5.57356E-03	3.38835E-03	2.38026E-03	1.82470E-03
1.54031E-03	0.	0.	0.	0.	0.
0.	7.63716E-02	7.04695E-02	3.11809E-02	1.86256E-02	1.24075E-02
7.59282E-03	4.28778E-03	2.66776E-03	1.89449E-03	1.46082E-03	1.23640E-03
0.	0.	0.	0.	0.	1.78669E-01
9.43103E-02	3.03338E-02	1.45336E-02	8.94492E-03	6.01445E-03	3.65909E-03
2.01726E-03	1.21822E-03	8.44615E-04	6.39137E-04	5.34710E-04	0.
0.	0.	0.	2.29644E-01	1.93516E-02	1.21088E-02
-7.77021E-03	-5.15564E-03	-3.76088E-03	-2.84493E-03	-1.95367E-03	-1.22199E-03
-8.05251E-04	-5.89459E-04	-4.63081E-04	-3.95768E-04		

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TABLE 3-5 (Continued)

CONTENTS OF CROSS SECTION DATA TAPE - TAPE14

SEQ. NO.	TAPE NO.	GROUPS	TITLE
1	1	29	REGION 1 C,U235,AL P1
2	2	29	REGION 1 C,U235,AL P1
3	3	16	REGION 1 C,U235,AL P1
4	4	16	REGION 1 C,U235,AL P1
5	5	13	REGION 1 C,U235,AL P1
6	6	13	REGION 1 C,U235,AL P1

sections are those listed for each element in the composition. If NPRIN = 1, the microscopic, broad-group, neutron and photon cross sections are then printed out for each element in the composition. The microscopic, broad-group, photon, neutron, and coupled neutron-photon cross sections are then printed out. If  $P_\ell$  composition data are requested, these data follow the  $P_0$  data.

Finally, the output tape is rewound and read to obtain a complete listing of the contents of the tape. The contents are then printed listing the tape ID numbers, the number of energy groups for each set, and the title given to each set on the tape.

### 3.5.2 Punched Output

Four sets of data are punched on cards by the APPROPOS code. These are:

- 1) The fine-group flux spectra for each zone in the ANISN-W calculation (NLIB = 4 or 5),
- 2) The broad-group fluxes by mesh interval (defined from the ANISN-W tape data) and by broad-group (NLIB = 4 or 5),
- 3) Library and composition data for the NAGS code, and
- 4) Transport cross sections for the DOT-IIW and ANISN-W codes (NTRIG = 0).

The fine-group flux spectra are the integral fluxes by zone. These data are punched on cards in a FORTRAN (6E12.5) format. Each flux spectra begins on a new card.

The broad-group fluxes are punched out on cards by mesh interval. Each energy group of data begins on a new card. Again, a (6E12.5) format is used. These data are preceded by a 3U card (containing a 3 punched in column 2 and a U punched in column 3) and followed by a T card (containing a T in column 3). These data are applicable as flux guess data for the ANISN-W and DOT-IIW codes; their use could save a factor of 1.5 or more in running time in these codes for eigenvalue calculations.

The library data for the NAGS code are punched on cards next. The parameter, NAA and the arrays, GPF, GDF, DOSEG, DOSEN and UGB are punched on cards using a

(6E12.5) format, as well. Each array begins on a new card. The code then punches out the arrays, ID, AMU, GNA, and LABEL, on one card as well as the arrays, GI, GA, SE, SNA, and URHO, each beginning on a new card. Again, the (6E12.5) FORTRAN format is used.

The composition data for the NAGS code are also punched out on cards. The composition title is first output, followed by the parameters, IS, JS, JF, NELE, and IND, in a (6I3) format, followed by NID (I, n) and ADEN (n) in an (I3, E12.5) format. These data are then followed by SF, SA, SE, and SI arrays, where region-dependent data in a broad-group structure are provided. Each of these four arrays begins on a new card and a (6E12.5) format is used.

Finally, if NTRIG = 0, the coupled, the neutron, and/or the photon transport cross sections (depending on NOD) are punched out on cards in a (6E12.5) FORTRAN format. Because these data (in a typical calculation) require many, many cards, tape transmittal of the data to the ANISN-W and DOT-IIW codes is recommended.

### 3.5.3 Tape Output

Up to three output tapes are obtained from the APPROPOS code. These are:

- 1) Tape 10, containing the Master Library Number 3 and 6 data, (NAPL = 1);
- 2) Tape 4, containing the spectra by zone; and
- 3) Tape 14, containing the output transport cross section data for use in the

DOT-IIW and ANISN-W codes.

When NAPL = 1, the Master Library Number 6 data are input from cards and placed behind the Master Library Number 3 data on tape 10. Subsequent calculations should be made with NAPL = 2 where read access only is provided for tape 10. Only when a new set of data are included in Master Library Number 6 or the "production" tape 10 is being generated for the first time should this type of calculation be made.

Tape 4 contains the spectra by zone. Odd numbered records contain two words: the spectra ID number and the number of fine-groups; even numbered records contain the actual flux spectra. Each set of flux spectra contain NGF values.

Tape 14 contains the output cross section data for the ANISN-W and DOT-IIW discrete ordinates transport codes. The first record on this tape contains two words: the tape label and the number of sets of cross section data in the tape. Even numbered records contain 4 integer words (where the fourth integer is the cross section set ID number required by ANISN-W and DOT-IIW) and 8 alphanumeric words of title information. Odd numbered records after the first record contain the actual cross sections. The coupled, neutron-photon cross section sets are first placed on tape for all compositions and all  $P_\ell$  orders follow; and the photon cross section data for all compositions and all  $P_\ell$  orders conclude these data.

All three of these tapes contain end-of-file marks after the required data.

## 3.6 PROGRAM LOGIC

Presented in this section is an overall description of the program logic in the APPROPOS code. Each of the principal operations is described to give the user insight into the processing steps performed by the code.

### 3.6.1 Subroutine Description

Shown in Table 3-6 is a description of each subroutine and its principal function in the APPROPOS code. As shown in this table, each operation or processing step is performed by a separate subroutine within the code. This modular approach facilitates the checkout of the code as well as the inclusion of additional modular subroutines to extend the capability of the code.

### 3.6.2 Calculation Procedure

The APPROPOS code performs the required calculations in a specific, logical manner. The first phase of the calculations involves computing core storage requirements for the flux spectra computations. If sufficient core storage is available, the spectral data are processed. The code then redefines core storage for the cross section group-collapsing calculations and performs these computations using the weighting spectra from the previous step. After these steps, the core storage is redefined a final time for the remainder of the calculations.

The next phase of the calculations involves reading of the Master Library 6 data from cards or tape. Selected portions of these library data are printed out and punched on cards for the NAGS code. Microscopic gamma ray transport cross sections are then read into core for only those elements in the problem.

The code now begins the composition loop. Elemental data are read from cards and, depending on the input options chosen, neutron, gamma ray, and coupled neutron-gamma ray transport cross section data are calculated and placed on the output data tape. After all composition data are read, the output tape is rewound and read to obtain a convenient listing of the data on the output tape for the user.



TABLE 3-6

## LIST OF APPROPOS CODE SUBROUTINES AND THEIR PRINCIPAL FUNCTIONS

<u>Subroutine Name</u>	<u>Principal Function</u>
APPROPOS	Initializes core storage, computes flexible dimension data storage, prints out Data Sets 1 and 2, controls code logic for spectra input, group-collapse, and upscatter-removal calculations
SLAVE	Controls code logic for the remainder of the calculations, reads and prints the region data from Data Set 4 and performs final edit of the output cross section tape
LIBRAR	Reads in Master Library 6 data (including photon production data and selected nuclear parameters), adds Master Library 6 to Master Library 3, if requested
MICTAP	Reads in microscopic gamma ray transport cross sections from Master Library 4
ERROT	Prints an informative error message when an end-of-file is encountered on any of the library tapes
NAGLIB	Prints and punches on cards the library of data prepared for the NAGS code
MICROG	Assists in reading microscopic gamma ray data from tape by $P_{\ell}$ order
MICRON	Reads broad-group microscopic neutron transport cross section and neutron reaction rate cross section data from scratch tape
TOMMIX	Performs mixing operations by composition for both neutron and photon microscopic cross section data
GASP	Forms the gamma ray production matrix linking the neutron and gamma ray transport cross section data for simultaneous calculations

TABLE 3-6 (Continued)

<u>Subroutine Name</u>	<u>Principal Functions</u>
COUPLE	Places on output tape, prints, and/or punches on cards the simultaneous transport cross section matrix
SEQUEN	Places on output tape, prints, and/or punches on cards the neutron and gamma ray transport cross section matrices for sequential analyses
SCOUT	Prints out two-dimensional arrays from various phases of the calculation
WATE	Sets up the neutron reaction rate cross section collapsing operation over the selected spectral data and controls the spectral weighting of the neutron transport cross section data
WATE 1	Performs the spectral weighting and group-collapsing of the reaction rate data
WATE 2	Performs the spectral weighting and group-collapsing of the neutron transport cross section data
SPECT	Reads the ANISN-W output tape to compute the region average flux spectra to be placed on Tape 4 for use in subsequent APPROPOS calculations
GOUT	Rearranges a variable dimension array for printing
OW	Prints out a special page of output at the conclusion of a successful calculation

### 3.7 METHOD OF SOLUTION

Because the APPROPOS code is essentially a data processing code, the method of solution in the code reduces to the program logic described in Section 3.6.

Three basic calculations are performed by the APPROPOS code. The first major calculation is the group-collapse operation using the spectral weighting data. The broad-group cross section,  $\bar{\sigma}_g$ , (whether a reaction rate or a transport cross section) is computed in the following manner:

$$\bar{\sigma}_g = \frac{\sum_{g=m}^n \varphi_g \sigma_g}{\sum_{g=m}^n \varphi_g}$$

where:  $\varphi_g$  is the weighting spectrum for fine-group,  $g$ ,

and:  $m$  and  $n$  are the upper and lower bounds of the particular broad-group within the fine-group data.

If reciprocal weighting is chosen and the particular cross section set includes a transport corrected set of data, then  $\bar{\sigma}_g$ , the broad-group cross section, is calculated by:

$$\bar{\sigma}_g = \frac{\sum_{g=m}^n \varphi_g}{\sum_{g=m}^n \frac{\varphi_g}{\sigma_g^{tr}}}$$

where:  $\varphi_g$  is defined above,

and:  $\sigma_g^{tr}$  is the transport cross section for fine-group,  $g$ ;  $m$  and  $n$  are defined above.

The second major calculation in the APPROPOS code is the upscatter-removal calculation. The redefined, down-scatter cross section into group h from group g, where  $g < h$ , is calculated by

$$\bar{\sigma}_{g \rightarrow h} = \frac{\sum_{g=1}^{NGN} \left( \varphi_g \sigma_{g \rightarrow h} - \varphi_h \sigma_{h \rightarrow g} \right)}{\sum_{g=1}^{NGN} \varphi_g}$$

Thus the net transfer of particles (or energy) between groups h and g is preserved by this technique.

The final major calculation in the code is the calculation of the scatter matrix elements from a given neutron broad-group, g, to a particular gamma ray group, k.

The calculation, by element, is as follows:

$$\sigma_{g \rightarrow k} = \left[ \left( \Gamma_k (n;f)_p + \Gamma_k (n;f)_d \right) * \sigma_f^g \right] + \left[ \Gamma_k (n, \gamma) * \sigma^g (n, \gamma) \right] + \left[ \Gamma_{g,k} (n; n', \gamma) * \sigma^g (n; n', \gamma) \right]$$

where:  $\Gamma_k (n;f)_p$  is the spectrum of prompt gamma ray energy from the fission of <sup>235</sup>Uranium,

$\Gamma_k (n;f)_d$  is the spectrum of decay gamma ray energy, for a specific reactor run time, from the fission of <sup>235</sup>Uranium,

$\Gamma_k (n, \gamma)$  is the spectrum of gamma ray energy due to (n,  $\gamma$ ) reactions (and in particular cases, (n;p,  $\gamma$ ) and (n; $\alpha$ ,  $\gamma$ ) reactions, as well),

$\Gamma_{g,k} (n; n', \gamma)$  is the spectrum of gamma ray energy released, including continuum and/or discrete events, from the inelastic scattering of neutrons,

$\sigma_f^g$  is the microscopic, broad-group fission cross section for the element,

$\sigma^g(n, \gamma)$  is the microscopic, broad-group capture cross section for the element, and

$\sigma^g(n; n', \gamma)$  is the microscopic, broad-group total inelastic scatter cross section for the element.

This cross section,  $\sigma_{g \rightarrow k'}$  is generated only for coupled calculations. All remaining operations in the code are basically data processing operations.

## 4.0 NAGS CODE

When the vast amount of data handling required in a complete, two-dimensional radiation analysis of a nuclear system is considered, the need for an automated, data processing link between discrete ordinate transport techniques and both point kernel and Monte Carlo techniques is evident. The NAGS code provides this needed link. NAGS processes multigroup, neutron and photon flux distributions for one-dimensional, slab or cylinder geometry models, or two-dimensional,  $r,z$  or  $r,\theta$  geometry models. Flux input data to the NAGS code are obtained by magnetic tape or disk from the ANISN-W or DOT-IIW discrete ordinate transport codes described in Volumes 4 and 5 of this report. Additional input data required by the NAGS code are prepared by the APPROPOS code described in this volume. The NAGS code provides: 1) neutron and photon source data for use in point kernel, Monte Carlo, or discrete ordinate transport analyses, 2) neutron and photon dose rates, and 3) nuclear energy deposition data (neutron and photon) for use in subsequent thermal and hydraulic design analyses. Source distribution data are generated, on punched data cards for input into the KAP-VI code (Volume 6) and on magnetic tape for use in the ANISN-W or DOT-IIW codes. Optional, SC-4020 plotting of the source distribution or energy deposition data is also provided.

#### 4.1 COMPUTER CODE SYNOPSIS

1. Name: NAGS<sup>(1)</sup> (Neutron And Gamma Ray Sources)

2. Computer: The code is designed for the UNIVAC-1108 computer.

3. Nature of Physical Problem Solved: The NAGS code provides: 1) neutron and photon source data for use in point kernel, Monte Carlo, or discrete ordinate transport analyses, 2) neutron and photon dose rates, and 3) nuclear energy deposition data (neutron and photon) for use in subsequent thermal and hydraulic design analyses.

4. Method of Solution: NAGS processes multigroup, neutron and photon flux distributions for one-dimensional, slab or cylinder geometry models, or two-dimensional,  $r,z$  or  $r,\theta$  geometry models. Flux input data to the NAGS code are obtained by magnetic tape or disk from the ANISN-W<sup>(2)</sup> or DOT-IIW<sup>(3)</sup> discrete ordinate transport codes. Additional input data required by the NAGS code are prepared by the APPROPOS code<sup>(1)</sup>.

5. Restrictions on the Complexity of the Problem: The NAGS computer code utilizes flexible dimensioning and magnetic tape or disk files to process the required data. Because of the use of the flexible dimensioning technique, no size restriction is imposed on any given array but the sum of the length of all data arrays is restricted by the available computer core memory.

6. Typical Running Time: A typical, design calculation (containing 3000 mesh cells, 16 neutron energy groups, 13 gamma ray groups, 15 elements, and 60 regions) to compute the neutron and gamma ray source distributions requires 5 to 10 minutes of UNIVAC-1108 CPU time.

7. Unusual Features of the Code: The use of flexible dimensioning and the optional ability to plot the source distribution and energy deposition data with the SC-4020 plotter are included in the NAGS code.

8. Related or Auxiliary Codes: Flux input data are obtained from the ANISN-W<sup>(2)</sup> and DOT-IIW<sup>(3)</sup> codes. Input cross section data are provided by the APPROPOS<sup>(1)</sup> code.

9. Status: The code is in production use at the Marshall Space Flight Center (MSFC). Users at MSFC load the code from a tape or disk with control cards followed by user's input data.

10. References:

1. R. G. Soltész, R. K. Disney, and S. L. Zeigler, WANL-PR(LL)-034, Volume 3, "Cross Section Generation and Data Processing Techniques," August 1970.
2. R. G. Soltész and R. K. Disney, WANL-PR(LL)-034, Volume 4, "One-Dimensional, Discrete Ordinate Transport Technique," August 1970.
3. R. K. Disney, R. G. Soltész, J. Jedruch, and S. L. Zeigler, WANL-PR(LL)-034, Volume 5, "Two-Dimensional, Discrete Ordinate Transport Techniques," August 1970.
4. R. K. Disney and S. L. Zeigler, WANL-PR(LL)-034, Volume 6, "Point Kernel Techniques," August 1970.

11. Machine Requirements: The NAGS code is in production at MSFC on the UNIVAC-1108 computer with 65K core storage locations. The program requires approximately 16K decimal locations for the program; the remaining 49K decimal locations are available for problem data storage.

12. Programming Language Used: The NAGS code is written in standard, USASI FORTRAN-IV.

13. Operating System or Monitor Under Which Program is Executed: The NAGS code is operational under the UNIVAC-1108, EXEC 8 Monitor System at MSFC.

14. Other Programming or Operating Information or Restrictions: None.

15. Name and Establishment of Authors:

R. K. Disney, R. G. Soltész, and S. L. Zeigler  
Westinghouse Astronuclear Laboratory  
P. O. Box 10864  
Pittsburgh, Pa. 15236



## 4.2 INPUT DATA DESCRIPTION

### 4.2.1 Input Format

The input data for a NAGS problem are subdivided into four sets of data. These four sets, are as follows:

- 1) General problem data - integer data pertaining to data or array dimensions (i.e., number of mesh, number of groups, etc.), problem title information, integer control words, flux normalization parameters, neutron fission parameters, and mesh cell specifications;
- 2) Flux data - input flux data required for the NAGS code, including mode of input;(the flux data are supplied from tape or disk);
- 3) Library data - neutron and photon multigroup quantities, and for each element: identification, physical constants and groupwise nuclear data;
- 4) Region data - region title information, region composition by element or material, and depending upon the library option or type of calculation, region dependent multigroup neutron cross sections.

All card input to the NAGS code is entered in fixed, FORTRAN formats. For convenience, the number columns required per input parameter are either 3, 6, or 12 so that the probability of an input error due to card format is minimized.

The initial data input to the NAGS program specifies: 1) the amount of available core data storage, 2) the data array sizes of all input quantities, 3) the program input/output control options, 4) the flux normalization constants, 5) the fission neutron spectrum and the number of neutrons per fission event, and 6) the mesh cell dimensions of the problem geometry. These data are input as described in Data Set 1 in Table 4-1.

Input flux data for the NAGS code are input from binary tape from either the one-dimensional ANISN-W, or two-dimensional DOT-IIW, discrete ordinate transport code. Input flux data is supplied from tape 11, tape12, or both tape 11 and 12 depending on the values of NTYPE and NBIN in Data Set 1. The input flux data are assumed to be group

independent such that a logical tape record is  $ICT \times JCT$  long and there are  $NGN(NTYPE = 1)$ ,  $NGG(NTYPE = 3)$ , or  $NGN + NGG(NTYPE = 2)$  records on the binary tape.

The library data for the NAGS code are a compilation of the nuclear and radiation data for the reactor geometry and for the elements in the reactor. These library data, are obtained as a complete punched decimal data deck from the APPROPOS code or can be input by the user. The data are divided into two sections referred to as general data and element data. The general data include neutron and photon group dependent quantities required for photon energy release from fission, neutron dose rate, neutron kinetic energy heating, and photon dose rate calculations. The element data are required for each element in the problem. These data are described in Data Set 3 in Table 4-1.

The final input data to a NAGS problem are the region data which: (1) titles the region input and calculation data, (2) defines the location of the region in the two dimensional mesh cell description, (3) defines the number of elements in the region, (4) provides a program control word, and (5) depending on the type of NAGS problem (source or energy deposition), provides the material density and weight in the region, the element identification numbers, the element weight fractions or atom densities, and microscopic cross section data.

The description of a region in  $R, Z$  or  $R, \theta$  geometry and the specification of the region external boundaries for a region are illustrated in Figure 4-1. These regions may be parts of a larger irregular region. The user must describe irregular regions as a composite of NAGS regions. The user must exercise caution in specifying regions so that region mesh overlays do not occur for photon or neutron source calculations because the NAGS region calculations are always initialized (all values set to 0.0) for each region and in source calculations, the source data are saved for all mesh cells for subsequent reactor geometry integrals, and for the generation of the fixed distributed source tape.

The input data cards for each region and each type of calculation are described in Data Set 4. These data cards are repeated for each NAGS region calculation in the problem.

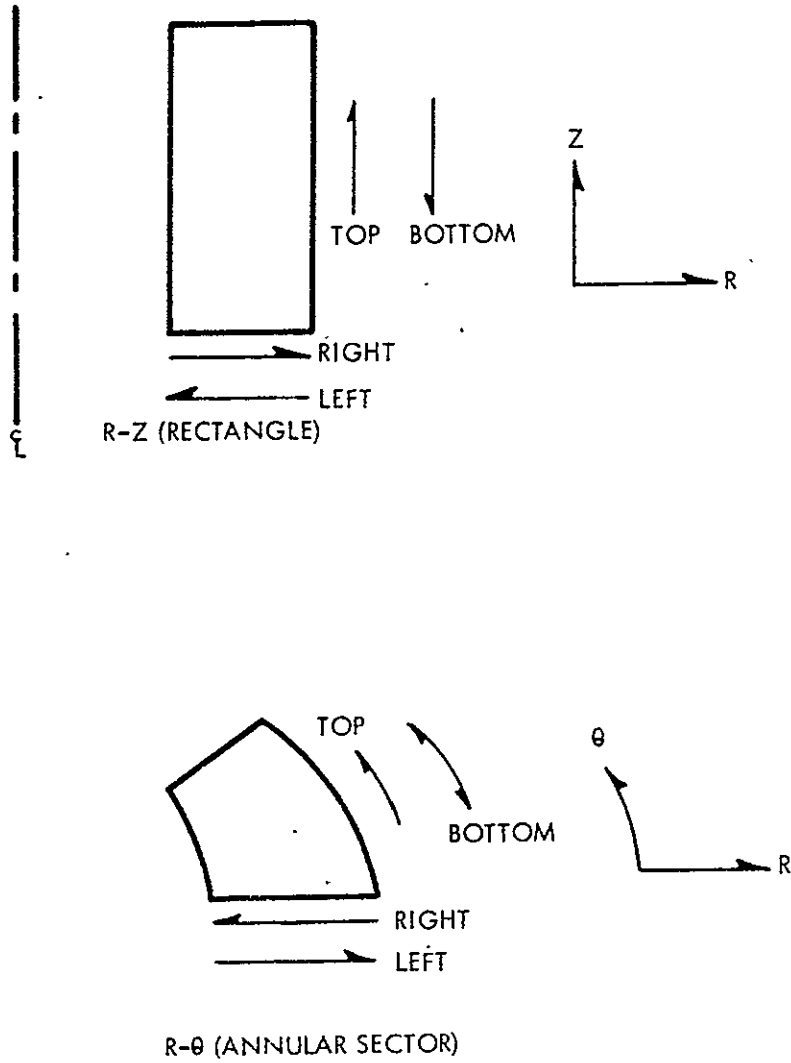


Figure 4-1. NAGS Region Geometry and Boundary Specification

#### 4.2.2 Input Data Instructions

This section is to be used as a guide in preparing problem input data for the NAGS code. Other sections present a more detailed description of the data presented here.

TABLE 4-1 INPUT INSTRUCTIONS FOR THE NAGS CODE

DATA SET 1 - General Problem Data

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
1	(15)	1-5	NMAXRS*	Maximum number of locations available for SATURN data (i.e., NMAXRS=47000 <sub>10</sub> on the UNIVAC-1108, EXEC 8 Computer with a 65K core memory storage available).
2	(2413)	1-3	ICT	Number of radial mesh intervals in the input flux solution.
		4-6	ICM	Number of redefined radial mesh intervals to be used in all calculations and output data.
		7-9	JCT	Number of axial** mesh intervals in the input flux solution.
		10-12	JCM	Number of redefined axial mesh intervals to be used in all calculations.
		13-15	NGN	Total number of neutron groups NOTE: If NTYPE = 3, then NGN is input as NGG since only photon fluxes are required input to the NAGS program when NTYPE = 3.
		16-18	NFAST	Number of fast neutron groups (Neutron kinetic energy is calculated for NFAST groups).
		19-21	NI	Number of fast neutron groups for photon production from neutron inelastic scatter.
		22-24	NGG	Number of photon energy groups.
		25-27	NEL	Number of elements in the library data.

\* The maximum value of NMAXRS is determined by the maximum size of blank common set at code compile time.

\*\* Azimuthal coordinates in revolutions (R- $\theta$  input flux solutions) can be substituted for axial coordinates in centimeters (R-Z input flux solutions) without any program changes. All further references to axial will also imply azimuthal.

TABLE 4-1 (CONTINUED)

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
2 (cont.)		28-30	NTYPE	<p>Program control word for the type of calculation to be performed.</p> <p>NTYPE = 1: Photon or neutron source calculation.</p> <p>NTYPE = 2: Combined neutron and photon energy deposition calculation.</p> <p>NTYPE = 3: Photon energy deposition calculation only (i.e., fission product decay heating).</p>
		31-33	NGSDP	<p>Program control word for punched output.</p> <p>NGSDP = 0: No punched output</p> <p>NGSDP = 1: Source Data punched out for the KAP-VI point kernel code</p> <p>NGSDP = 2: Source Data punched out for the FASTER code.</p> <p>NGSDP = 3: Source Data punched out for both codes.</p>
		34-36	NPLOT	<p>Program control word for SC-4020 plotting</p> <p>NPLOT = 0: No plotted output</p> <p>NPLOT = 1: Plotted source or energy deposition distributions</p>
		37-39	NCRD	<p>Program control word for classification of plotted output.</p> <p>NCRD = 0: Plotted output is unclassified</p> <p>NCRD = 1: Plotted output contains Confidential Restricted Data according to the Atomic Energy Act of 1954. This parameter tells the code to place the appropriate CRD label at the top and bottom of each graph</p>

TABLE 4-1 (CONTINUED)

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
2(cont.)		40-42	NCOPY	Type of plotted output NCOPY = 9: Hard copy only NCOPY = 35: Microfilm only NCOPY = 44: Both hard copy and microfilm
		43-45	NPRINT	Flux Print Option NPRINT = 0: No fluxes are printed NPRINT = 1: Neutron fluxes are printed NPRINT = 2: Photon fluxes are printed NPRINT = 3: Both neutron and photo: fluxes are printed, if input
3	(12A6)	1-72	TITLE	Overall problem title (72 alphanumeric characters).
4	(24I3)	1-3	NCD	Not presently used by the program. NCD = 0.
		4-6	NBIN	Input flux data control word which specifies input mode of flux data for different types of calculations (refer to Data Set 2 for details).
		7-9	NLIB	Library data option. NLIB = 0: Short library data option with region dependent neutron cross section data included with region input for each element, m. NLIB = 1: Long library data option with region independent neutron cross section data included in the library for each element, m.

4

TABLE 4-1 (CONTINUED)

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
4(cont.)				Source positioning indices in the radial direction for all calculated results. NEX and NEX1 are provided to enable the user to perform a NAGS calculation on a section of a reactor geometry and then position this section of data in a different reactor or problem geometry.
		10-12	NEX	The number of zero entries to the right of the NAGS calculated sources in each radial row.
		13-15	NEX1	The number of zero entries to the left of the NAGS calculated results in each radial row.
		16-18	ISTART	Starting radial mesh cell number in the NAGS input fluxes to be used in the redefinition of flux data. If in storage allocation, a flux edit is possible or desired for only a section of the input flux data then the user may specify $ISTART \neq 1$ . ISTART is equal to the left mesh cell number of a section of the reactor geometry. The NAGS program redefines the flux data such that this left mesh cell number flux data will be the first mesh cell of the section. The mesh coordinates of the cells are altered to agree with the new mesh cell description.
		19-21	JSTART	Starting axial mesh cell number in the NAGS input to be used in redefinition of flux data. The discussion of ISTART is applicable to JSTART.



TABLE 4-1 (CONTINUED)

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
4(cont.)		22-24	NPUN	<p>Binary tape output control word. Neutron or photon source data are placed on tape. The tape contains NGN or NGG logical records each of size, <math>(NEX1 + ICM + NEX)*JCO</math>.</p> <p>NPUN = 0: No binary data tape of sources is to be prepared.</p> <p>NPUN = 1: Neutron distributed source <math>(Q_{IJ}^g)</math> is placed on Tape 8.</p> <p>NPUN = 2: Total photon distributed source <math>(Q_{T IJ}^k)</math> is placed on Tape 8.</p> <p>NPUN = 3: Fission product decay photon distributed source <math>(Q_{D IJ}^k)</math> is placed on Tape 8.</p>
		25-27	JCO	<p>Source positioning index in axial direction for all calculated results. This index is similar in operation to the NEX index in that the program generated output on Tape 8 has logical records of size <math>(NEX1 + ICM + NEX)*JCO</math> where the last <math>(NEX1 + ICM + NEX)*JCO - JCM</math> pieces of data in each logical record are 0.0's. JCO must be greater than or equal to JCM.</p>
5	(E12.5)	1-12	ZREF	<p>Reference plane distance in inches from <math>Z = 0.0</math>. This input quantity adjusts all axial dimensions by <math>Z_i = ZREF - .3936 * Z_i</math> so that energy deposition and source data can be printed relative to a Z plane other than at 0.0.</p>

TABLE 4-1 (CONTINUED)

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
6	(6E12.5)	1-12	ENU	Average number of neutrons released per fission event, $\nu_g$ . For photon flux input, ENU = 1.0.
		13-24	EFF	Fraction of fissions due to neutron fission events, EFF = 1.0, except where cross section data represents $(n, 2n)$ reactions by pseudo-fission.
		25-36	EFK	Multiplication factor, $K_{eff}$ of the problem which provides input flux data. For photon flux input, EFK = 1.0.
		37-48	VOLC	Volume of fissionable regions. For R-Z input flux data, VOLC = 1.0.
		49-60	CONV	Conversion factor for input flux data in units of fissions per second.
		61-72	PK	Area factor to account for partial geometrical solutions in transport problems (i.e., PK = 1.0 for R-Z geometry but for R- $\theta$ problems, $PK = \frac{\theta}{2\pi}$ )
7	(6E12.5)	1-12, 13-24 25-36, etc.	CHI	The fission neutron spectrum, $x_g$ (i.e., the fraction of a fission neutron born in each group, $g$ ). $\sum_{g=1}^{NGN} x^g = 1.0$ (NGN Values)

TABLE 4-1 (CONTINUED)

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
8	(6E12.5)	1-12, 13-24, 25-36, etc.	UNU	Neutron release rate (No. of neutrons) per neutron fission event by group, $\nu_g$ .  (NGN Values)
9	(2413)	1-3, 4-6, etc.	IC	Mesh coordinate number of the right radial mesh coordinate of each re-defined mesh cell. (e.g., if no redefining or reduction of mesh cell description is required, IC = 2, 3, 4, 5, 10, 11, 12, ... ICT; or, if a reduction of two mesh intervals must be made, IC = 2, 4, 5, ... 10, 12, ... ICT, where 3 and 11 are removed.)  (ICM Values)
10	(2413)	1-3, 4-6, etc.	JC	Mesh coordinate number of the top mesh coordinate of each redefined mesh cell. The discussion of IC is applicable to JC.  (JCM Values)
11	(6E12.5)	1-12, 13-24, 25-36, etc.	R	Radial mesh coordinate (line) dimensions for the input flux data (ICT + 1 values).
12	(6E12.5)	1-12, 13-24, 25-36, etc.	Z	Axial mesh coordinate (line) dimensions for the input flux data (JCT + 1 values). For r, $\theta$ problems, the coordinates in the $\theta$ - direction are input in units of revolutions.

TABLE 4-1 (CONTINUED)

DATA SET 2 - FLUX INPUT DATA FROM TAPE

<u>Type of Calculation</u>	<u>(Input Parameter)</u>		<u>(Type of Flux Data)</u>		<u>(Source of Flux Data)</u>
	<u>NTYPE</u>	<u>NBIN</u>	<u>Tape 11</u>	<u>Tape 12</u>	
Photon or Neutron Source	1	1	Neutron	----	DOT-IIW or NAGS
	1	2	Neutron	----	DOT-IIW or NAGS
	1	3	----	Neutron	ANISN-W
Neutron and Photon Energy Deposition	2	1	Neutron	Photon	DOT-IIW or NAGS
	2	2	Neutron and Photon	----	DOT-IIW or NAGS
	2	3	----	Neutron and Photon	ANISN-W
Fission Product Decay Heating	3	1	Photon	----	DOT-IIW or NAGS
	3	2	Photon	----	DOT-IIW or NAGS
	3	3	----	Photon	ANISN-W

Note: 1) If NBIN = 1 or 2, neutron flux data tapes contain NGN records and photon flux data tapes contain NGG records.

2) If NBIN = 3, the respective data tapes contain a lead record of arbitrary length before the flux data records.

TABLE 4-1 (CONTINUED)

DATA SET 3 - Library Data

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
	General Library Data			
13	I3	1 - 3	NEL	Number of elements in the library. (This parameter should agree with the parameter, NEL, on card 2 of Data Set 1).
14	(6E12.5)	1-12, 13-24, 25-36, etc.	SFPS	Prompt fission photon spectrum for each photon energy group (MeV/fission) NGG values
15	(6E12.5)	1-12, 13-24, 25-36, etc.	SFDS	Fission product decay photon spectrum for each photon energy group (MeV/fission) NGG values
16	(6E12.5)	1-12, 13-24, 25-36, etc.	DKG	Photon dose rate conversion factors for each photon energy group (Dose rate/MeV-cm <sup>-2</sup> -sec <sup>-1</sup> ) NGG values
17	(6E12.5)	1-12, 13-24, 25-36, etc.	DK	Neutron dose rate conversion factors for each neutron group (Dose rate/n cm <sup>-2</sup> -sec <sup>-1</sup> ) NGN values
18	(6E12.5)	1-12, 13-24, 25-36, etc.	DU	Upper lethargy of each neutron group. NGN values. At 10 Mev, DU = 0.0
19	Data Cards (13, 2E12.5, 22X, A6)	19 - 28 are required for each element in the library. 1 - 3	NID	Element or nuclide identification number (a table of element identification numbers for the MSFC library are presented in Volume 2 of this report).

TABLE 4-1 (CONTINUED)

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
		4 - 15	AMU	Atomic weight of element (grams/gram-atom)
		16 - 27	ENA	Energy of charged particle (alpha) emission with neutron absorption (Mev/absorption)
		50 - 55	LABEL	A six character descriptive title for the element
20	(6E12.5)	1-12, 13-24, 25-36, etc.	SINS	Neutron inelastic scatter photon energy spectra for each photon energy group arising from neutron inelastic scatter events occurring in the fast neutron groups (Mev/event) NGG values for each of NI neutron groups with each NGG value defining a set of data starting on a new card
21	(6E12.5)	1-12, 13-24, 25-36, etc.	SAS	Neutron radiative capture gamma ray spectra for gamma ray groups (Mev/capture). NGG values
22	(6E12.5)	1-12, 13-24, 25-36, etc.	SS	Microscopic neutron "effective" energy deposition cross sections for neutron kinetic energy deposition calculations. NFAST values
23	(6E12.5)	1-12, 13-24, 25-36, etc.	SNA	Microscopic neutron absorption cross sections for charged particle (alpha emission) NGN values
24	(6E12.5)	1-12, 13-24, 25-36, etc.	SAG	Microscopic gamma ray mass energy absorption coefficients for gamma ray groups. (cm <sup>2</sup> /gram) NGG values

Data Cards 25-28 are only entered if NLIB = 1 on card 4 in Data Set 1

TABLE 4-1 (CONTINUED)

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
25	(6E12.5)	1-12, 13-24, 25-36, etc.	SF	Microscopic neutron fission cross sections, $\sigma_{fm}^g$ . NGN values
26	(6E12.5)	1-12, 13-24, 25-36, etc.	SA	Microscopic neutron absorption cross sections (radiative capture), $\sigma_{cm}^g$ . NGN values
27	(6E12.5)	1-12, 13-24, 25-36, etc.	SS	Microscopic neutron "effective" energy deposition cross sections, $\sigma_{em}^g$ . NFAST values.
28	(6E12.5)	1-12, 13-24, 25-36, etc.	SIN	Microscopic neutron inelastic scatter cross sections for production of photons, $\sigma_{sm}^g$ . NI values

TABLE 4-1 (CONTINUED)

## DATA SET 4 - Region Data

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
29	(12A6)	1 - 72	ID	A 72 character title or description of the region. The first 48 characters appear as the main title on plotted data
30	(2413)	1 - 3	IS	IS is the radial mesh collapsed line number corresponding to the left boundary of the region (See Figure 4-1)
		4 - 6	IF	IF is the radial collapsed mesh line corresponding to the right boundary of the region (See Figure 4-1)
		7 - 9	JS	JS is the axial collapsed (or angular) mesh line number corresponding to the bottom boundary of the region (See Figure 4-1)
		10 - 12	JF	JF is the axial collapsed (or angular) mesh line number corresponding to the top boundary of the region (See Figure 4-1)
		13 - 15	IEL	Number of elements in the region NOTE: If IEL is entered as a negative number, the program assumes that this region is identical in composition to the preceding region and the microscopic data cards (Card 31, 32, etc.) are deleted from the deck. The next data card will be the title card (Card 29 of the next sub-region)



TABLE 4-1 (CONTINUED)

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
30(cont.)		16 - 18	IND	Control word. This data controls the sequence of operations which are to be performed at the completion of each region calculation. If, IND = 1, the program assumes another region follows and will return to read data (card 29) after calculations for the present region are completed. If, IND $\neq$ 1, the program assumes that this is the last region and when calculations are complete the program transfers control to the next NAGS operation, which is the calculation of region integrals and distributions.
Data Cards 31-35 are only required for a source calculation (NTYPE = 1)				
31	(I3,E12.5)	1 - 3	NLM	Element identification number corresponding to the library element identification number NID.
		4 -15	DNM	Atom density of element in region ( $\times 10^{-24}$ )
Data Cards 32-35 are only required if NLIB = 0				
32	(6E12.5)	1-12, 13-24, 25-36, etc.	SF	Microscopic neutron fission cross section, $\sigma^g$ fm <sup>2</sup> NGN values
33	(6E12.5)	1-12, 13-24, 25-36, etc.	SA	Microscopic neutron absorption cross sections (radiative capture), $\sigma^g$ m NGN values

**TABLE 4-1 (CONTINUED)**

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
34	(6E12.5)	1-12, 13-24, 25-36, etc.	SS	Microscopic neutron "effective" energy deposition cross section $\sigma_{em}^g$ . NFAST values.
35	(6E12.5)	1-12, 13-24, 25-36, etc.	SIN	Microscopic neutron inelastic scatter cross sections for production of photons, $\sigma_{sm}^g$ .  NI values

Data cards 31-35 are repeated for each element in the region (IEL repeats)

This concludes the required input data for a source calculation.

Note that the last set of region data must have IND on card 30  $\neq$  1.

Data cards 36-42 are only required for on energy deposition calculation (NTYPE = 2 or 3)

36	(2E12.5)	12	DGM	Density of the material (i.e., stainless steel, inconel, fueled graphite, beryllium) in the NAGS region (grams/cm <sup>3</sup> of the solid material)
		13 - 24	WTGM	Weight of the material in the NAGS region (kilograms)
37	(I3, E12.5)	1 - 3	NLM	Element identification number corresponding to the library element identification numbers NID.
		4 - 15	DNM	Weight fraction of the element NLM in the material described by DGM and WTGM (e.g., the weight fraction of Fe, in stainless steel).

TABLE 4-1 (CONTINUED)

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
Data Cards 38-42 are only required if NLIB = 0				
38	(6E12.5)	1-12, 13-24, 25-36, etc.	SF	Microscopic neutron fission cross section, $\sigma_{fm}^g$ . NGN values
39	(6E12.5)	1-12, 13-24, 25-36, etc.	SA	Microscopic neutron absorption cross sections (radiative capture), $\sigma_m^g$ . NGN values
40	(6E12.5)	1-12, 13-24, 25-36, etc.	SS	Microscopic neutron elastic scatter cross sections, $\sigma_{em}^g$ . NFAST values
41	(6E12.5)	1-12, 13-24, 25-36, etc.	SIN	Microscopic neutron inelastic scatter cross sections for production of photons, $\sigma_{sm}^g$ . NI values
42	(6E12.5)	1-12, 13-24, 25-36, etc.	SA	If $\Gamma(n, \alpha) \neq 0$ , (ENA), then NGN values of $\sigma(n, \alpha)$ are required as input

Data Cards 37-42 are repeated for each element in the region (IEL repeats).

This concludes the required input data for an energy deposition calculation. Note that the last set of region data must have IND on card 30  $\neq$  1.

## 4.3 DETAILED INPUT DATA INFORMATION

### 4.3.1 Geometry Description

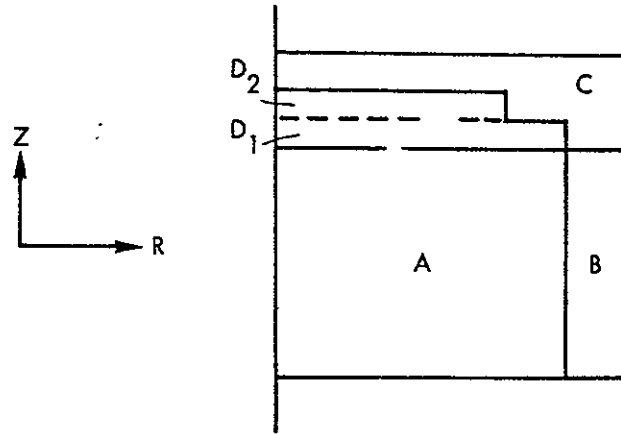
The problem geometry is described in the NAGS code as a two-dimensional reactor mockup in  $r, z$  or  $r, \theta$  geometry. This geometry is similar to that used in the discrete ordinate transport code, DOT-IIW. The nuclear system is described geometrically in NAGS as a series of rectangular or angular sector regions in a two-dimensional mesh cell layout. Figure 4-2 illustrates the limitations of the geometry and the method by which an irregular region,  $D$ , must be described. Because the program operates on each NAGS region as a separate problem, the maximum number of NAGS regions in a single problem is unlimited.

The integration techniques used to obtain particle fluxes, reaction rates, response rates, or particle source data are identical to the DOT-IIW transport method program techniques. Hence, completely consistent results are obtained in NAGS and DOT-IIW, i.e., the total number of neutrons and photons from the DOT-IIW problem is conserved. Interpolation and extrapolation techniques employed in NAGS are based on a linear variation of flux or source in the mesh cells and an exponential falloff of flux or source at the external boundaries of the reactor mockup.

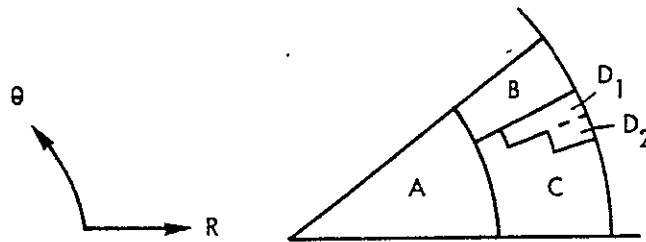
### 4.3.2 Flux Normalization

Normalization of the flux data is performed after redefinition of the mesh cell description. The constants for the calculation of the normalization factor,  $NF$ , are dependent upon the source of the flux data (i.e., neutron flux from DOT-IIW neutron transport, neutron flux from a previous NAGS problem, or photon flux from DOT-IIW). The user of NAGS has at his disposal a six parameter normalization factor. These six parameters are required input for each problem and are, also, descriptive of neutron flux normalization constants for a DOT-IIW problem. The normalization factor is computed as:

1. R-Z GEOMETRY



2. R- $\theta$  GEOMETRY



NOTE: A, B, C, D ARE MASTER REGIONS,  $D_1$ ,  $D_2$  ARE  
SUBREGIONS OF MASTER REGION D  
REGION DESCRIPTIONS FOR A, B, C,  $D_1$ ,  $D_2$   
ARE REQUIRED INPUT FOR NAGS

Figure 4-2. Sample Irregular Region Geometry for the NAGS Code

$$NF = \frac{\nu \cdot K_1 \cdot P}{K_2 \cdot k_{\text{eff}} \cdot f \cdot A}$$

where:

$\nu$  = the average number of neutrons per fission. (e.g.,

$\nu = 2.445$  for a nuclear rocket flight-type reactor).

$K_1$  = the fissions per second per watt of power.  $K_1$  is dependent upon the operating history, gamma ray energy production, and neutron and gamma ray energy leakage from a reactor system. For a nuclear rocket flight-type reactor with 15 minutes of full power operation, the fissions per second required to produce one watt of thermal power is calculated to be  $3.21 \times 10^{10}$  fissions/watt-second.

$P$  = the total reactor power in watts. Hence  $K_1 \times P$  gives the fissions per second at full reactor power.

$K_2$  = the parameter of revolutions. This parameter is 1.0 for  $r, z$ , DOT-IIW problems and is included in the calculation of  $NF$  to account for symmetry in the  $r, \theta$  plane. In  $r, \theta$  problems, the parameter  $K_2$  is  $\theta/2\pi$ .

$k_{\text{eff}}$  = the effective neutron multiplication factor (eigenvalue) of the DOT-IIW neutron transport problem and is used to normalize all fluxes to a critical ( $k_{\text{eff}} = 1.0$ ) reactor system.

$f$  = the fraction of fission events in the DOT-IIW problem which produce fission energy. This factor is included for the case when the  $(n, 2n)$  neutron interactions are included in the flux solution as pseudo-fission events. For DOT-IIW problems with the MSFC library cross sections, beryllium  $(n, 2n)$  cross sections are not included as fission and  $P$  is input as 1.0.

$A$  = the area (or volume) factor. This factor is required only if the neutron flux solution is normalized to some value other than the integral of fissions over the source volume. For DOT-IIW problems this value is always 1.0.

Hence, the normalization factor for a 1575 MW flight-type nuclear rocket reactor, in an  $r, z$ , DOT-IIW neutron transport problem with a multiplication factor of 1.01 is computed internally by NAGS as:

$$NF = \frac{2.445 * 3.21 \times 10^{10} * 1575 \times 10^9}{1.0 * 1.01 * 1.0 * 1.0} = 1.225 \times 10^{20}$$

Fluxes printed out by NAGS using the above normalization constant will be in units of  $\frac{\text{neutrons}}{\text{cm}^2\text{-sec}}$  at full power (1575 MW) conditions. In normalizing flux data from a photon

transport problem, or a previous NAGS problem, the six normalization parameters are normally set equal to 1.0 if the flux solution in the DOT-IIW photon transport problem is based on normalized distributed fixed source data supplied by the previous NAGS photon source problem. Also, the neutron flux data from the NAGS problem is a processed library data tape based on previously normalized flux data.

#### 4.3.3 Generation of Collapsed Mesh, Flux Tape

The final operation on the input flux data is the generation of a binary work tape containing the groupwise fluxes to be used in later reaction rate and response rate calculations. This data tape can be saved for use in subsequent NAGS problems. For example, the neutron flux data tape used in the calculation distributed photon sources is used as input for the combined neutron and photon energy deposition calculation. This neutron flux data tape has the same mesh cell description as the photon source data and the photon flux data.

The binary flux tape, which is generated on Tape 10, remains on this unit throughout the NAGS problem. The tape contains a logical tape record for each group with a total of ICM (number of redefined radial mesh cells)  $\times$  JCM (number of redefined axial mesh cells) pieces of data in each logical tape record.

#### 4.3.4 Library Data

Library data for a NAGS problem include standard neutron and photon multigroup constants as well as nuclear data for each element in the reactor geometry. This library is generated by the APPROPOS code in a format consistent with the NAGS code input requirements.

The nuclear constants required in the library for each neutron and photon energy group are:

- 1) Prompt fission photon energy,  $\Gamma_p^k$ , for each photon group,  $k$ .
- 2) Fission product decay photon energy,  $\Gamma_p^k$ , for each photon group,  $k$ , and for a specific reactor operating history (e.g., a nuclear rocket reactor with 60 minutes operation at full power).
- 3) Photon flux to dose rate conversion factors,  $K_D^k$ , for each photon group,  $k$ .
- 4) Neutron flux to dose rate conversion factors,  $K_D^g$ , for each neutron group,  $g$ .
- 5) Neutron multigroup parameters of upper lethargy,  $\mu^g$ , for each neutron group,  $g$ .

The other nuclear library data are required for each element or isotope,  $m$ , in the library and are as follows:

- 1) Identification number,  $NID_m$
- 2) Atomic mass,  $A_m$
- 3) Average energy of each alpha particle emission from neutron capture,  $E(n, \alpha)$
- 4) A six (6) character alphanumeric title (i.e., HYDROG, CARBON, etc.)
- 5) Inelastic neutron scattering photon energy,  $\Gamma_{sgm}^k$ , from an inelastic event in neutron group,  $g$ , for photon energy release in group,  $k$ .
- 6) The "effective" energy deposition cross section  $\sigma_g^{el, eff}$  which is computed

by

$$\sigma_g^{el, eff} = \frac{\Delta E_g}{\Delta U_g} \times \frac{2A}{(A+1)^2} \times (1 - \mu_g^{cm}) \times \sigma_g^{el}$$



where

$\frac{\Delta E_g}{\Delta U_g}$  is the average energy of group  $g$ ,

$\frac{2A}{(A+1)^2}$  is the average energy loss per collision,

$(1 - \mu_g^{cm})$  is the convection term for anisotropic scattering,

$\Delta E_g$  is the energy width of group  $g$ ,

$\Delta U_g$  is the lethargy width of group  $g$ ,

$A$  is the atomic mass of the scattering nucleus,

$\mu_g^{cm}$  is the average cosine of the scattering angle in the center-of-mass coordinate system for group  $g$ ,

$\sigma_g^{el}$  is the total microscopic elastic scattering cross section for group  $g$ ,

- 7) Neutron absorption cross section for  $(n, \alpha)$  reaction,  $\sigma_{n,\alpha}^g$  for each neutron group,  $g$ .
- 8) Neutron radiative capture photon energy,  $\Gamma_{cm}^k$ , for each material and photon group,  $k$ .
- 9) Photon mass energy absorption coefficient  $(\frac{\mu}{\rho})_{am}^k$  for each photon group,  $k$ .
- 10) Neutron fission cross sections,  $\sigma_{fm}^g$ , for each neutron group,  $g$ .
- 11) Neutron radiative capture cross sections,  $\sigma_{cm}^g$ , for each neutron group,  $g$ .
- 12) "Effective" energy deposition cross sections,  $\sigma_{el, eff}^g$ , for each fast neutron group,  $g$ .
- 13) Neutron inelastic scattering cross sections,  $\sigma_{sm}^g$ , for each fast neutron group for which inelastic scattering is to be calculated.

The last four sets of cross section data (defined above) are required input only

when the user employs the NAGS library option of region independent cross section data.

#### 4.3.5 Region Data

Region input data for a NAGS problem are dependent on the type of calculation being performed. The region data are processed on an individual region basis. Required data for each region are:

- 1) A seventy-two (72) character alphanumeric title describing the region
- 2) Region boundary mesh cell numbers in the redefined mesh cell description
- 3) The number of elements in the region, and
- 4) A program control the reading of new region data or to proceed to the next step of the NAGS data processing.

There are two types of calculations which can be performed by NAGS. The first type is the neutron interaction calculation which results in the production of neutron and photon sources in the mesh cells. The second type is the calculation of neutron and/or photon interactions which results in energy deposition in the mesh cell.

Region input data required for a photon source calculation are dependent on the NAGS library used for the problem. The element microscopic cross section data described below are only required when the NLIB = 0 option is used. The region input data required for each element,  $m$ , follows as:

- 1) Element identification number,  $L_m$ ,
- 2) Element number density,  $N_m$ ,
- 3) Element microscopic groupwise neutron cross sections for,
  - (a) fission,  $\sigma_{fm}^g$ ,
  - (b) radiative capture,  $\sigma_{cm}^g$ ,
  - (c) "effective" energy deposition,  $\sigma_{em, eff}^g$ ,
  - (d) inelastic scattering,  $\sigma_{sm}^g$ .

The region data required for calculation of energy deposition of neutrons and photons are input for the material (e.g., fueled graphite, stainless steel, etc.) in the NAGS region. This technique is used because reactor components or structures are represented as part of a homogeneous region material in neutron and photon transport. For subsequent thermal analyses, the total heating and its distribution in these components is required. Hence, an Inconel bolt can be represented individually in a region to obtain its total heating. The input data required for the energy deposition calculation in each material,  $n$ , in each region are:

- 1) Material density in the region,  $\rho_n$
- 2) Weight of the material in the region,  $W_n$

Input data for each element or constituent of the above material (if NLIB = 1) are required as:

- 1) Element identification number,  $L_m$
- 2) Weight fraction,  $N_m$  of the element,  $L_m$ , in material,  $n$ .

The data are then processed on a mesh cell basis to obtain the total photon source or energy deposition in each mesh cell of a region.

An option is included in the program to eliminate repetitive input data for a NAGS region of identical composition to the previous NAGS region. This option is specified by a negative sign on the number of elements for a NAGS region. The program will then use the region element data ( $L_m$ ,  $N_m$  and element cross sections) from the preceding NAGS region for all calculations in that region.

#### 4.3.6 Problem Size Determination

To determine the number of core memory storage locations required for data of a given problem, each of the expressions below should be evaluated and summed as noted. The value of the sum, including the conditions imposed on the expressions, provides the value of the required input parameter, NMAXRS, on card 1 of Data Set 1. For a NAGS calculation to run successfully, the input value of NMAXRS must be greater than or equal to the

calculated value of NMAXRS. All quantities in the expressions below are required input parameters defined in Section 4.2.2 except where defined. The symbolism,  $\text{MAX}(x_1, x_2, \dots)$ , signifies the maximum value of the quantities or expressions,  $x_i$ , in the parenthesis is used in the calculation of the overall expression.

$$1. A_1 = 2 * [(ICT * JCT) + (ICT + JCT + 1)]$$

$$2. A_2 = [(ICM * JCM) * (NGG + 2)] + [(ICM + JCM) * 10] , \text{ for } NTYPE = 1$$

or

$$A_2 = [(ICM * JCM) * 3] + [(ICM + JCM) * 10] , \text{ for } NTYPE = 2 \text{ or } 3$$

$$3. A_3 = NEL * [(NGN * 3) + [(NI + 2) * NGG] + [(NFAST * 2) + NI] + 8]$$

$$4. A_4 = [4 * NGG] + [5 * NGN]$$

$$5. A_5 = 0, \text{ for } NGSDP = 0 \text{ or } 1.$$

or

$$A_5 = \text{MAX}(ICT, JCT) , \text{ for } NGSDP = 2 \text{ or } 3$$

$$6. A_6 = 0, \text{ for } NPLOT = 0$$

or

$$A_6 = 2 * \text{MAX}(ICT, JCT) , \text{ for } NPLOT = 1$$

The summation of  $A_i$ 's yields the total storage locations for a particular problem, such that:

$$NMAXRS = \sum_{i=1}^6 A_i$$

## 4.4 PROBLEM SETUP INFORMATION

This section describes the data deck setup for the NAGS code. Information on tape assignments, running time, error messages, and a sample problem, card input is provided.

### 4.4.1 Tape Assignments

The NAGS code requires a maximum of 5 tape or disk files. The specific number of files required is dependent upon the type of calculation. The file assignments for the NAGS code are:

- Tape 5 Input Disk
- Tape 6 Printed Output Disk
- Tape 7 Punched Output Disk
- Tape 8 Distributed Source Output Tape (NTYPE = 1)
- Tape 9 Intermediate Scratch Disk
- Tape 10 Scratch Disk Containing Fluxes from Mesh Cell Deletion Operation
- Tape 11 Input Flux Tape (NTYPE and NBIN)
- Tape 12 Input Flux Tape (NTYPE and NBIN)

Generally, disk devices should be requested for tapes 9 and 10.

### 4.4.2 Running Time

A typical, design calculation (containing 3000 mesh cells, 16 neutron energy groups, 13 gamma ray groups, 15 elements, and 60 regions) to compute the neutron and gamma ray source distributions requires 5 to 10 minutes of UNIVAC-1108 CPU time.

### 4.4.3 Error Messages

A number of NAGS code generated error messages may be encountered in running a NAGS problem. These messages are primarily due to incorrect problem input. The error

messages are generally self-explanatory.

<u>Message</u>	<u>Explanation</u>
Dimension error. Overflow of (1400, for example) locations)	Problem is too large to fit on the computer or else the value of NMAXRS was input incorrectly
Error in radial or axial dimensions	Either $R_{i+1} < R_i$ or $Z_{i+1} < Z_i$
Error in radial or axial mesh indexing	Either $IC_{i+1} < IC_i$ or $JC_i < JC_i$
Element No. (37, for example) is not in library	An element has been requested that does not appear in the library or else the element number was input incorrectly

#### 4.4.4 Sample Problem Input

A listing of the input data for a NAGS sample problem has been included in this report in Table 4-2 to illustrate the structure of a complete set of input data. The printout for this sample problem is presented in Section 4.5.1.

TABLE 4-2

SAMPLE PROBLEM CARD INPUT FOR THE NAGS CODE

```

53000
34 34 80 80 16 11 6 13 8 1 1 1 0 9 1
PROBLEM 15.701 2-D NAGS SOURCE CALCULATION, MSFC SAMPLE PROBLEM
0 1 0 0 0 1 1 2 80
0.0
1.0 1.0 1.0 1.0 1.0 1.0
.22758648 .34550195 .18047802 .15218986 .07861765 .01536485
.00026119 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
3.01049 2.64814 2.55098 2.49739 2.45818 2.43868
2.43513 2.43422 2.43401 2.4340 2.4340 2.4340
2.4340 2.4340 2.4340 2.4340
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
26 27 28 29 30 31 32 33 34 35
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73
74 75 76 77 78 79 80 81
0.0 7.0 12.0 16.0 20.0 24.0
28.0 32.0 35.0 38.0 40.0 42.0
43.5 45.0 46.0 47.0 47.75 48.50
49.0 49.5 50.0 50.4 50.8 51.3
52.0 53.0 54.5 55.88 57.5 59.0
60.5 62.0 63.5 65.0 66.04
0.0 1.0 2.5 3.5 6.0 9.0
14.0 20.0 27.0 34.0 41.0 48.0
55.0 62.0 69.0 76.0 83.0 90.0
97.0 104.0 111.0 118.0 125.0 130.0
133.0 135.0 136.3 137.16 138.0 139.0
139.7 140.9 143.9 147.9 151.9 154.94
155.07 155.20 155.33 155.46 155.59 155.72
155.85 156.04 156.44 157.04 158.14 159.24
160.74 162.24 163.74 165.24 167.24 169.24
171.24 173.24 175.24 177.24 179.24 181.24
183.24 185.24 186.74 188.24 189.24 190.24
190.94 191.64 192.04 192.24 192.44 192.64
192.84 192.94 193.04 198.0 204.0 210.0
215.9 217.5 218.44
8
3.00000E-03 1.50000E-02 4.00000E-02 1.11000E-01 2.52000E-01 5.59000E-01
3.63000E-01 5.03000E-01 7.08000E-01 9.47000E-01 1.38900E&00 2.05300E&00
1.23500E&00
0. 0. 0. 4.27000E-02 2.30200E-01 5.87000E-01
3.69000E-01 5.00000E-01 5.87000E-01 8.51000E-01 1.00900E&00 1.15200E&00
2.67000E-01
1.06300E-06 1.08300E-06 1.11600E-06 1.16600E-06 1.24000E-06 1.33200E-06
1.41700E-06 1.50400E-06 1.56400E-06 1.67300E-06 1.80300E-06 2.11200E-06
3.51600E-06

```

TABLE 4-2 (Continued)

1.20000E-04	1.05000E-04	8.80000E-05	6.35000E-05	3.25000E-05	1.03000E-05
1.15000E-06	1.73000E-07	2.10000E-08	9.00000E-09	1.90000E-08	5.62000E-08
1.00000E-07	1.00000E-07	1.00000E-07	1.00000E-07		
0.	1.25000E&00	2.00000E&00	2.50000E&00	3.25000E&00	4.50000E&00
6.50000E&00	7.50000E&00	9.75000E&00	1.17500E&01	1.37500E&01	1.55000E&01
1.73000E&01	1.82000E&01	1.89000E&01	2.00000E&01		
1	1.00797E&00	0.		HYDRGG	
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.					
0.	2.22500E&00	0.	0.	0.	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
2.56600E-02	2.67000E-02	2.83600E-02	3.06500E-02	3.39300E-02	3.78400E-02
4.12200E-02	4.37300E-02	4.65800E-02	5.02500E-02	5.43500E-02	6.37100E-02
1.05000E-01					
5	1.20111E&01	0.		CARBON	
0.	0.	0.	0.	4.26700E&00	0.
0.	0.	0.	0.	0.	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.





TABLE 4-2 (Continued)

0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	3.37500E-01	1.19100E-01
0.	0.	0.	0.	3.74400E-01	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
1.55200E-02	1.58500E-02	1.64200E-02	1.72500E-02	1.84800E-02	2.00200E-02
2.13400E-02	2.24300E-02	2.37100E-02	2.53900E-02	2.73900E-02	3.20800E-02
5.33700E-02					
10	2.35044E-02	0.		U-235	
0.	0.	0.	0.	3.66200E-03	3.74900E-02
7.23400E-02	1.49400E-01	2.81100E-01	5.65700E-01	8.55300E-01	9.39200E-01
2.38300E-01					
0.	0.	0.	0.	0.	0.
8.00600E-04	6.07200E-03	3.01900E-02	1.70600E-01	4.84300E-01	8.12500E-01
2.60400E-01					
0.	0.	0.	0.	0.	0.
0.	0.	0.	2.04600E-02	1.68200E-01	5.02200E-01
2.16600E-01					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	2.31100E-02	1.81300E-01
2.00500E-01					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	9.48200E-02
1.67900E-01					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	9.47400E-02
1.17800E-01					
0.	0.	8.49300E-02	5.18200E-02	2.08100E-01	4.59700E-01
3.21900E-01	4.57600E-01	5.74400E-01	7.87000E-01	1.15900E-01	1.69400E-01
6.09500E-01					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
4.27900E-02	4.15600E-02	3.99400E-02	3.80400E-02	3.57000E-02	3.35100E-02
3.23200E-02	3.19600E-02	3.19200E-02	3.46500E-02	4.39500E-02	1.07800E-01
4.42700E-01					

TABLE 4-2 (Continued)

12	2.38051E-02	0.			U-238	
0.	0.	4.39900E-02	4.72700E-01	6.73000E-01	3.88100E-01	
1.22900E-01	1.29000E-01	1.43700E-01	1.79500E-01	1.82900E-01	2.36000E-01	
1.74400E-01						
0.	0.	0.	0.	0.	0.	
5.33700E-03	2.36100E-02	4.60000E-02	1.11200E-01	1.74200E-01	2.78500E-01	
2.18700E-01						
0.	0.	0.	0.	0.	0.	
0.	0.	0.	8.63200E-03	5.20500E-02	2.38600E-01	
1.94100E-01						
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	6.92500E-03	1.21200E-01	
2.02500E-01						
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	5.62100E-02	
9.95400E-02						
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
0.						
0.	0.	0.	0.	1.12000E-01	4.50000E-01	
1.04000E-01	2.99000E-01	6.34000E-01	7.16000E-01	6.19000E-01	1.06900E-01	
6.26000E-01						
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.			
4.27900E-02	4.15600E-02	3.99400E-02	3.80400E-02	3.57000E-02	3.35100E-02	
3.23200E-02	3.19600E-02	3.19200E-02	3.46500E-02	4.39500E-02	1.07800E-01	
4.42700E-01						
27	5.19960E-01	0.			CHROMI	
5.56400E-01	1.37400E-01	4.92800E-01	4.62200E-01	7.28400E-01	5.86400E-01	
1.95100E-01	1.51400E-01	1.65300E-01	3.52700E-01	4.99000E-01	2.92200E-01	
1.26100E-01						
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
0.						
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
0.						
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
0.						
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
0.						
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	

TABLE 4-2 (Continued)

0.					
4.64900E+00	8.67300E-01	7.79100E-01	5.73800E-01	2.29300E-01	2.88200E-01
0.	9.92000E-02	8.03900E-02	7.48300E-02	8.33200E-02	4.57800E-01
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
2.28500E-02	2.25800E-02	2.23300E-02	2.20500E-02	2.18200E-02	2.17500E-02
2.19100E-02	2.22200E-02	2.28500E-02	2.38800E-02	2.55800E-02	3.05400E-02
5.48500E-02					
29 5.58470E+01	0.				
				IRON	
1.32500E-01	6.51400E-02	2.33600E-01	4.21300E-01	3.24900E-01	7.98000E-01
5.09500E-01	4.36700E-01	4.95900E-01	5.68600E-01	4.73700E-01	3.37700E-01
8.30700E-02					
0.	0.	0.	0.	0.	0.
2.10000E-03	1.80000E-03	3.34800E-02	6.19500E-02	2.52000E-01	2.65100E-01
6.52000E-02					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	2.34800E-01	2.67400E-01
6.57800E-02					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
3.70900E+00	5.29800E-01	7.16000E-01	7.52700E-01	6.59700E-01	6.49300E-01
2.27300E-01	0.	9.79900E-02	3.27600E-01	2.55400E-02	2.53400E-02
4.67400E-02					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
2.39800E-02	2.36600E-02	2.33300E-02	2.29400E-02	2.25400E-02	2.23300E-02
2.23900E-02	2.26300E-02	2.32000E-02	2.41900E-02	2.59100E-02	3.11700E-02
5.72700E-02					
31 5.87100E+01	0.				
				NICKEL	
6.31800E-02	3.37500E-02	1.98300E-01	2.92400E-01	5.90900E-01	5.40200E-01
3.44600E-01	3.68700E-01	2.47800E-01	1.23400E+00	4.07700E-01	2.63700E-01
8.45300E-02					
0.	0.	0.	0.	0.	0.
0.	3.91600E-03	2.81600E-02	1.24600E+00	2.86700E-01	2.53400E-02

TABLE 4-2 (Continued)

0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	1.20300E-00	2.52200E-01	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.					
6.30600E-00	8.05600E-02	1.13500E-00	4.77600E-01	1.38000E-01	1.44300E-01
1.89900E-01	4.35400E-02	9.18000E-02	6.40000E-02	3.51700E-02	8.76300E-02
7.32100E-02					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
2.54600E-02	2.50700E-02	2.46400E-02	2.41700E-02	2.36800E-02	2.33000E-02
2.32300E-02	2.34000E-02	2.39300E-02	2.48000E-02	2.66700E-02	3.21600E-02
6.10800E-02					
127	9.29060E-01	0.		NIGBIU	
0.	0.	0.	0.	0.	0.
0.	0.	1.92000E-00	0.	0.	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	1.92000E-00	0.	0.	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	1.08000E-00	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	7.41300E-01
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.					
4.70000E-02	1.20000E-01	3.18000E-01	1.18800E-00	1.23100E-00	1.48200E-00
6.72000E-01	6.98000E-01	6.98000E-01	4.00000E-01	1.45000E-01	9.30000E-02
1.20000E-01					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

TABLE 4-2 (Continued)

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
2.92900E-02	2.86200E-02	2.78100E-02	2.67600E-02	2.54500E-02	2.41900E-02
2.34500E-02	2.32100E-02	2.33400E-02	2.40000E-02	2.59400E-02	3.43600E-02
8.33600E-02					
RADIAL CORE CENTER REGION P1					
1	13	1	28	9	4
5	7.54000E-02				
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	3.48974E-07
8.69269E-06	1.41880E-05	4.02460E-05	1.09464E-04	2.87078E-04	6.31610E-04
1.22557E-03	1.81351E-03	2.66626E-03	5.03252E-03		
9.08066E-01	5.05130E-01	3.75930E-01	2.60614E-01	1.26680E-01	3.15478E-02
6.29482E-03	1.47791E-03	1.76559E-04	2.42593E-05	3.45624E-06	
4.53210E-02	0.	0.	0.	0.	0.
27	4.50000E-06				
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
5.84923E-03	2.93096E-03	4.01501E-03	4.00000E-03	4.75340E-03	6.53130E-03
2.50207E-02	4.17416E-02	3.90032E-02	9.85172E-02	2.43568E-01	5.32158E-01
1.03107E&00	1.51894E&00	2.19993E&00	4.12774E&00		
1.22257E-01	1.59622E-01	9.22759E-02	5.71190E-02	2.96628E-02	8.45080E-03
4.02053E-03	8.27698E-04	4.08414E-05	5.63454E-06	8.00685E-07	
1.30188E&00	5.38524E-01	6.60972E-02	1.64962E-03	0.	0.
1	8.02500E-05				
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	1.01116E-03	3.46556E-03	9.56791E-03	2.68259E-02	6.13091E-02
1.18981E-01	1.76031E-01	2.58804E-01	4.88972E-01		
2.1700E&00	1.60871E&00	1.23459E&00	9.31440E-01	5.73917E-01	2.04950E-01
5.26189E-02	1.24366E-02	1.50435E-03	2.06689E-04	2.94471E-05	
0.	0.	0.	0.	0.	0.
1	2.40750E-04				
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	1.01116E-03	3.46556E-03	9.56791E-03	2.68259E-02	6.13091E-02
1.18981E-01	1.76031E-01	2.58804E-01	4.88972E-01		
2.11700E&00	1.60871E&00	1.23459E&00	9.31440E-01	5.73917E-01	2.04950E-01
5.26189E-02	1.24366E-02	1.50435E-03	2.06689E-04	2.94471E-05	
0.	0.	0.	0.	0.	0.

TABLE 4-2 (Continued)

29	2.91000E-05					
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.
5.80229E-03	2.92126E-03	4.01728E-03	5.00760E-03	5.82127E-03	2.60135E-02	
5.57471E-02	4.27721E-02	4.76414E-02	8.20592E-02	1.95652E-01	4.64203E-01	
8.99067E-01	1.32425E00	1.91897E00	3.60061E00			
1.30685E-01	1.01528E-01	6.01563E-02	5.69963E-02	2.41738E-02	9.74023E-03	
2.43662E-03	5.11586E-04	1.00192E-04	1.42973E-05	2.03694E-06		
1.21653E00	6.89274E-01	2.76909E-01	0.	0.	0.	
31	5.40000E-05					
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.
1.99178E-01	8.03013E-02	1.50000E-02	1.29965E-02	9.91540E-03	1.33923E-02	
1.81230E-02	2.43469E-02	5.46080E-02	1.29857E-01	3.27500E-01	8.44371E-01	
1.63497E00	2.40809E00	3.48938E00	6.54779E00			
1.16224E-01	1.23044E-01	1.03101E-01	5.98817E-02	3.93383E-02	2.16557E-02	
4.72784E-03	1.83108E-03	1.43090E-04	2.04617E-05	2.93210E-06		
1.33262E00	8.08237E-01	0.	0.	0.	0.	
127	2.00000E-04					
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.
0.	0.	3.24937E-02	5.19452E-02	7.66140E-02	3.17851E-01	
7.63640E-01	1.38592E00	1.35340E00	2.39832E-01	0.	2.01961E-01	
3.90955E-01	5.75818E-01	8.34451E-01	1.56560E00			
7.50313E-02	6.58131E-02	8.90552E-02	7.73842E-02	4.17989E-02	8.54890E-03	
1.46218E-03	3.24611E-04	3.61916E-05	4.89326E-06	6.97145E-07		
2.07432E00	1.74822E00	7.96587E-01	6.47492E-03	0.	0.	
10	1.74000E-04					
1.27709E00	1.28970E00	1.23002E00	1.18805E00	1.39953E00	2.25693E00	
4.19871E00	6.99173E00	1.73327E01	3.74176E01	2.60877E01	6.78783E01	
1.85408E02	2.68181E02	4.34848E02	8.86653E02			
2.36118E-02	5.25910E-02	9.21408E-02	1.56516E-01	3.05837E-01	7.70792E-01	
1.7941E00	3.22406E00	8.63740E00	2.35536E01	1.84506E01	1.16230E01	
3.95214E01	4.69418E01	7.60849E01	1.55192E02			
3.49747E-02	3.33389E-02	2.30221E-02	1.62182E-02	1.15926E-02	3.78874E-03	
8.33250E-04	1.96378E-04	2.33971E-05	3.93205E-06	5.07664E-07		
1.91011E00	1.75340E00	1.53611E00	1.63361E00	1.32056E00	8.48940E-02	
12	1.40000E-05					
6.03293E-01	4.62700E-01	2.50127E-02	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
1.14151E-02	4.90165E-02	1.24987E-01	1.36793E-01	1.81945E-01	2.90633E-01	
3.99396E-01	1.62498E00	9.00224E00	4.62022E01	6.22639E01	4.98406E-01	
9.63881E-01	1.41999E00	2.05962E00	3.88053E00			
4.01062E-02	2.99111E-02	2.43606E-02	2.29898E-02	1.44995E-02	4.99696E-03	

TABLE 4-2 (Continued)

1.19125E-03 3.44526E-04 2.35423E-05 3.23450E-06 4.46035E-07  
2.47843E00 2.52100E00 2.12516E00 1.62838E00 1.01087E00 1.26831E-01

## 4.5 DESCRIPTION OF OUTPUT

The NAGS code provides printed output, tape output, and punched card output to interface with subsequent point kernel, discrete ordinates transport, and/or Monte Carlo analyses. Each of the forms of output are described in this section.

### 4.5.1 Printed Output

The first section of output from a NAGS calculation (as shown in Table 4-3) is a listing of the storage requirements and starting locations of the variables in the flexible dimension allocation. The code then prints a message indicating the total number of storage locations required to execute the problem.

The next page of output lists selected parameters in Data Set 1. These parameters set the variable dimension requirements. Below this listing is a tabulation of the IC, JC, R, and Z arrays. The IC and JC arrays are used to perform mesh deletion operations; the R and Z arrays are the coordinate dimensions of the mesh lines bounding the mesh cells in the problem geometry. The code lists the neutron fission parameters,  $\chi_g$  and  $\nu_g$ , as a function of neutron energy group. The zero reference plane is printed below the tables. This parameter provides a convenient method of shifting the z - coordinates for heating calculations.

The problem normalization factors are printed on the next page. The last parameter, the power normalization factor, is the computed scale factor for the flux normalization.

The next section of output lists the neutron and/or photon scalar fluxes by mesh cell and energy group. These fluxes have been normalized by NAGS, and mesh deletion operations have been performed.

The library input data are printed next. The first section lists the prompt and decay gamma ray spectrum of energy released from the fission of <sup>235</sup>Uranium. Neutron and gamma ray dose rate conversion factors as well as the upper lethargy of each neutron group are also listed. Library data for each element are printed next. The atomic mass units of the element, the energy of the emitted a particle, the element name, the spectrum of gamma ray energy emitted from thermal neutron capture and inelastic neutron scattering, and the mass/energy



absorption coefficient are listed, by element.

The next section of printout lists the region title, the parameters, IS, IF, JS, JF, NELE, and IND, as well as the region-dependent or-independent microscopic cross section data by element within the region. These data are repeated for each region in the problem.

The next section lists the results of the calculations within each region. If the calculation is a source calculation, the following information is printed:

- 1) The parameters, IS, JS, JF, and JS and their corresponding mesh line coordinate;
- 2) The number of elements within the region;
- 3) The GAM ID number, the element name, the atom density (in barns/atom  $\times 10^{24}$ ), the physical density (in gms/cm<sup>3</sup>), the weight (in grams), the number of fissions (fissions/sec), and the number of inelastic neutron scattering events (neutron inelastic scatters/sec).  
These quantities are region integrated quantities, where applicable;
- 4) The region volume (in cm<sup>3</sup>);
- 5) The region weight (in grams);
- 6) The region integrated photon source (MeV/sec), fissions (fissions/sec), neutron source (neutrons/sec), and the photon source by photon energy group for both region integrated and region average conditions;
- 7) The region integrated neutron flux;
- 8) The relative photon, fission, and neutron distributions in each of the coordinate directions;

- 9) The actual data points that are plotted (if requested); and
- 10) The card images of the source distributions punched on cards and provided for the KAP-VI code (if requested).

The next page of output lists the total photon source (MeV/sec), the total fissions (fissions/sec), and the total neutron source (neutrons/sec) over the entire problem geometry.

The next section of output lists the neutron source distribution by mesh cell. These data are followed by a listing of the fission source distribution by mesh cell. These two output data differ by  $\nu_g$ , the number of neutrons released per fission as a function of neutron group,  $g$ .

The photon distributed source by mesh cell and by photon energy group is the final section of printout for a source calculation.

For a heating calculation, the region output from the region calculation lists the total neutron and photon energy deposition as well as the relative distributions along the coordinate axes.

Following these region data, the neutron and gamma ray dose rate, by mesh cell, are listed.

#### 4.5.2 Tape Output

At the conclusion of a source calculation, the distributed neutron or photon source (depending on NPUN) by mesh cell and energy group is placed on tape 8 in the form acceptable to the ANISN-W and DOT-IIW codes. The neutron source tape contains NGN records, where each record is ICM by JCM words long (if zeros are not added); the photon source tape contains NGG records, where each record is also ICM by JCM in length.

Tape 10 contains the normalized, mesh cell deleted, scalar fluxes. This tape may be used for a subsequent NAGS calculation or as a flux guess for subsequent DOT-IIW calculations.

Both tapes 8 and 10 contain end-of-file marks after the required data.

### 4.5.3 Punched Card Output

Punched card output consists of punched output source distributions in the format acceptable to the KAP-VI point kernel code. These cards are listed in the region output data for convenience.

TABLE 4-3

SAMPLE PROBLEM COMPUTER PRINTOUT FOR THE NAGS CODE

THE STORAGE REQUIREMENTS ARE DETERMINED FROM THE I ARRAY AS FOLLOWS

14	34	80	80	16	11	6	13	8	35	81	34	80	2720	15	80	160
AND THE STARTING LOCATIONS OF EACH								VARIABLE ARE DETERMINED FROM THE J ARRAY								
1	36	117	151	231	265	345	379	459	3179	5899	46699	46715	46731	46744	46757	46765
46893	47021	47069	47157	47261	47885	47893	47893	47901	47989	48117	48117	48133	48133	48149	48253	48266
48300	48380	48482	48584	48824	49064	49098	49178	49191	49199	49207	49215	49295	49455	49615	49615	49649
49709	49737	49745														

TABLE 4-3 (Continued)

YOUR NAGS IV PROBLEM HAS USED 49745 LOCATIONS OF THE AVAILABLE 53000 DATA STORAGE LOCATIONS

PROBLEM IN LINK 1

TABLE 4-3 (Continued)

PROGRAM NAGS IV

PROBLEM 15.701 2-D NAGS SOURCE CALCULATION, MSFC SAMPLE PROBLEM

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. . . . .
NO. OF RADIAL MESH INTERVALS** 34
NO. OF COL. INTERVALS (R) ***** 34
NO. OF AXIAL MESH INTERVALS** 80
NO. OF COL. INTERVALS (Z) *** 80
PUNCH OPTION***** 1
NO. OF NEUTRON GROUPS***** 16
NO. OF GAMMA RAY GROUPS***** 13
NO. OF MATERIALS***** 8
TAPE INPUT***** 1
LIBRARY OPTION***** 0
TAPE OUTPUT***** 2
PLOT OPTION***** 1
PLOT CLASSIFICATION***** 0
NO. OF ZEHOS (RT)***** 0
NO. OF ZEHOS (LT)***** 0
STARTING INTERVAL(R)***** 1
STARTING INTERVAL(Z)***** 1

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. . . . .
IC(I)  2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
        26 27 28 29 30 31 32 33 34 35

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

JC(J)  50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73
        74 75 76 77 78 79 80 81

R(I)   0.000  7.000  12.000  16.000  20.000  24.000  28.000  32.000  35.000  38.000
        40.000  42.000  43.500  45.000  46.000  47.000  47.750  48.500  49.000  49.500
        50.000  50.400  50.800  51.300  52.000  53.000  54.500  55.880  57.500  59.000
        60.500  62.000  63.500  65.000  66.040

Z(J)   0.000  1.000  2.500  3.500  6.000  9.000  14.000  20.000  27.000  34.000

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TABLE 4-3 (Continued)

41,000	48,000	55,000	62,000	69,000	76,000	83,000	90,000	97,000	104,000
111,000	118,000	125,000	130,000	133,000	135,000	136,300	137,160	138,000	139,000
139,700	140,900	143,900	147,900	151,900	154,940	155,070	155,200	155,330	155,460
155,590	155,720	155,850	156,040	156,440	157,040	158,140	159,240	160,740	162,240
163,740	165,240	167,240	169,240	171,240	173,240	175,240	177,240	179,240	181,240
183,240	185,240	186,740	188,240	189,240	190,240	190,940	191,640	192,040	192,240
192,440	192,640	192,840	192,940	193,040	198,000	204,000	210,000	215,900	217,500
218,440									

TABLE 4-3 (Continued)

NEUTRON FISSION PARAMETERS BY GROUP

GROUP	NU	CHI
1	3.01049E+00	2.27586E-01
2	2.64814E+00	3.45502E-01
3	2.55098E+00	1.80478E-01
4	2.49739E+00	1.52190E-01
5	2.45818E+00	7.86176E-02
6	2.43868E+00	1.53648E-02
7	2.43513E+00	2.61190E-04
8	2.43422E+00	0.
9	2.43401E+00	0.
10	2.43400E+00	0.
11	2.43400E+00	0.
12	2.43400E+00	0.
13	2.43400E+00	0.
14	2.43400E+00	0.
15	2.43400E+00	0.
16	2.43400E+00	0.

ZERO REFERENCE PLANE IS AT 0.000000 INCHES



TABLE 4-3 (Continued)

PROBLEM NORMALIZATION PARAMETERS

EFFECTIVE NU *****	1.00000E+00
FISSION FRACTION *****	1.00000E+00
KEFF *****	1.00000E+00
FISSION VOLUME *****	1.00000E+00
CONVERSION CONSTANT *****	1.00000E+00
NORMALIZATION CONSTANT *****	1.00000E+00
POWER NORMALIZATION FACTOR **	1.00000E+00

TABLE 4-3 (Continued)

NEUTRON FLUXES		GROUP NO. 1							
		1	2	3	4	5	6	7	8
		0.50	1.75	3.00	4.75	7.50	11.50	17.00	23.50
1	3.50	8.4804E-07	1.0652E-06	1.2665E-06	1.5186E-06	1.8862E-06	2.3727E-06	2.9915E-06	3.6581E-06
2	9.50	8.4614E-07	1.0630E-06	1.2638E-06	1.5155E-06	1.8826E-06	2.3681E-06	2.9859E-06	3.6508E-06
3	14.00	8.4301E-07	1.0594E-06	1.2597E-06	1.5107E-06	1.8768E-06	2.3609E-06	2.9765E-06	3.6392E-06
4	18.00	8.3840E-07	1.0540E-06	1.2538E-06	1.5038E-06	1.8683E-06	2.3503E-06	2.9628E-06	3.6222E-06
5	22.00	8.3174E-07	1.0461E-06	1.2446E-06	1.4932E-06	1.8555E-06	2.3340E-06	2.9419E-06	3.5962E-06
6	26.00	8.2148E-07	1.0342E-06	1.2311E-06	1.4774E-06	1.8361E-06	2.3093E-06	2.9098E-06	3.5568E-06
7	30.00	8.0630E-07	1.0164E-06	1.2108E-06	1.4536E-06	1.8068E-06	2.2714E-06	2.8610E-06	3.4975E-06
8	33.50	7.8756E-07	9.9422E-07	1.1855E-06	1.4240E-06	1.7697E-06	2.2234E-06	2.7999E-06	3.4232E-06
9	36.50	7.6441E-07	9.6712E-07	1.1542E-06	1.3870E-06	1.7231E-06	2.1632E-06	2.7245E-06	3.3313E-06
10	39.00	7.3905E-07	9.3731E-07	1.1202E-06	1.3460E-06	1.6712E-06	2.0972E-06	2.6422E-06	3.2310E-06
11	41.00	7.1217E-07	9.0545E-07	1.0835E-06	1.3019E-06	1.6150E-06	2.0271E-06	2.5547E-06	3.1241E-06
12	42.75	6.8299E-07	8.7079E-07	1.0432E-06	1.2532E-06	1.5536E-06	1.9513E-06	2.4597E-06	3.0079E-06
13	44.25	6.5118E-07	8.3334E-07	9.9920E-07	1.1997E-06	1.4874E-06	1.8692E-06	2.3566E-06	2.8812E-06
14	45.50	6.1968E-07	7.9582E-07	9.5526E-07	1.1459E-06	1.4217E-06	1.7872E-06	2.2531E-06	2.7537E-06
15	46.50	5.8977E-07	7.5928E-07	9.1214E-07	1.0939E-06	1.3578E-06	1.7073E-06	2.1512E-06	2.6287E-06
16	47.37	5.5967E-07	7.2273E-07	8.6795E-07	1.0414E-06	1.2929E-06	1.6255E-06	2.0470E-06	2.5013E-06
17	48.12	5.2990E-07	6.8628E-07	8.2396E-07	9.8851E-07	1.2276E-06	1.5422E-06	1.9419E-06	2.3729E-06
18	48.75	5.0266E-07	6.5206E-07	7.8263E-07	9.3873E-07	1.1654E-06	1.4635E-06	1.8429E-06	2.2520E-06
19	49.25	4.7843E-07	6.2106E-07	7.4472E-07	8.9298E-07	1.1083E-06	1.3918E-06	1.7529E-06	2.1420E-06
20	49.75	4.5181E-07	5.8610E-07	7.0147E-07	8.4114E-07	1.0443E-06	1.3119E-06	1.6525E-06	2.0194E-06
21	50.20	4.2544E-07	5.5000E-07	6.5720E-07	7.8910E-07	9.8038E-07	1.2324E-06	1.5526E-06	1.8976E-06
22	50.60	3.9807E-07	5.1253E-07	6.1314E-07	7.3742E-07	9.1728E-07	1.1539E-06	1.4541E-06	1.7774E-06
23	51.05	3.4957E-07	4.4944E-07	5.4029E-07	6.5120E-07	8.1202E-07	1.0225E-06	1.2894E-06	1.5773E-06
24	51.65	2.8179E-07	3.6118E-07	4.3644E-07	5.2845E-07	6.6134E-07	8.3444E-07	1.0530E-06	1.2876E-06
25	52.50	2.1291E-07	2.7162E-07	3.2874E-07	4.0030E-07	5.0309E-07	6.3660E-07	8.0416E-07	9.8369E-07
26	53.75	1.4542E-07	1.8517E-07	2.2455E-07	2.7507E-07	3.4731E-07	4.4094E-07	5.5795E-07	6.8273E-07
27	55.19	9.4523E-08	1.2012E-07	1.4566E-07	1.8025E-07	2.2910E-07	2.9157E-07	3.6972E-07	4.5259E-07
28	56.69	6.3241E-08	8.0137E-08	9.6629E-08	1.2048E-07	1.5463E-07	1.9750E-07	2.5064E-07	3.0703E-07
29	58.25	4.2208E-08	5.3112E-08	6.3927E-08	7.9545E-08	1.0304E-07	1.3252E-07	1.6837E-07	2.0633E-07
30	59.75	2.8940E-08	3.6526E-08	4.3775E-08	5.4014E-08	7.0552E-08	9.1162E-08	1.1619E-07	1.4242E-07
31	61.25	2.0006E-08	2.5266E-08	2.9872E-08	3.6884E-08	4.8095E-08	6.2691E-08	8.0017E-08	9.8176E-08
32	62.75	1.3851E-08	1.7125E-08	2.0315E-08	2.4949E-08	3.2307E-08	4.2500E-08	5.4340E-08	6.6707E-08
33	64.25	9.9640E-09	1.2223E-08	1.4488E-08	1.7521E-08	2.2644E-08	2.9854E-08	3.8362E-08	4.7071E-08
34	65.52	8.1077E-09	9.6562E-09	1.1244E-08	1.3594E-08	1.7373E-08	2.3024E-08	2.9642E-08	3.6421E-08
		9	10	11	12	13	14	15	16
		30.50	37.50	44.50	51.50	58.50	65.50	72.50	79.50
1	3.50	4.2998E-06	4.8518E-06	5.3052E-06	5.6511E-06	5.8830E-06	5.9966E-06	5.9893E-06	5.8615E-06
2	9.50	4.2911E-06	4.8422E-06	5.2946E-06	5.6398E-06	5.8713E-06	5.9846E-06	5.9774E-06	5.8498E-06
3	14.00	4.2774E-06	4.8268E-06	5.2777E-06	5.6218E-06	5.8527E-06	5.9655E-06	5.9583E-06	5.8312E-06
4	18.00	4.2575E-06	4.8043E-06	5.2530E-06	5.5956E-06	5.8253E-06	5.9376E-06	5.9305E-06	5.8040E-06
5	22.00	4.2270E-06	4.7699E-06	5.2154E-06	5.5555E-06	5.7835E-06	5.8951E-06	5.8880E-06	5.7624E-06
6	26.00	4.1810E-06	4.7178E-06	5.1584E-06	5.4949E-06	5.7203E-06	5.8308E-06	5.8237E-06	5.6994E-06
7	30.00	4.1111E-06	4.6389E-06	5.0723E-06	5.4030E-06	5.6248E-06	5.7333E-06	5.7264E-06	5.6042E-06
8	33.50	4.0234E-06	4.5404E-06	4.9647E-06	5.2882E-06	5.5054E-06	5.6114E-06	5.6047E-06	5.4851E-06

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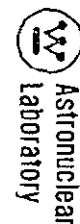


TABLE 4-3 (Continued)

9	36.50	3.9158E-06	4.4187E-06	4.8313E-06	5.1462E-06	5.3574E-06	5.4607E-06	5.4541E-06	5.3378E-06
10	39.00	3.7979E-06	4.2856E-06	4.6854E-06	4.9910E-06	5.1957E-06	5.2960E-06	5.2895E-06	5.1768E-06
11	41.00	3.6723E-06	4.1433E-06	4.5294E-06	4.8254E-06	5.0232E-06	5.1202E-06	5.1139E-06	5.0049E-06
12	42.75	3.5352E-06	3.9882E-06	4.3607E-06	4.6449E-06	4.8355E-06	4.9287E-06	4.9229E-06	4.8176E-06
13	44.25	3.3856E-06	3.8196E-06	4.1765E-06	4.4483E-06	4.6312E-06	4.7202E-06	4.7148E-06	4.6141E-06
14	45.50	3.2355E-06	3.6506E-06	3.9912E-06	4.2515E-06	4.4258E-06	4.5113E-06	4.5057E-06	4.4098E-06
15	46.50	3.0888E-06	3.4851E-06	3.8101E-06	4.0587E-06	4.2249E-06	4.3067E-06	4.3013E-06	4.2096E-06
16	47.37	2.9392E-06	3.3161E-06	3.6256E-06	3.8619E-06	4.0204E-06	4.0979E-06	4.0930E-06	4.0056E-06
17	48.12	2.7883E-06	3.1458E-06	3.4395E-06	3.6636E-06	3.8140E-06	3.8875E-06	3.8828E-06	3.8000E-06
18	48.75	2.6462E-06	2.9855E-06	3.2642E-06	3.4770E-06	3.6196E-06	3.6894E-06	3.6850E-06	3.6064E-06
19	49.25	2.5170E-06	2.8398E-06	3.1049E-06	3.3073E-06	3.4430E-06	3.5094E-06	3.5052E-06	3.4303E-06
20	49.75	2.3731E-06	2.6774E-06	2.9274E-06	3.1182E-06	3.2462E-06	3.3087E-06	3.3048E-06	3.2342E-06
21	50.20	2.2299E-06	2.5160E-06	2.7509E-06	2.9302E-06	3.0504E-06	3.1092E-06	3.1055E-06	3.0392E-06
22	50.60	2.0888E-06	2.3564E-06	2.5769E-06	2.7449E-06	2.8575E-06	2.9126E-06	2.9091E-06	2.8470E-06
23	51.05	1.9526E-06	2.0903E-06	2.2855E-06	2.4344E-06	2.5344E-06	2.5832E-06	2.5801E-06	2.5250E-06
24	51.65	1.5135E-06	1.7077E-06	1.8672E-06	1.9889E-06	2.0706E-06	2.1105E-06	2.1079E-06	2.0630E-06
25	52.50	1.1563E-06	1.3048E-06	1.4266E-06	1.5197E-06	1.5820E-06	1.6126E-06	1.6106E-06	1.5763E-06
26	53.75	8.0266E-07	9.0576E-07	9.9038E-07	1.0549E-06	1.0983E-06	1.1194E-06	1.1181E-06	1.0942E-06
27	55.19	5.3219E-07	6.0054E-07	6.5664E-07	6.9946E-07	7.2822E-07	7.4222E-07	7.4137E-07	7.2551E-07
28	56.69	3.6106E-07	4.0742E-07	4.4555E-07	4.7454E-07	4.9408E-07	5.0355E-07	5.0300E-07	4.9222E-07
29	58.25	2.4264E-07	2.7389E-07	2.9934E-07	3.1903E-07	3.2201E-07	3.3852E-07	3.3803E-07	3.3087E-07
30	59.75	1.6744E-07	1.8909E-07	2.0662E-07	2.2024E-07	2.2914E-07	2.3370E-07	2.3328E-07	2.2843E-07
31	61.25	1.1546E-07	1.3028E-07	1.4255E-07	1.5171E-07	1.5808E-07	1.6101E-07	1.6090E-07	1.5743E-07
32	62.75	7.8504E-08	8.8531E-08	9.6894E-08	1.0313E-07	1.0744E-07	1.0944E-07	1.0938E-07	1.0697E-07
33	64.25	5.5432E-08	6.2532E-08	6.8389E-08	7.2858E-08	7.5834E-08	7.7312E-08	7.7210E-08	7.5558E-08
34	65.52	4.2885E-08	4.8386E-08	5.2945E-08	5.6342E-08	5.8731E-08	5.9787E-08	5.9775E-08	5.8466E-08
		17	18	19	20	21	22	23	24
		86.50	93.50	100.50	107.50	114.50	121.50	127.50	131.50
1	3.50	5.6154E-06	5.2571E-06	4.7926E-06	4.2317E-06	3.5858E-06	2.8665E-06	2.1995E-06	1.7224E-06
2	9.50	5.6046E-06	5.2466E-06	4.7830E-06	4.2232E-06	3.5786E-06	2.8607E-06	2.1948E-06	1.7186E-06
3	14.00	5.5867E-06	5.2299E-06	4.7677E-06	4.2096E-06	3.5672E-06	2.8515E-06	2.1877E-06	1.7126E-06
4	18.00	5.5606E-06	5.2054E-06	4.7455E-06	4.1899E-06	3.5503E-06	2.8382E-06	2.1772E-06	1.7039E-06
5	22.00	5.5208E-06	5.1681E-06	4.7115E-06	4.1597E-06	3.5247E-06	2.8177E-06	2.1614E-06	1.6910E-06
6	26.00	5.4606E-06	5.1116E-06	4.6600E-06	4.1143E-06	3.4858E-06	2.7866E-06	2.1376E-06	1.6716E-06
7	30.00	5.3603E-06	5.0262E-06	4.5814E-06	4.0458E-06	3.4271E-06	2.7394E-06	2.1016E-06	1.6428E-06
8	33.50	5.2552E-06	4.9196E-06	4.4844E-06	3.9594E-06	3.3539E-06	2.6802E-06	2.0562E-06	1.6072E-06
9	36.50	5.1140E-06	4.7874E-06	4.3642E-06	3.8529E-06	3.2636E-06	2.6071E-06	1.9997E-06	1.5632E-06
10	39.00	4.9596E-06	4.6428E-06	4.2327E-06	3.7366E-06	3.1651E-06	2.5275E-06	1.9378E-06	1.5147E-06
11	41.00	4.7951E-06	4.4886E-06	4.0922E-06	3.6129E-06	3.0601E-06	2.4432E-06	1.8717E-06	1.4628E-06
12	42.75	4.6159E-06	4.3209E-06	3.9389E-06	3.4780E-06	2.9460E-06	2.3519E-06	1.8003E-06	1.4062E-06
13	44.25	4.4206E-06	4.1384E-06	3.7724E-06	3.3308E-06	2.8218E-06	2.2530E-06	1.7236E-06	1.3451E-06
14	45.50	4.2247E-06	3.9549E-06	3.6055E-06	3.1830E-06	2.6969E-06	2.1538E-06	1.6475E-06	1.2842E-06
15	46.50	4.0331E-06	3.7754E-06	3.4414E-06	3.0387E-06	2.5742E-06	2.0564E-06	1.5735E-06	1.2257E-06
16	47.37	3.8377E-06	3.5926E-06	3.2750E-06	2.8917E-06	2.4493E-06	1.9568E-06	1.4981E-06	1.1669E-06
17	48.12	3.6407E-06	3.4081E-06	3.1068E-06	2.7432E-06	2.3237E-06	1.8561E-06	1.4216E-06	1.1078E-06
18	48.75	3.4552E-06	3.2344E-06	2.9480E-06	2.6033E-06	2.2055E-06	1.7614E-06	1.3497E-06	1.0521E-06
19	49.25	3.2866E-06	3.0766E-06	2.8047E-06	2.4762E-06	2.0978E-06	1.6754E-06	1.2829E-06	1.0007E-06

TABLE 4-3 (Continued)

20	49.75	3.0987E-06	2.9007E-06	2.6444E-06	2.3347E-06	1.9778E-06	1.5796E-06	1.2093E-06	9.4283E-07
21	50.20	2.9118E-06	2.7258E-06	2.4849E-06	2.1939E-06	1.8585E-06	1.4843E-06	1.1360E-06	8.8521E-07
22	50.60	2.7277E-06	2.5534E-06	2.3277E-06	2.0552E-06	1.7409E-06	1.3904E-06	1.0639E-06	8.2836E-07
23	51.05	2.4192E-06	2.2646E-06	2.0645E-06	1.8227E-06	1.5441E-06	1.2330E-06	9.4319E-07	7.3340E-07
24	51.65	1.9765E-06	1.8502E-06	1.6867E-06	1.4891E-06	1.2614E-06	1.0072E-06	7.7001E-07	5.9770E-07
25	52.50	1.5101E-06	1.4137E-06	1.2887E-06	1.1378E-06	9.6374E-07	7.6947E-07	5.8764E-07	4.5533E-07
26	53.75	1.0484E-06	9.8138E-07	8.9463E-07	7.8985E-07	6.6902E-07	5.3401E-07	4.0729E-07	3.1554E-07
27	55.19	6.9514E-07	6.5068E-07	5.9322E-07	5.2366E-07	4.4365E-07	3.5381E-07	2.6992E-07	2.0935E-07
28	56.69	4.7163E-07	4.4147E-07	4.0245E-07	3.5532E-07	3.0093E-07	2.3994E-07	1.8339E-07	1.4178E-07
29	58.25	3.1698E-07	2.9671E-07	2.7052E-07	2.3882E-07	2.0218E-07	1.6137E-07	1.2327E-07	9.4819E-08
30	59.75	2.1875E-07	2.0483E-07	1.8674E-07	1.6478E-07	1.3962E-07	1.1140E-07	8.4981E-08	6.5093E-08
31	61.25	1.5080E-07	1.4126E-07	1.2865E-07	1.1368E-07	9.6197E-08	7.6849E-08	5.8379E-08	4.4690E-08
32	62.75	1.0255E-07	9.5981E-08	8.7449E-08	7.7301E-08	6.5344E-08	5.2289E-08	3.9465E-08	3.0320E-08
33	64.25	7.2415E-08	6.7748E-08	6.1791E-08	5.4545E-08	4.6172E-08	3.6902E-08	2.7761E-08	2.1464E-08
34	65.52	5.6028E-08	5.2442E-08	4.7809E-08	4.2212E-08	3.5734E-08	2.8544E-08	2.1444E-08	1.6768E-08
		25	26	27	28	29	30	31	32
		134.00	135.65	136.73	137.58	138.50	139.35	140.30	142.40
1	3.50	1.4014E-06	1.1730E-06	1.0123E-06	8.9670E-07	7.9817E-07	7.1904E-07	6.3357E-07	4.7731E-07
2	9.50	1.3980E-06	1.1699E-06	1.0094E-06	8.9393E-07	7.9534E-07	7.1618E-07	6.3091E-07	4.7497E-07
3	14.00	1.3927E-06	1.1651E-06	1.0044E-06	8.8944E-07	7.9097E-07	7.1193E-07	6.2668E-07	4.7117E-07
4	18.00	1.3851E-06	1.1581E-06	9.9824E-07	8.8317E-07	7.8480E-07	7.0570E-07	6.2066E-07	4.6592E-07
5	22.00	1.3737E-06	1.1478E-06	9.8870E-07	8.7387E-07	7.7549E-07	6.9652E-07	6.1194E-07	4.5820E-07
6	26.00	1.3569E-06	1.1326E-06	9.7444E-07	8.6009E-07	7.6209E-07	6.8334E-07	5.9912E-07	4.4716E-07
7	30.00	1.3322E-06	1.1103E-06	9.5364E-07	8.4018E-07	7.4252E-07	6.6398E-07	5.8075E-07	4.3157E-07
8	33.50	1.3018E-06	1.0830E-06	9.2842E-07	8.1598E-07	7.1883E-07	6.4087E-07	5.5880E-07	4.1331E-07
9	36.50	1.2648E-06	1.0502E-06	8.9801E-07	7.8681E-07	6.9062E-07	6.1341E-07	5.3291E-07	3.9258E-07
10	39.00	1.2248E-06	1.0148E-06	8.6528E-07	7.5582E-07	6.6062E-07	5.8425E-07	5.0579E-07	3.7149E-07
11	41.00	1.1824E-06	9.7761E-07	8.3125E-07	7.2347E-07	6.2949E-07	5.5445E-07	4.7840E-07	3.5085E-07
12	42.75	1.1362E-06	9.3771E-07	7.9496E-07	6.8901E-07	5.9653E-07	5.2308E-07	4.5001E-07	3.2986E-07
13	44.25	1.0864E-06	8.9528E-07	7.5621E-07	6.5256E-07	5.6222E-07	4.9065E-07	4.2147E-07	3.0848E-07
14	45.50	1.0369E-06	8.5334E-07	7.1832E-07	6.1740E-07	5.2891E-07	4.5985E-07	3.9499E-07	2.8814E-07
15	46.50	9.8922E-07	8.1314E-07	6.8282E-07	5.8421E-07	4.9820E-07	4.3216E-07	3.7102E-07	2.6979E-07
16	47.37	9.4107E-07	7.7329E-07	6.4759E-07	5.5149E-07	4.6860E-07	4.0581E-07	3.4839E-07	2.5278E-07
17	48.12	8.9321E-07	7.3399E-07	6.1321E-07	5.2031E-07	4.4059E-07	3.8146E-07	3.2801E-07	2.3804E-07
18	48.75	8.4854E-07	6.9747E-07	5.8196E-07	4.9202E-07	4.1583E-07	3.6083E-07	3.1058E-07	2.2638E-07
19	49.25	8.0781E-07	6.6471E-07	5.5444E-07	4.6751E-07	3.9524E-07	3.4416E-07	2.9726E-07	2.1864E-07
20	49.75	7.6142E-07	6.2806E-07	5.2451E-07	4.4165E-07	3.7464E-07	3.2899E-07	2.8621E-07	2.1226E-07
21	50.20	7.1414E-07	5.9027E-07	4.9513E-07	4.1756E-07	3.5808E-07	3.1838E-07	2.7803E-07	2.0703E-07
22	50.60	6.6725E-07	5.5081E-07	4.6461E-07	3.9801E-07	3.4715E-07	3.1035E-07	2.7151E-07	2.0248E-07
23	51.05	5.8980E-07	4.8498E-07	4.1169E-07	3.7224E-07	3.3670E-07	3.0077E-07	2.6460E-07	1.9735E-07
24	51.65	4.7939E-07	3.9362E-07	3.3860E-07	3.2339E-07	3.1243E-07	2.8606E-07	2.5368E-07	1.9048E-07
25	52.50	3.6459E-07	3.0115E-07	2.6334E-07	2.5706E-07	2.6235E-07	2.5272E-07	2.2912E-07	1.7790E-07
26	53.75	2.5295E-07	2.1093E-07	1.8758E-07	1.8665E-07	1.9756E-07	1.9841E-07	1.8344E-07	1.4890E-07
27	55.19	1.6772E-07	1.4184E-07	1.2871E-07	1.3000E-07	1.4205E-07	1.4906E-07	1.3905E-07	1.1141E-07
28	56.69	1.1377E-07	9.8179E-08	9.0694E-08	9.2486E-08	1.0225E-07	1.1041E-07	1.0810E-07	8.5223E-08
29	58.25	7.6907E-08	6.7655E-08	6.3672E-08	6.5191E-08	7.2273E-08	7.9185E-08	8.2784E-08	6.8942E-08
30	59.75	5.3568E-08	4.8030E-08	4.5656E-08	4.7001E-08	5.1648E-08	5.7292E-08	6.3434E-08	5.7353E-08

TABLE 4-3 (Continued)

31	61.25	3.7272E-08	3.4251E-08	3.2927E-08	3.3792E-08	3.7367E-08	4.1356E-08	4.7084E-08	4.8293E-08
32	62.75	2.5746E-08	2.4092E-08	2.3628E-08	2.4221E-08	2.6820E-08	3.0222E-08	3.4936E-08	3.9589E-08
33	64.25	1.8670E-08	1.7717E-08	1.7386E-08	1.7540E-08	1.9076E-08	2.1514E-08	2.5409E-08	3.1492E-08
34	65.52	1.4844E-08	1.4368E-08	1.3942E-08	1.3387E-08	1.3870E-08	1.5576E-08	1.8371E-08	2.4087E-08
		33	34	35	36	37	38	39	40
		145.90	149.90	153.42	155.00	155.13	155.26	155.39	155.52
1	3.50	2.9873E-07	1.7674E-07	1.1230E-07	9.0604E-08	8.8565E-08	8.6573E-08	8.4630E-08	8.2736E-08
2	9.50	2.9683E-07	1.7543E-07	1.1138E-07	8.9836E-08	8.7854E-08	8.5924E-08	8.4040E-08	8.2197E-08
3	14.00	2.9390E-07	1.7333E-07	1.1008E-07	8.8950E-08	8.6945E-08	8.4977E-08	8.3054E-08	8.1184E-08
4	18.00	2.8977E-07	1.7058E-07	1.0840E-07	8.7612E-08	8.5703E-08	8.3857E-08	8.2062E-08	8.0307E-08
5	22.00	2.8394E-07	1.6686E-07	1.0632E-07	8.6299E-08	8.4413E-08	8.2650E-08	8.0718E-08	7.8922E-08
6	26.00	2.7584E-07	1.6207E-07	1.0374E-07	8.4233E-08	8.2361E-08	8.0548E-08	7.8788E-08	7.7075E-08
7	30.00	2.6510E-07	1.5608E-07	1.0000E-07	8.0892E-08	7.9045E-08	7.7221E-08	7.5423E-08	7.3650E-08
8	33.50	2.5321E-07	1.4946E-07	9.5091E-08	7.5952E-08	7.4110E-08	7.2329E-08	7.0605E-08	6.8946E-08
9	36.50	2.4033E-07	1.4157E-07	8.8522E-08	6.9875E-08	6.8237E-08	6.6657E-08	6.5139E-08	6.3672E-08
10	39.00	2.2734E-07	1.3266E-07	8.1385E-08	6.4260E-08	6.2918E-08	6.1621E-08	6.0335E-08	5.9065E-08
11	41.00	2.1411E-07	1.2292E-07	7.4588E-08	5.9440E-08	5.8096E-08	5.6737E-08	5.5402E-08	5.4090E-08
12	42.75	1.9986E-07	1.1277E-07	6.8014E-08	5.3938E-08	5.2585E-08	5.1278E-08	4.9948E-08	4.8581E-08
13	44.25	1.8491E-07	1.0311E-07	6.1860E-08	4.8388E-08	4.6991E-08	4.5559E-08	4.4176E-08	4.2913E-08
14	45.50	1.7101E-07	9.4843E-08	5.7070E-08	4.4522E-08	4.3422E-08	4.2577E-08	4.1976E-08	4.1549E-08
15	46.50	1.5932E-07	8.8703E-08	5.4917E-08	4.4698E-08	4.4166E-08	4.3642E-08	4.2995E-08	4.2122E-08
16	47.37	1.4932E-07	8.4582E-08	5.3936E-08	4.4443E-08	4.3453E-08	4.2239E-08	4.0866E-08	3.9486E-08
17	48.12	1.4191E-07	8.2350E-08	5.2315E-08	4.1883E-08	4.0668E-08	3.9507E-08	3.8488E-08	3.7662E-08
18	48.75	1.3713E-07	8.0385E-08	5.0614E-08	4.0400E-08	3.9486E-08	3.8642E-08	3.7906E-08	3.7201E-08
19	49.25	1.3399E-07	7.8417E-08	4.9492E-08	3.9981E-08	3.8929E-08	3.8017E-08	3.7164E-08	3.6243E-08
20	49.75	1.3069E-07	7.6511E-08	4.8383E-08	3.8758E-08	3.7920E-08	3.7153E-08	3.6293E-08	3.5462E-08
21	50.20	1.2765E-07	7.4850E-08	4.7352E-08	3.7817E-08	3.7085E-08	3.6221E-08	3.5413E-08	3.4639E-08
22	50.60	1.2496E-07	7.3366E-08	4.6418E-08	3.7380E-08	3.6419E-08	3.5538E-08	3.4694E-08	3.3870E-08
23	51.05	1.2196E-07	7.1664E-08	4.5355E-08	3.6000E-08	3.5395E-08	3.4642E-08	3.3863E-08	3.3109E-08
24	51.65	1.1790E-07	6.9406E-08	4.3758E-08	3.5430E-08	3.4191E-08	3.3394E-08	3.2668E-08	3.1951E-08
25	52.50	1.1231E-07	6.5896E-08	4.1583E-08	3.3497E-08	3.2916E-08	3.1993E-08	3.1186E-08	3.0456E-08
26	53.75	1.0107E-07	6.1037E-08	3.8281E-08	3.0036E-08	2.9695E-08	2.9374E-08	2.8800E-08	2.8141E-08
27	55.19	8.0716E-08	5.4460E-08	3.5020E-08	2.7507E-08	2.6126E-08	2.5395E-08	2.5108E-08	2.4868E-08
28	56.69	5.9304E-08	4.3965E-08	3.3157E-08	2.9413E-08	2.8612E-08	2.7244E-08	2.5842E-08	2.4785E-08
29	58.25	4.5434E-08	3.2484E-08	2.7292E-08	2.6688E-08	2.7070E-08	2.7365E-08	2.7194E-08	2.6957E-08
30	59.75	3.6562E-08	2.4908E-08	1.9558E-08	1.6507E-08	1.7044E-08	1.7636E-08	1.7894E-08	1.8428E-08
31	61.25	3.1277E-08	1.8615E-08	1.6127E-08	1.2692E-08	1.1423E-08	1.0784E-08	1.0458E-08	1.0339E-08
32	62.75	2.8921E-08	1.3756E-08	1.2555E-08	1.4126E-08	1.3314E-08	1.2132E-08	1.0993E-08	1.0011E-08
33	64.25	2.5936E-08	1.1375E-08	8.0750E-09	1.0348E-08	1.0285E-08	1.0241E-08	9.8620E-09	9.2427E-09
34	65.52	2.2333E-08	9.4297E-09	5.8215E-09	6.6783E-09	7.6280E-09	8.0690E-09	8.5481E-09	8.8004E-09
		41	42	43	44	45	46	47	48
		155.65	155.78	155.94	156.24	156.74	157.59	158.69	159.99
1.	3.50	8.0891E-08	7.9097E-08	7.6961E-08	7.3205E-08	6.7253E-08	5.8365E-08	4.8452E-08	3.9099E-08
2	9.50	8.0388E-08	7.8606E-08	7.6457E-08	7.2689E-08	6.6789E-08	5.8016E-08	4.8203E-08	3.8905E-08
3	14.00	7.9374E-08	7.7638E-08	7.5599E-08	7.1995E-08	6.6198E-08	5.7499E-08	4.7797E-08	3.8609E-08
4	18.00	7.8578E-08	7.6853E-08	7.4748E-08	7.1076E-08	6.5388E-08	5.6887E-08	4.7276E-08	3.7988E-08
5	22.00	7.7175E-08	7.5504E-08	7.3545E-08	7.0051E-08	6.4382E-08	5.5818E-08	4.6138E-08	3.7030E-08

TABLE 4-3 (Continued)

6	26.00	7.5396E-08	7.3718E-08	7.1667E-08	6.8076E-08	6.2443E-08	5.3936E-08	4.4539E-08	3.5911E-08
7	30.00	7.1910E-08	7.0239E-08	6.8270E-08	6.4778E-08	5.9237E-08	5.1256E-08	4.2549E-08	3.4177E-08
8	33.50	6.7347E-08	6.5763E-08	6.3856E-08	6.0618E-08	5.5717E-08	4.8452E-08	4.0042E-08	3.1924E-08
9	36.50	6.2248E-08	6.0905E-08	5.9339E-08	5.6554E-08	5.2003E-08	4.4766E-08	3.6638E-08	2.9241E-08
10	39.00	5.7819E-08	5.6537E-08	5.4954E-08	5.2119E-08	4.7413E-08	4.0654E-08	3.3377E-08	2.6312E-08
11	41.00	5.2783E-08	5.1527E-08	4.9973E-08	4.7073E-08	4.2748E-08	3.6562E-08	2.9645E-08	2.3378E-08
12	42.75	4.7192E-08	4.5738E-08	4.4057E-08	4.1618E-08	3.7996E-08	3.2606E-08	2.6771E-08	2.1538E-08
13	44.25	4.1814E-08	4.0973E-08	4.0129E-08	3.8398E-08	3.5384E-08	3.0767E-08	2.5628E-08	2.0681E-08
14	45.50	4.1178E-08	4.0608E-08	3.9605E-08	3.7659E-08	3.4504E-08	2.9848E-08	2.4618E-08	1.9709E-08
15	46.50	4.0998E-08	3.9809E-08	3.8449E-08	3.6261E-08	3.3098E-08	2.8546E-08	2.3602E-08	1.8978E-08
16	47.37	3.8288E-08	3.7294E-08	3.6274E-08	3.4543E-08	3.1727E-08	2.7523E-08	2.2764E-08	1.8352E-08
17	48.12	3.6973E-08	3.6293E-08	3.5361E-08	3.3617E-08	3.0810E-08	2.6684E-08	2.2169E-08	1.7794E-08
18	48.75	3.6360E-08	3.5458E-08	3.4442E-08	3.2682E-08	3.0039E-08	2.6054E-08	2.1543E-08	1.7359E-08
19	49.25	3.5399E-08	3.4608E-08	3.3600E-08	3.1929E-08	2.9358E-08	2.5510E-08	2.1059E-08	1.6868E-08
20	49.75	3.4605E-08	3.3783E-08	3.2915E-08	3.1359E-08	2.8753E-08	2.4785E-08	2.0539E-08	1.6486E-08
21	50.20	3.3945E-08	3.3235E-08	3.2290E-08	3.0659E-08	2.8080E-08	2.4224E-08	2.0008E-08	1.6183E-08
22	50.60	3.3053E-08	3.2337E-08	3.1529E-08	2.9947E-08	2.7395E-08	2.3748E-08	1.9689E-08	1.5822E-08
23	51.05	3.2377E-08	3.1593E-08	3.0648E-08	2.9108E-08	2.6724E-08	2.3206E-08	1.9291E-08	1.5502E-08
24	51.65	3.1245E-08	3.0586E-08	2.9762E-08	2.8237E-08	2.5901E-08	2.2496E-08	1.8671E-08	1.5034E-08
25	52.50	2.9753E-08	2.9046E-08	2.8736E-08	2.6879E-08	2.4717E-08	2.1452E-08	1.7801E-08	1.4325E-08
26	53.75	2.7488E-08	2.6877E-08	2.6143E-08	2.4883E-08	2.2883E-08	1.9960E-08	1.6646E-08	1.3452E-08
27	55.19	2.4555E-08	2.4162E-08	2.3651E-08	2.2685E-08	2.1043E-08	1.8472E-08	1.5520E-08	1.2635E-08
28	56.64	2.4037E-08	2.3473E-08	2.2863E-08	2.1816E-08	2.0160E-08	1.7604E-08	1.4690E-08	1.1921E-08
29	58.25	2.6217E-08	2.5343E-08	2.4367E-08	2.2886E-08	2.0759E-08	1.7737E-08	1.4432E-08	1.1432E-08
30	59.75	1.8935E-08	1.9386E-08	1.9429E-08	1.9682E-08	1.8757E-08	1.6774E-08	1.4103E-08	1.1205E-08
31	61.25	1.0327E-08	1.0139E-08	1.0182E-08	1.0892E-08	1.1570E-08	1.1594E-08	1.1062E-08	9.7811E-09
32	62.75	9.2402E-09	8.7900E-09	8.2019E-09	7.2598E-09	6.8147E-09	6.5647E-09	6.2317E-09	6.1868E-09
33	64.25	8.5490E-09	7.7044E-09	7.0631E-09	6.3229E-09	5.3877E-09	5.0362E-09	4.3767E-09	3.4851E-09
34	65.52	8.6981E-09	8.4688E-09	7.5666E-09	6.1312E-09	4.5789E-09	3.7160E-09	3.9448E-09	3.3002E-09
		49	50	51	52	53	54	55	56
		161.49	162.99	164.49	166.24	168.24	170.24	172.24	174.24
1	3.50	3.0440E-08	2.3723E-08	1.8491E-08	1.3843E-08	9.8845E-09	7.0953E-09	5.0536E-09	3.6185E-09
2	9.50	3.0282E-08	2.3571E-08	1.8273E-08	1.3729E-08	9.8360E-09	6.9961E-09	5.0411E-09	3.5822E-09
3	14.00	2.9981E-08	2.3168E-08	1.8072E-08	1.3599E-08	9.6853E-09	6.9407E-09	4.8944E-09	3.5313E-09
4	18.00	2.9346E-08	2.2929E-08	1.7835E-08	1.3279E-08	9.4945E-09	6.7684E-09	4.8743E-09	3.4381E-09
5	22.00	2.8839E-08	2.2318E-08	1.7266E-08	1.3010E-08	9.2538E-09	6.5782E-09	4.6475E-09	3.3223E-09
6	26.00	2.7780E-08	2.1557E-08	1.6758E-08	1.2425E-08	8.8131E-09	6.2598E-09	4.4535E-09	3.1478E-09
7	30.00	2.6408E-08	2.0346E-08	1.5643E-08	1.1683E-08	8.2655E-09	5.8288E-09	4.0995E-09	2.8791E-09
8	33.50	2.4491E-08	1.8874E-08	1.4560E-08	1.0740E-08	7.5121E-09	5.2378E-09	3.6411E-09	2.5454E-09
9	36.50	2.2404E-08	1.7074E-08	1.3011E-08	9.5227E-09	6.6169E-09	4.6341E-09	3.2837E-09	2.3225E-09
10	39.00	1.9874E-08	1.5087E-08	1.1460E-08	8.5015E-09	6.0333E-09	4.2778E-09	3.0066E-09	2.1450E-09
11	41.00	1.7825E-08	1.3750E-08	1.0700E-08	7.9696E-09	5.6349E-09	4.0046E-09	2.8699E-09	2.0129E-09
12	42.75	1.6803E-08	1.3046E-08	1.0064E-08	7.5197E-09	5.3514E-09	3.7833E-09	2.6770E-09	1.9272E-09
13	44.25	1.5977E-08	1.2366E-08	9.5998E-09	7.1236E-09	5.0640E-09	3.6216E-09	2.5351E-09	1.7964E-09
14	45.50	1.5288E-08	1.1814E-08	9.1165E-09	6.8684E-09	4.8211E-09	3.3997E-09	2.4687E-09	1.7192E-09
15	46.50	1.4676E-08	1.1427E-08	8.8093E-09	6.5209E-09	4.6789E-09	3.2876E-09	2.3249E-09	1.6760E-09
16	47.37	1.4258E-08	1.0944E-08	8.5057E-09	6.3219E-09	4.4562E-09	3.2223E-09	2.2399E-09	1.5859E-09

TABLE 4-3 (Continued)

17	48.12	1.3769E-08	1.0639E-08	8.1628E-09	6.1564E-09	4.3487E-09	3.0520E-09	2.2113E-09	1.5529E-09
18	48.75	1.3315E-08	1.0328E-08	8.0416E-09	5.9199E-09	4.2639E-09	2.9792E-09	2.1107E-09	1.5600E-09
19	49.25	1.3089E-08	1.0068E-08	7.8524E-09	5.8362E-09	4.0904E-09	2.9720E-09	2.0726E-09	1.4984E-09
20	49.75	1.2757E-08	9.9276E-09	7.5951E-09	5.7099E-09	4.0244E-09	2.8632E-09	2.0959E-09	1.4540E-09
21	50.20	1.2502E-08	9.6770E-09	7.4901E-09	5.5264E-09	3.9940E-09	2.8114E-09	2.0381E-09	1.4836E-09
22	50.60	1.2310E-08	9.4539E-09	7.3194E-09	5.4673E-09	3.8794E-09	2.8270E-09	1.9850E-09	1.4611E-09
23	51.05	1.1971E-08	9.2698E-09	7.1332E-09	5.3702E-09	3.8332E-09	2.7538E-09	2.0020E-09	1.4030E-09
24	51.65	1.1596E-08	8.9504E-09	6.9831E-09	5.2261E-09	3.7710E-09	2.7055E-09	1.9434E-09	1.4033E-09
25	52.50	1.1106E-08	8.6264E-09	6.7225E-09	5.0912E-09	3.6552E-09	2.6359E-09	1.8853E-09	1.3482E-09
26	53.75	1.0491E-08	8.2192E-09	6.4403E-09	4.8590E-09	3.5033E-09	2.5056E-09	1.8010E-09	1.2848E-09
27	55.19	9.9191E-09	7.7764E-09	6.0973E-09	4.6016E-09	3.2902E-09	2.3693E-09	1.6877E-09	1.2102E-09
28	56.64	9.3367E-09	7.3078E-09	5.7011E-09	4.2899E-09	3.0848E-09	2.1997E-09	1.5802E-09	1.1248E-09
29	58.25	8.7725E-09	6.7899E-09	5.2867E-09	3.9701E-09	2.8391E-09	2.0417E-09	1.4506E-09	1.0425E-09
30	59.75	8.4812E-09	6.4381E-09	4.9299E-09	3.6764E-09	2.6189E-09	1.8646E-09	1.3424E-09	9.5026E-10
31	61.25	7.9418E-09	6.1682E-09	4.6942E-09	3.4382E-09	2.4142E-09	1.7142E-09	1.2128E-09	8.7530E-10
32	62.75	5.9219E-09	5.2073E-09	4.2691E-09	3.2102E-09	2.2502E-09	1.5691E-09	1.1113E-09	7.7595E-10
33	64.25	3.2308E-09	3.2673E-09	3.1968E-09	2.7784E-09	2.1289E-09	1.5218E-09	1.0484E-09	7.3854E-10
34	65.52	2.2109E-09	1.7911E-09	1.7990E-09	1.9952E-09	1.8350E-09	1.4687E-09	1.0469E-09	7.1314E-10
		57	58	59	60	61	62	63	64
		176.24	178.24	180.24	182.24	184.24	185.99	187.49	188.74
1	3.50	2.5915E-09	1.8468E-09	1.3224E-09	9.3856E-10	6.7076E-10	4.9334E-10	3.8170E-10	3.0584E-10
2	9.50	2.5497E-09	1.8285E-09	1.2963E-09	9.3559E-10	6.6010E-10	4.9054E-10	3.7679E-10	3.0077E-10
3	14.00	2.5262E-09	1.7936E-09	1.2902E-09	8.9777E-10	6.5086E-10	4.6926E-10	3.6712E-10	2.9236E-10
4	18.00	2.4487E-09	1.7400E-09	1.2301E-09	8.9314E-10	6.1721E-10	4.6651E-10	3.4958E-10	2.8340E-10
5	22.00	2.3551E-09	1.6815E-09	1.1898E-09	8.3311E-10	6.0286E-10	4.2702E-10	3.4019E-10	2.6035E-10
6	26.00	2.307E-09	1.5660E-09	1.1127E-09	7.7928E-10	5.4073E-10	4.0284E-10	3.1302E-10	2.4788E-10
7	30.00	2.0132E-09	1.4137E-09	9.8175E-10	7.0024E-10	4.9003E-10	3.6216E-10	2.8070E-10	2.2456E-10
8	33.50	1.7972E-09	1.2673E-09	9.0058E-10	6.2358E-10	4.3302E-10	3.3253E-10	2.5412E-10	2.0265E-10
9	36.50	1.6326E-09	1.1580E-09	8.2486E-10	5.8942E-10	4.0749E-10	2.9606E-10	2.3547E-10	1.9142E-10
10	39.00	1.5378E-09	1.0846E-09	7.6064E-10	5.4147E-10	3.8686E-10	2.8897E-10	2.1570E-10	1.7120E-10
11	41.00	1.4263E-09	1.0206E-09	7.2613E-10	5.0825E-10	3.6525E-10	2.6526E-10	2.0561E-10	1.6967E-10
12	42.75	1.3500E-09	9.5125E-10	6.8104E-10	4.7313E-10	3.5175E-10	2.5208E-10	1.9008E-10	1.5285E-10
13	44.25	1.2949E-09	9.1763E-10	6.3602E-10	4.4984E-10	3.2715E-10	2.4928E-10	1.8356E-10	1.4434E-10
14	45.50	1.2115E-09	8.6881E-10	6.3298E-10	4.2950E-10	3.0884E-10	2.4983E-10	1.8029E-10	1.5263E-10
15	46.50	1.1809E-09	8.2198E-10	6.0168E-10	4.4417E-10	2.9139E-10	2.3560E-10	1.7559E-10	1.4594E-10
16	47.37	1.1516E-09	8.3444E-10	5.5635E-10	4.3807E-10	2.9984E-10	2.2201E-10	1.7462E-10	1.3361E-10
17	48.12	1.0969E-09	8.1592E-10	5.7664E-10	3.9456E-10	2.9311E-10	2.2096E-10	1.7347E-10	1.3118E-10
18	48.75	1.0872E-09	7.6037E-10	5.9828E-10	3.9680E-10	2.6568E-10	2.2161E-10	1.7213E-10	1.3519E-10
19	49.25	1.1083E-09	7.4535E-10	5.4912E-10	4.2596E-10	2.6099E-10	1.9797E-10	1.7207E-10	1.4379E-10
20	49.75	1.0687E-09	7.8958E-10	5.0994E-10	4.0190E-10	2.9063E-10	1.7963E-10	1.5350E-10	1.4467E-10
21	50.20	1.0073E-09	7.7800E-10	5.4046E-10	3.5621E-10	2.9262E-10	2.0691E-10	1.3239E-10	1.2689E-10
22	50.60	1.0314E-09	7.1939E-10	5.5446E-10	3.6802E-10	2.5033E-10	2.3186E-10	1.4752E-10	1.0155E-10
23	51.05	1.0299E-09	7.2259E-10	5.1036E-10	3.8862E-10	2.4807E-10	1.8797E-10	1.7654E-10	1.1298E-10
24	51.65	9.8055E-10	7.2119E-10	5.0507E-10	3.5253E-10	2.8139E-10	1.7170E-10	1.4228E-10	1.4023E-10
25	52.50	9.7129E-10	6.7774E-10	4.9770E-10	3.4148E-10	2.4743E-10	2.0243E-10	1.3294E-10	9.9801E-11
26	53.75	9.1466E-10	6.6019E-10	4.5916E-10	3.3505E-10	2.3453E-10	1.6993E-10	1.4625E-10	1.1791E-10
27	55.19	8.6422E-10	6.1000E-10	4.4514E-10	3.0435E-10	2.2381E-10	1.6797E-10	1.1834E-10	1.0342E-10

TABLE 4-3 (Continued)

28	56.69	8.0410E-10	5.7542E-10	4.0281E-10	2.9699E-10	2.0222E-10	1.5202E-10	1.2636E-10	9.0011E-11
29	58.25	7.4010E-10	5.2795E-10	3.8199E-10	2.6289E-10	1.9766E-10	1.3784E-10	1.0301E-10	1.0175E-10
30	59.75	6.8450E-10	4.8683E-10	3.4489E-10	2.5305E-10	1.6907E-10	1.3483E-10	9.8327E-11	6.8150E-11
31	61.25	6.1782E-10	4.4423E-10	3.1598E-10	2.1978E-10	1.6519E-10	1.0929E-10	8.8370E-11	6.6601E-11
32	62.75	5.5424E-10	3.9188E-10	2.7977E-10	2.0053E-10	1.3550E-10	1.1194E-10	8.7194E-11	7.2125E-11
33	64.25	5.0387E-10	3.6386E-10	2.5224E-10	1.7962E-10	1.3151E-10	8.6479E-11	7.4071E-11	6.0932E-11
34	65.52	5.0524E-10	3.3480E-10	2.4763E-10	1.6812E-10	1.1965E-10	9.7095E-11	6.1781E-11	5.4779E-11
		65	66	67	68	69	70	71	72
		189.74	190.59	191.29	191.84	192.14	192.34	192.54	192.74
1	3.50	2.5538E-10	2.1827E-10	1.9074E-10	1.7144E-10	1.6080E-10	1.5361E-10	1.4698E-10	1.4083E-10
2	9.50	2.5212E-10	2.1413E-10	1.8764E-10	1.6606E-10	1.5662E-10	1.5136E-10	1.4518E-10	1.3826E-10
3	14.00	2.4313E-10	2.0902E-10	1.8099E-10	1.6556E-10	1.5411E-10	1.4508E-10	1.3835E-10	1.3346E-10
4	18.00	2.3566E-10	1.9773E-10	1.7200E-10	1.5116E-10	1.4382E-10	1.4029E-10	1.3522E-10	1.2802E-10
5	22.00	2.2081E-10	1.9282E-10	1.6303E-10	1.4693E-10	1.3716E-10	1.2875E-10	1.2220E-10	1.1818E-10
6	26.00	1.9929E-10	1.6775E-10	1.4440E-10	1.3284E-10	1.2434E-10	1.2134E-10	1.1691E-10	1.1045E-10
7	30.00	1.8760E-10	1.6094E-10	1.3464E-10	1.2101E-10	1.1533E-10	1.0893E-10	1.0376E-10	1.0031E-10
8	33.50	1.6982E-10	1.4429E-10	1.3076E-10	1.1372E-10	1.0330E-10	1.0044E-10	9.6819E-11	9.2058E-11
9	36.50	1.5684E-10	1.3488E-10	1.1662E-10	1.0660E-10	1.0217E-10	9.6391E-11	9.1478E-11	8.7183E-11
10	39.00	1.4453E-10	1.2383E-10	1.0731E-10	9.7415E-11	9.1777E-11	8.9091E-11	8.4869E-11	8.1067E-11
11	41.00	1.3824E-10	1.1447E-10	1.0479E-10	9.0133E-11	8.2360E-11	8.0359E-11	7.9833E-11	7.7579E-11
12	42.75	1.3662E-10	1.1640E-10	9.5719E-11	9.2278E-11	8.7790E-11	8.1401E-11	7.4909E-11	7.2186E-11
13	44.25	1.2283E-10	1.1071E-10	9.5178E-11	8.1820E-11	7.8753E-11	7.5782E-11	7.3074E-11	7.0394E-11
14	45.50	1.1749E-10	1.0130E-10	9.6200E-11	8.4063E-11	7.2248E-11	7.0930E-11	6.9485E-11	6.6858E-11
15	46.50	1.1905E-10	1.0055E-10	8.9047E-11	8.4442E-11	8.0651E-11	7.2223E-11	6.7625E-11	6.4649E-11
16	47.37	1.1658E-10	9.9664E-11	8.4391E-11	7.7454E-11	8.0176E-11	7.8603E-11	6.9848E-11	6.4833E-11
17	48.12	1.1084E-10	9.4912E-11	8.3453E-11	7.3423E-11	6.7337E-11	6.9942E-11	6.9403E-11	6.6658E-11
18	48.75	1.0740E-10	9.0928E-11	8.1445E-11	7.2709E-11	6.5549E-11	6.4174E-11	6.2828E-11	6.1635E-11
19	49.25	1.0691E-10	9.0621E-11	7.8782E-11	7.1563E-11	6.9063E-11	6.3378E-11	6.0117E-11	5.7468E-11
20	49.75	1.1553E-10	9.2526E-11	7.6892E-11	6.8145E-11	6.6443E-11	6.5972E-11	6.2623E-11	5.9277E-11
21	50.20	1.1796E-10	1.0089E-10	7.9395E-11	6.5787E-11	6.1322E-11	6.0413E-11	5.9966E-11	5.9926E-11
22	50.60	1.0386E-10	1.0220E-10	8.8833E-11	6.9303E-11	6.2416E-11	6.0222E-11	5.6895E-11	5.5706E-11
23	51.05	8.4930E-11	8.1402E-11	8.7436E-11	7.9663E-11	6.7510E-11	6.2740E-11	6.0552E-11	5.6689E-11
24	51.65	1.0282E-10	7.1451E-11	6.3280E-11	7.0242E-11	6.9176E-11	6.4451E-11	5.9944E-11	5.8114E-11
25	52.50	9.6022E-11	9.2201E-11	6.9238E-11	5.3730E-11	5.4389E-11	5.2870E-11	5.1581E-11	4.8679E-11
26	53.75	8.6841E-11	7.1356E-11	6.9262E-11	6.4544E-11	5.7831E-11	5.3996E-11	5.1510E-11	4.9223E-11
27	55.19	9.8078E-11	8.3276E-11	6.5869E-11	5.8005E-11	5.8300E-11	5.5986E-11	5.3503E-11	5.1608E-11
28	56.69	7.1513E-11	6.8869E-11	6.6611E-11	5.9833E-11	5.4062E-11	5.2061E-11	4.9313E-11	4.6145E-11
29	58.25	7.9253E-11	5.6819E-11	4.7237E-11	4.5056E-11	4.3536E-11	4.2399E-11	4.3038E-11	4.2403E-11
30	59.75	7.0703E-11	6.7868E-11	5.6540E-11	4.7673E-11	4.4024E-11	4.0895E-11	3.7356E-11	3.6177E-11
31	61.25	4.7356E-11	4.1318E-11	4.0322E-11	3.9021E-11	3.8970E-11	3.8775E-11	3.8157E-11	3.5445E-11
32	62.75	6.1047E-11	4.9307E-11	4.0642E-11	3.4270E-11	3.0890E-11	2.9155E-11	2.8140E-11	2.8720E-11
33	64.25	5.1100E-11	4.9339E-11	4.5570E-11	4.1359E-11	3.9282E-11	3.7639E-11	3.5348E-11	3.2345E-11
34	65.52	4.7108E-11	3.6161E-11	3.5900E-11	3.6849E-11	3.5962E-11	3.5629E-11	3.5826E-11	3.6288E-11
		73	74	75	76	77	78	79	80
		192.89	192.99	195.52	201.00	207.00	212.95	216.70	217.97
1	3.50	1.3633E-10	1.3333E-10	1.2266E-10	1.0280E-10	8.2739E-11	6.5419E-11	5.2200E-11	4.3279E-11
2	9.50	1.3301E-10	1.2970E-10	1.1950E-10	1.0019E-10	8.0940E-11	6.4878E-11	5.2501E-11	4.2793E-11



TABLE 4-3 (Continued)

3	14.00	1.3007E-10	1.2756E-10	1.1619E-10	9.6446E-11	7.7325E-11	6.1412E-11	4.9754E-11	4.0858E-11
4	18.00	1.2244E-10	1.1913E-10	1.1034E-10	9.1810E-11	7.2973E-11	5.8205E-11	4.6658E-11	3.8282E-11
5	22.00	1.1540E-10	1.1318E-10	1.0277E-10	8.5457E-11	6.8698E-11	5.4938E-11	4.4477E-11	3.6170E-11
6	26.00	1.0566E-10	1.0291E-10	9.4955E-11	7.9541E-11	6.4084E-11	5.1619E-11	4.2012E-11	3.4633E-11
7	30.00	9.7528E-11	9.5342E-11	8.7422E-11	7.3791E-11	5.9575E-11	4.8267E-11	3.9284E-11	3.2029E-11
8	33.50	8.9177E-11	8.7601E-11	8.0908E-11	6.8095E-11	5.5826E-11	4.5921E-11	3.7069E-11	3.0327E-11
9	36.50	8.3175E-11	8.0497E-11	7.4899E-11	6.3731E-11	5.2298E-11	4.3867E-11	3.5526E-11	2.9132E-11
10	39.00	7.9878E-11	7.8872E-11	7.0454E-11	6.0099E-11	5.0086E-11	4.1407E-11	3.4664E-11	2.7343E-11
11	41.00	7.3922E-11	7.1910E-11	6.7193E-11	5.7079E-11	4.8018E-11	3.9785E-11	3.2645E-11	2.7171E-11
12	42.75	6.9811E-11	6.8732E-11	6.4279E-11	5.4539E-11	4.5742E-11	3.8749E-11	3.0746E-11	2.6208E-11
13	44.25	6.8581E-11	6.7042E-11	6.2116E-11	5.2406E-11	4.3728E-11	3.7528E-11	3.0241E-11	2.4018E-11
14	45.50	6.3801E-11	6.2165E-11	5.9490E-11	5.1156E-11	4.1925E-11	3.6400E-11	2.9743E-11	2.3470E-11
15	46.50	6.3229E-11	6.1705E-11	5.6952E-11	4.9780E-11	4.1108E-11	3.5076E-11	2.9644E-11	2.3038E-11
16	47.37	6.2534E-11	6.1962E-11	5.5775E-11	4.7713E-11	4.0811E-11	3.3985E-11	2.8900E-11	2.2544E-11
17	48.12	6.2366E-11	5.9923E-11	5.5284E-11	4.6207E-11	3.9855E-11	3.3796E-11	2.7235E-11	2.2478E-11
18	48.75	6.2078E-11	5.9813E-11	5.4432E-11	4.5665E-11	3.8531E-11	3.3755E-11	2.6632E-11	2.1803E-11
19	49.25	5.5137E-11	5.5874E-11	5.2916E-11	4.5632E-11	3.7522E-11	3.3246E-11	2.7353E-11	2.1387E-11
20	49.75	5.6691E-11	5.3925E-11	5.1055E-11	4.5346E-11	3.7102E-11	3.2167E-11	2.7904E-11	2.1719E-11
21	50.20	5.9152E-11	5.8176E-11	5.0079E-11	4.4310E-11	3.7347E-11	3.1069E-11	2.7524E-11	2.2533E-11
22	50.60	5.5831E-11	5.5759E-11	4.9834E-11	4.3039E-11	3.7409E-11	3.0615E-11	2.5653E-11	2.2769E-11
23	51.05	5.3968E-11	5.3262E-11	4.9446E-11	4.1995E-11	3.6893E-11	3.0561E-11	2.4024E-11	2.1174E-11
24	51.65	5.6439E-11	5.4709E-11	4.9504E-11	4.0787E-11	3.5950E-11	3.0495E-11	2.3373E-11	1.9687E-11
25	52.50	4.7537E-11	4.7298E-11	4.7442E-11	4.0680E-11	3.3746E-11	3.0420E-11	2.3236E-11	1.8852E-11
26	53.75	4.6514E-11	4.4618E-11	4.2373E-11	3.9331E-11	3.2742E-11	2.8209E-11	2.4526E-11	1.8629E-11
27	55.19	5.1070E-11	5.0343E-11	4.1431E-11	3.4464E-11	3.2754E-11	2.6376E-11	2.1791E-11	1.8697E-11
28	56.69	4.3985E-11	4.3223E-11	4.1217E-11	3.2866E-11	2.8803E-11	2.7094E-11	2.0059E-11	1.5850E-11
29	58.25	4.1112E-11	3.9593E-11	3.7052E-11	3.3376E-11	2.6436E-11	2.4380E-11	2.3492E-11	1.7514E-11
30	59.75	3.6000E-11	3.6051E-11	3.3407E-11	3.0896E-11	2.7594E-11	2.1769E-11	1.9258E-11	1.8101E-11
31	61.25	3.3451E-11	3.2310E-11	3.1118E-11	2.8097E-11	2.6702E-11	2.3033E-11	1.6296E-11	1.2720E-11
32	62.75	2.8633E-11	2.8109E-11	2.7939E-11	2.6849E-11	2.4606E-11	2.3365E-11	1.9087E-11	1.3867E-11
33	64.25	3.1017E-11	3.0397E-11	2.4049E-11	2.0961E-11	2.0736E-11	1.8374E-11	1.7263E-11	1.3901E-11
34	65.52	3.5411E-11	3.5097E-11	2.3894E-11	1.2880E-11	1.4964E-11	1.2697E-11	1.0574E-11	1.0654E-11

TABLE 4-3 (CONTINUED)

THE FLUXES FOR GROUPS 2 TO 16 ARE PRINTED IN A SIMILAR MANNER

TABLE 4-3 (Continued)

PROMPT FISSION AND FISSION PROD. DECAY SPECTRA AND GAMMA DOSE CONSTANTS

3.0000E-03	1.5000E-02	4.0000E-02	1.1100E-01	2.5200E-01	5.5900E-01	3.6300E-01	5.0300E-01
7.0800E-01	9.4700E-01	1.3890E+00	2.0530E+00	1.2350E+00			
0.	0.	0.	4.2700E-02	2.3020E-01	5.8700E-01	3.6900E-01	5.0000E-01
5.8700E-01	8.5100E-01	1.0090E+00	1.1520E+00	2.6700E-01			
1.0630E-06	1.0830E-06	1.1160E-06	1.1660E-06	1.2400E-06	1.3320E-06	1.4170E-06	1.5040E-06
1.5640E-06	1.6730E-06	1.8030E-06	2.1120E-06	3.5160E-06			

NEUTRON DOSE CONSTANTS

1.2000E-04	1.0500E-04	8.8000E-05	6.3500E-05	3.2500E-05	1.0300E-05	1.1500E-06	1.7300E-07
2.1000E-08	9.0000E-09	1.9000E-08	5.6200E-08	1.0000E-07	1.0000E-07	1.0000E-07	1.0000E-07

UPPER ENERGY BY GROUP

0.	1.2500E+00	2.0000E+00	2.5000E+00	3.2500E+00	4.5000E+00	6.5000E+00	7.5000E+00
9.7500E+00	1.1750E+01	1.3750E+01	1.5500E+01	1.7300E+01	1.8200E+01	1.8900E+01	2.0000E+01

TABLE 4-3 (Continued)

LIBRARY DATA FOR ELEMENT NO. 1

GAM ID	A.M.U.	(I <sub>0</sub> -AL)/2	I <sub>0</sub> (N,AL)	ELEMENT NAME					
1	1.0080E+00	0.		HYDROG					
1	Q(N,GAMMA)								
	0.	0.	0.	0.	0.	0.	0.	0.	2.2250E+00
	0.	0.	0.	0.	0.				
MASS ABSORPTION COEFFICIENT									
1	2.5660E-02	2.6700E-02	2.8360E-02	3.0650E-02	3.3930E-02	3.7840E-02	4.1220E-02	4.3730E-02	
	4.6580E-02	5.0250E-02	5.4350E-02	6.3710E-02	1.0690E-01				
GRP Q(N+N+,GAMMA)									
1	1	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.
1	2	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.
1	3	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.
1	4	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.
1	5	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.
1	6	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.

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TABLE 4-3 (Continued)

LIBRARY DATA FOR ELEMENT NO. 2

GAM ID	A.M.U.	(1.-AL)/2	Q(N,AL)	ELEMENT NAME					
5	1.2011E+01	0.		CARBON					
	Q(N,GAMMA)								
5	0.	0.	0.	0.	3.3750E+00	1.1910E+00	0.	0.	
	0.	0.	3.7440E-01	0.	0.				
MASS ABSORPTION COEFFICIENT									
5	1.5570E-02	1.5850E-02	1.6420E-02	1.7250E-02	1.8480E-02	2.0020E-02	2.1340E-02	2.2430E-02	
	2.3710E-02	2.5390E-02	2.7390E-02	3.2080E-02	5.3370E-02				
	GRP Q(N,N+,GAMMA)								
5	1	0.	0.	0.	4.2670E+00	0.	0.	0.	
		0.	0.	0.	0.				
5	2	0.	0.	0.	0.	0.	0.	0.	
		0.	0.	0.	0.				
5	3	0.	0.	0.	0.	0.	0.	0.	
		0.	0.	0.	0.				
5	4	0.	0.	0.	0.	0.	0.	0.	
		0.	0.	0.	0.				
5	5	0.	0.	0.	0.	0.	0.	0.	
		0.	0.	0.	0.				
5	6	0.	0.	0.	0.	0.	0.	0.	
		0.	0.	0.	0.				

TABLE 4-3 (Continued)

LIBRARY DATA FOR ELEMENT NO. 3

GAM ID	A.M.U.	(I.-AL)/2	Q(N+AL)	ELEMENT NAME					
10	2.3504E+02	0.		U-235					
	Q(N+GAMMA)								
10	0.	0.	8.4936E-02	5.1820E-02	2.0810E-01	4.5970E-01	3.2190E-01	4.5760E-01	
	5.7440E-01	7.8700E-01	1.1590E+00	1.6940E+00	6.0950E-01				
	MASS ABSORPTION COEFFICIENT								
10	4.2790E-02	4.1560E-02	3.9940E-02	3.8040E-02	3.5700E-02	3.3510E-02	3.2320E-02	3.1960E-02	
	3.1920E-02	3.4650E-02	4.3950E-02	1.0780E-01	4.4270E-01				
	GRP Q(N,N+GAMMA)								
10	1	0.	0.	0.	3.6620E-03	3.7490E-02	7.2340E-02	1.4940E-01	
		2.8110E-01	5.6570E-01	8.5530E-01	9.3920E-01	2.3830E-01			
10	2	0.	0.	0.	0.	0.	8.0060E-04	6.0720E-03	
		3.0190E-02	1.7060E-01	4.8430E-01	8.1250E-01	2.6040E-01			
10	3	0.	0.	0.	0.	0.	0.	0.	
		0.	2.0460E-02	1.6820E-01	5.0220E-01	2.1660E-01			
10	4	0.	0.	0.	0.	0.	0.	0.	
		0.	0.	2.3110E-02	1.8130E-01	2.0050E-01			
10	5	0.	0.	0.	0.	0.	0.	0.	
		0.	0.	0.	9.4820E-02	1.6790E-01			
10	6	0.	0.	0.	0.	0.	0.	0.	
		0.	0.	0.	9.4740E-02	1.6780E-01			

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TABLE 4-3 (Continued)

LIBRARY DATA FOR ELEMENT NO. 4

GAM ID	A.M.U.	(I <sub>γ</sub> -AL)/2	Q(N <sub>γ</sub> AL)	ELEMENT NAME					
12	2.3805E+02	0.		U-238					
	Q(N <sub>γ</sub> GAMMA)								
12	0.	0.	0.	0.	1.1200E-01	4.5000E-01	1.0400E-01	2.9900E-01	
	6.3400E-01	7.1600E-01	6.1900E-01	1.0690E+00	6.2600E-01				
	MASS ABSORPTION COEFFICIENT								
12	4.2790E-02	4.1560E-02	3.9940E-02	3.8040E-02	3.5700E-02	3.3510E-02	3.2320E-02	3.1960E-02	
	3.1920E-02	3.4650E-02	4.3950E-02	1.0780E-01	4.4270E-01				
	GRP Q(N <sub>γ</sub> N <sub>γ</sub> GAMMA)								
12	1	0.	0.	4.3990E-02	4.7270E-01	6.7300E-01	3.8810E-01	1.2290E-01	1.2900E-01
		1.4370E-01	1.7950E-01	1.8290E-01	2.3600E-01	1.7440E-01			
12	2	0.	0.	0.	0.	0.	0.	5.3370E-03	2.3610E-02
		4.6000E-02	1.1120E-01	1.7420E-01	2.7850E-01	2.1870E-01			
12	3	0.	0.	0.	0.	0.	0.	0.	0.
		0.	8.6320E-03	5.2050E-02	2.3860E-01	1.9410E-01			
12	4	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	6.9250E-03	1.2120E-01	2.0250E-01			
12	5	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	5.6210E-02	9.9540E-02			
12	6	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.			

TABLE 4-3 (Continued)

LIBRARY DATA FOR ELEMENT NO. 5

GAM ID	A.M.U.	(I,-AL)/2	(Q(N,AL)	ELEMENT NAME					
27	5.1996E+01	0.		CHROMI					
	Q(N,GAMMA)								
27	4.6490E+00	8.6730E-01	7.7910E-01	5.7380E-01	2.2930E-01	2.8620E-01	0.	9.9200E-02	
	8.0390E-02	7.4830E-02	8.3320E-02	4.5780E-01	0.				
	MASS ABSORPTION COEFFICIENT								
27	2.2850E-02	2.2580E-02	2.2330E-02	2.2050E-02	2.1820E-02	2.1750E-02	2.1910E-02	2.2220E-02	
	2.2850E-02	2.3880E-02	2.5580E-02	3.0540E-02	5.4850E-02				
	GRP Q(N,N+,GAMMA)								
27	1	5.5640E-01	1.3740E-01	4.9280E-01	4.6220E-01	7.2840E-01	5.8640E-01	1.9510E-01	1.5140E-01
		1.6530E-01	3.5270E-01	4.9900E-01	2.9220E-01	1.2610E-01			
27	2	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.
27	3	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.
27	4	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.
27	5	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.
27	6	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.

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TABLE 4-3 (Continued)

LIBRARY DATA FOR ELEMENT NO. 6

GAM ID	A.M.U.	(I,-AL)/2	(Q(N,AL)	ELEMENT NAME					
29	5.5847E+01	0.		IRON					
29	Q(N,GAMMA)								
	3.7090E+00	5.2980E-01	7.1600E-01	7.5270E-01	6.5970E-01	6.4930E-01	2.2730E-01	0.	
	9.7990E-02	3.2760E-01	2.5540E-02	2.5340E-02	4.6740E-02				
MASS ABSORPTION COEFFICIENT									
29	2.3980E-02	2.3660E-02	2.3330E-02	2.2940E-02	2.2540E-02	2.2330E-02	2.2390E-02	2.2630E-02	
	2.3200E-02	2.4190E-02	2.5910E-02	3.1170E-02	5.7270E-02				
29	GRP Q(N,N+,GAMMA)								
1	1.3250E-01	6.5140E-02	2.3360E-01	4.2130E-01	3.2490E-01	7.9800E-01	5.0950E-01	4.3670E-01	
	4.9590E-01	5.6860E-01	4.7370E-01	3.3770E-01	8.3070E-02				
2	0.	0.	0.	0.	0.	0.	2.1000E-03	1.8000E-03	
	3.3480E-02	6.1950E-02	2.5200E-01	2.6510E-01	6.5200E-02				
3	0.	0.	0.	0.	0.	0.	0.	0.	
	0.	0.	2.3480E-01	2.6740E-01	6.5780E-02				
4	0.	0.	0.	0.	0.	0.	0.	0.	
	0.	0.	0.	0.	0.	0.	0.	0.	
5	0.	0.	0.	0.	0.	0.	0.	0.	
	0.	0.	0.	0.	0.	0.	0.	0.	
6	0.	0.	0.	0.	0.	0.	0.	0.	
	0.	0.	0.	0.	0.	0.	0.	0.	

TABLE 4-3 (Continued)

LIBRARY DATA FOR ELEMENT NO. 7

GAM ID	A.M.U.	(I.-AL)/2	(O(N.-AL)	ELEMENT NAME					
31	5.8710E+01	0.		NICKEL					
	G(N.GAMMA)								
31	6.3060E+00	8.0560E-02	1.1350E+00	4.7760E-01	1.3800E-01	1.4430E-01	1.8990E-01	4.3540E-02	
	9.1800E-02	6.4000E-02	3.5170E-02	8.7630E-02	7.3210E-02				
	MASS ABSORPTION COEFFICIENT								
31	2.5460E-02	2.5070E-02	2.4640E-02	2.4170E-02	2.3680E-02	2.3300E-02	2.3230E-02	2.3400E-02	
	2.3930E-02	2.4800E-02	2.6670E-02	3.2360E-02	6.1080E-02				
	GRP G(N.N.+GAMMA)								
31	1	6.3180E-02	3.3750E-02	1.9830E-01	2.9240E-01	5.9090E-01	5.4020E-01	3.4460E-01	3.6870E-01
		2.4780E-01	1.2340E+00	4.0770E-01	2.6370E-01	8.4530E-02			
31	2	0.	0.	0.	0.	0.	0.	0.	3.9160E-03
		2.8160E-02	1.2460E+00	2.8670E-01	2.5340E-02	0.			
31	3	0.	0.	0.	0.	0.	0.	0.	0.
		0.	1.2030E+00	2.5220E-01	0.	0.	0.	0.	0.
31	4	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.
31	5	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.
31	6	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.

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TABLE 4-3 (Continued)

LIBRARY DATA FOR ELEMENT NO. 8									
GAM ID	A.M.U.	(1-AL)/2	(Q(N,AL)		ELEMENT NAME				
127	9.2906E+01	0.			NIOBIU				
Q(N,GAMMA)									
127	4.7000E-02	1.2000E-01	3.1800E-01	1.1880E+00	1.2310E+00	1.4820E+00	6.7200E-01	6.9800E-01	
	6.9800E-01	4.0000E-01	1.4500E-01	9.3000E-02	1.2000E-01				
MASS ABSORPTION COEFFICIENT									
127	2.9290E-02	2.8620E-02	2.7810E-02	2.6760E-02	2.5450E-02	2.4190E-02	2.3450E-02	2.3210E-02	
	2.3340E-02	2.4000E-02	2.5940E-02	3.4360E-02	8.3360E-02				
GRP Q(N,N+GAMMA)									
127	1	0.	0.	0.	0.	0.	0.	0.	0.
		1.9200E+00	0.	0.	0.	0.	0.	0.	0.
127	2	0.	0.	0.	0.	0.	0.	0.	0.
		1.9200E+00	0.	0.	0.	0.	0.	0.	0.
127	3	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	1.0800E+00	0.	0.	0.	0.	0.
127	4	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	7.4100E-01	0.	0.	0.	0.
127	5	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.
127	6	0.	0.	0.	0.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

REGION OUTPUT

.....  
 RADIAL CORE CENTER REGION P1  
 .....

REGION PARAMETERS (IS, IF, JS, JF, NO. OF ELEM., CONTROL)

1 13 1 28 9 4

ELEMENT NO. = 5 NO. DENSITY = 7.5400E-02 ELEMENT ID CARBON

FISSION, ABSORPTION, INELASTIC SCATTER, ENERGY DEPOSITION, AND GAMMA RAY ENERGY ABSORPTION CROSS SECTION:

0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	3.4897E-07	8.6927E-06	1.4188E-05	
4.0246E-05	1.0946E-04	2.8708E-04	6.3161E-04	1.2256E-03	1.8135E-03	2.6663E-03	5.0325E-03	
4.5321E-02	0.	0.	0.	0.	0.			
9.0807E-01	5.0513E-01	3.7593E-01	2.6061E-01	1.2668E-01	3.1548E-02	6.2948E-03	1.4779E-03	
1.7656E-04	2.4259E-05	3.4562E-06						
1.5520E-02	1.5850E-02	1.6420E-02	1.7250E-02	1.8480E-02	2.0020E-02	2.1340E-02	2.2430E-02	
2.3710E-02	2.5390E-02	2.7390E-02	3.2080E-02	5.3370E-02				

ELEMENT NO. = 7 NO. DENSITY = 4.5000E-06 ELEMENT ID CHROMI

FISSION, ABSORPTION, INELASTIC SCATTER, ENERGY DEPOSITION, AND GAMMA RAY ENERGY ABSORPTION CROSS SECTION:

0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.
5.8492E-03	2.9310E-03	4.0150E-03	4.0000E-03	4.7534E-03	6.5313E-03	2.5021E-02	4.1742E-02	
3.9003E-02	9.8517E-02	2.4357E-01	5.3216E-01	1.0311E+00	1.5189E+00	2.1999E+00	4.1277E+00	
1.3019E+00	5.3852E-01	6.6097E-02	1.6496E-03	0.	0.			
1.2226E-01	1.5962E-01	9.2276E-02	5.7119E-02	2.9663E-02	0.4508E-03	4.0205E-03	8.2770E-04	
4.0841E-05	5.6345E-06	8.0068E-07						
2.2850E-02	2.2580E-02	2.2330E-02	2.2050E-02	2.1820E-02	2.1750E-02	2.1910E-02	2.2220E-02	

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TABLE 4-3 (Continued)

2.2850E-02 2.3880E-02 2.5580E-02 3.0540E-02 5.4850E-02

.....

ELEMENT NO.= 1 NO. DENSITY= 8.0250E-05 ELEMENT ID HYDROG

FISSION, ABSORPTION, INELASTIC SCATTER, ENERGY DEPOSITION, AND GAMMA RAY ENERGY ABSORPTION CROSS SECTION:

0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.0112E-03
3.4656E-03	9.5679E-03	2.6826E-02	6.1309E-02	1.1898E-01	1.7603E-01	2.5880E-01	4.8897E-01
0.	0.	0.	0.	0.	0.		
2.1170E+00	1.6087E+00	1.2346E+00	9.3144E-01	5.7392E-01	2.0495E-01	5.2619E-02	1.2437E-02
1.5044E-03	2.0669E-04	2.9447E-05					
2.5660E-02	2.6700E-02	2.8360E-02	3.0650E-02	3.3930E-02	3.7840E-02	4.1220E-02	4.3730E-02
4.6580E-02	5.0250E-02	5.4350E-02	6.3710E-02	1.0600E-01			

.....

ELEMENT NO.= 1 NO. DENSITY= 2.4075E-04 ELEMENT ID HYDROG

FISSION, ABSORPTION, INELASTIC SCATTER, ENERGY DEPOSITION, AND GAMMA RAY ENERGY ABSORPTION CROSS SECTION:

0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.0112E-03
3.4656E-03	9.5679E-03	2.6826E-02	6.1309E-02	1.1898E-01	1.7603E-01	2.5880E-01	4.8897E-01
0.	0.	0.	0.	0.	0.		
2.1170E+00	1.6087E+00	1.2346E+00	9.3144E-01	5.7392E-01	2.0495E-01	5.2619E-02	1.2437E-02
1.5044E-03	2.0669E-04	2.9447E-05					
2.5660E-02	2.6700E-02	2.8360E-02	3.0650E-02	3.3930E-02	3.7840E-02	4.1220E-02	4.3730E-02
4.6580E-02	5.0250E-02	5.4350E-02	6.3710E-02	1.0600E-01			

.....

ELEMENT NO.= 29 NO. DENSITY= 2.9100E-05 ELEMENT ID IRON

FISSION, ABSORPTION, INELASTIC SCATTER, ENERGY DEPOSITION, AND GAMMA RAY ENERGY ABSORPTION CROSS SECTION:

0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.

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TABLE 4-3 (Continued)

5.8023E-03	2.9213E-03	4.0173E-03	5.0076E-03	5.8213E-03	2.6014E-02	5.5747E-02	4.2772E-02
4.7641E-02	8.2059E-02	1.9565E-01	4.6420E-01	8.9907E-01	1.3242E+00	1.9190E+00	3.6006E+00
1.2165E+00	6.8927E-01	2.7691E-01	0.	0.	0.		
1.3068E-01	1.0153E-01	6.0156E-02	5.6996E-02	2.4174E-02	9.7402E-03	2.4366E-03	5.1159E-04
1.0019E-04	1.4297E-05	2.0369E-06					
2.3980E-02	2.3660E-02	2.3330E-02	2.2940E-02	2.2540E-02	2.2330E-02	2.2390E-02	2.2630E-02
2.3200E-02	2.4190E-02	2.5910E-02	3.1170E-02	5.7270E-02			

.....  
 ELEMENT NO. 31 NO. DENSITY= 5.4000E-05 ELEMENT ID NICKEL

FISSION, ABSORPTION, INELASTIC SCATTER, ENERGY DEPOSITION, AND GAMMA RAY ENERGY ABSORPTION CROSS SECTION:

0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
1.9918E-01	8.0301E-02	1.5000E-02	1.2997E-02	9.9154E-03	1.3392E-02	1.8123E-02	2.4347E-02
5.4608E-02	1.2986E-01	3.2750E-01	8.4437E-01	1.6350E+00	2.4081E+00	3.4994E+00	6.5478E+00
1.3326E+00	8.0824E-01	0.	0.	0.	0.		
1.1622E-01	1.2304E-01	1.0310E-01	5.9882E-02	3.9338E-02	2.1656E-02	4.7278E-03	1.8311E-03
1.4309E-04	2.0462E-05	2.9321E-06					
2.5460E-02	2.5070E-02	2.4640E-02	2.4170E-02	2.3680E-02	2.3300E-02	2.3230E-02	2.3400E-02
2.3930E-02	2.4800E-02	2.6670E-02	3.2360E-02	6.1080E-02			

.....  
 ELEMENT NO. 127 NO. DENSITY= 2.0000E-04 ELEMENT ID NIOBIUM

FISSION, ABSORPTION, INELASTIC SCATTER, ENERGY DEPOSITION, AND GAMMA RAY ENERGY ABSORPTION CROSS SECTION:

0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	3.2494E-02	5.1945E-02	7.6614E-02	3.1785E-01	7.6364E-01	1.3859E+00
1.3534E+00	2.3983E-01	0.	2.0196E-01	3.9095E-01	5.7582E-01	8.3445E-01	1.5656E+00
2.0743E+00	1.7482E+00	7.9659E-01	6.4749E-03	0.	0.		
7.5031E-02	6.5813E-02	8.9055E-02	7.7384E-02	4.1799E-02	8.5489E-03	1.4622E-03	3.2461E-04
3.6192E-05	4.8933E-06	6.9715E-07					

TABLE 4-3 (Continued)

2.9290E-02 2.8620E-02 2.7810E-02 2.6760E-02 2.5450E-02 2.4190E-02 2.3450E-02 2.3210E-02  
 2.3340E-02 2.4000E-02 2.5940E-02 3.4360E-02 8.3360E-02  
 .....

ELEMENT NO.= 10 NO. DENSITY= 1.7400E-04 ELEMENT ID U-235  
 FISSION, ABSORPTION, INELASTIC SCATTER, ENERGY DEPOSITION, AND GAMMA RAY ENERGY ABSORPTION CROSS SECTION:

1.2771E+00	1.2897E+00	1.2300E+00	1.1880E+00	1.3995E+00	2.2569E+00	4.1987E+00	6.9917E+00
1.7333E+01	3.7418E+01	2.6088E+01	6.7878E+01	1.8541E+02	2.6818E+02	4.3485E+02	8.8665E+02
2.3612E-02	5.2591E-02	9.2141E-02	1.5652E-01	3.0584E-01	7.7079E-01	1.3494E+00	3.2241E+00
8.6374E+00	2.3554E+01	1.8451E+01	1.1623E+01	3.9521E+01	4.6942E+01	7.6085E+01	1.5519E+02
1.9101E+00	1.7534E+00	1.5361E+00	1.6336E+00	1.3206E+00	8.4894E-02		
3.4975E-02	3.3339E-02	2.3022E-02	1.6218E-02	1.1593E-02	3.7887E-03	8.3325E-04	1.9638E-04
2.3397E-05	3.9320E-06	5.0766E-07					
4.2790E-02	4.1560E-02	3.9940E-02	3.8040E-02	3.5700E-02	3.3510E-02	3.2320E-02	3.1960E-02
3.1920E-02	3.4650E-02	4.3950E-02	1.0780E-01	4.4270E-01			

ELEMENT NO.= 12 NO. DENSITY= 1.4000E-05 ELEMENT ID U-238

FISSION, ABSORPTION, INELASTIC SCATTER, ENERGY DEPOSITION, AND GAMMA RAY ENERGY ABSORPTION CROSS SECTION:

6.0329E-01	4.6270E-01	2.5013E-02	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
1.1415E-02	4.9017E-02	1.2499E-01	1.3679E-01	1.8194E-01	2.9063E-01	3.9940E-01	1.6250E+00
9.0022E+00	4.6202E+01	6.2264E+01	4.9841E-01	9.6388E-01	1.4200E+00	2.0596E+00	3.8805E+00
2.4784E+00	2.5210E+00	2.1252E+00	1.6284E+00	1.0109E+00	1.2683E+01		
4.0106E-02	2.9911E-02	2.4361E-02	2.2990E-02	1.4499E-02	4.9970E-03	1.1912E-03	3.4453E-04
2.3542E-05	3.2345E-06	4.4603E-07					
4.2790E-02	4.1560E-02	3.9940E-02	3.8040E-02	3.5700E-02	3.3510E-02	3.2320E-02	3.1960E-02
3.1920E-02	3.4650E-02	4.3950E-02	1.0780E-01	4.4270E-01			

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TABLE 4-3 (Continued)

NAGS IV HAS PROCESSED 1 SEPERATE REGION PROBLEMS  
PROBLEM IN LINK



TABLE 4-3 (Continued)

RADIAL CORE CENTER REGION P1

REGION MESH BOUNDARIES

LEFT.... 1 0.00000  
 RIGHT... 13 43.50000  
 BOTTOM.. 1 0.00000  
 TOP..... 28 137.16000

NO. OF ELEMENTS... 9

ELEMENT NO. (GAM ID)	NAME	ATOM DENSITY	DENSITY	WEIGHT	CAPTURES	FISSIONS	IN. SCATTER
5	CARBON	7.54000E-02	1.50318E+00	1.22565E+06	8.17523E-04	7.03715E+01	4.94743E-01
27	CHROMI	4.50000E-06	3.88365E-04	3.16662E+02	4.59226E-05	0.	0.
1	HYDROG	8.02500E-05	1.34261E-04	1.09473E+02	8.12244E-05	0.	0.
1	HYDROG	2.40750E-04	4.02783E-04	3.28418E+02	2.43673E-04	0.	0.
29	IRON	2.91000E-05	2.64743E-03	2.19941E+03	2.85352E-04	0.	3.64138E-04
31	NICKEL	5.40000E-05	5.26215E-03	4.29061E+03	8.71434E-04	0.	6.50710E-04
127	NIOHIU	2.00000E-04	3.08412E-02	2.51470E+04	1.25961E-02	0.	5.84040E-03
10	U-235	1.74000E-04	6.78822E-02	5.53492E+04	1.22764E-01	3.40725E-01	1.23841E-02
12	U-238	1.40000E-05	5.53166E-03	4.51036E+03	7.03715E+01	4.94743E-01	1.13120E-03

REGION VOLUME..... 8.15372E+05

REGION WEIGHT..... 1.31790E+06

REGION INTEGRATED

PHOTON SOURCE.....	9.75341E+02
FISSIONS.....	7.06993E+01
NEUTRON SOURCE...	1.72115E+02
PHOTON SOURCE BY GROUP (INTEGRATED AND AVERAGE)	
1	2.19500E-01
2	1.06229E+00
3	2.84372E+00
4	1.08886E+01
5	3.47655E+01
6	8.11039E+01
7	5.18017E+01
8	7.09806E+01
9	9.16528E+01
10	1.27231E+02
11	1.69694E+02

TABLE 4-3 (Continued)

12	2.26820E+02	2.78180E-04
13	1.06278E+02	1.30343E-04

TABLE 4-3 (Continued)

RADIAL CORE CENTER REGION P1

REGION INTEGRATED FLUX

1	3.23778E+00
2	9.57078E+00
3	7.14169E+00
4	1.00403E+01
5	1.45586E+01
6	1.89540E+01
7	8.64621E+00
8	1.81496E+01
9	1.39194E+01
10	8.99482E+00
11	5.50258E+00
12	5.27378E+00
13	1.53961E+00
14	6.37352E-01
15	2.91397E-01
16	3.63089E-02

RELATIVE SOURCE AND FISSION DISTRIBUTIONS

RADIUS PHOTON				HEIGHT PHOTON			
DISTRIBUTIONS				DISTRIBUTIONS			
(CM.)	F(R)	F(R)	F(R)	(CM.)	F(Z)	F(Z)	F(Z)
0.0000	1.2119	1.2120	1.2120	0.0000	.0655	.0654	.0654
3.5000	1.2097	1.2098	1.2098	.5000	.0800	.0799	.0800
9.5000	1.1954	1.1955	1.1954	1.7500	.1321	.1320	.1321
14.0000	1.1742	1.1743	1.1743	3.0000	.1813	.1813	.1813
18.0000	1.1467	1.1468	1.1467	4.7500	.2467	.2467	.2467
22.0000	1.1104	1.1105	1.1104	7.5000	.3465	.3464	.3464
26.0000	1.0648	1.0648	1.0648	11.5000	.4839	.4839	.4839
30.0000	1.0098	1.0098	1.0098	17.0000	.6591	.6591	.6591
33.5000	.9554	.9553	.9553	23.5000	.8431	.8431	.8431
36.5000	.9049	.9049	.9049	30.5000	1.0139	1.0139	1.0139
39.0000	.8621	.8621	.8621	37.5000	1.1558	1.1558	1.1558
41.0000	.8290	.8289	.8289	44.5000	1.2693	1.2693	1.2693
42.7500	.8022	.8021	.8021	51.5000	1.3545	1.3545	1.3545
43.5000	.7918	.7917	.7917	58.5000	1.4112	1.4112	1.4112
				65.5000	1.4388	1.4388	1.4388
				72.5000	1.4372	1.4372	1.4372
				79.5000	1.4064	1.4065	1.4064
				86.5000	1.3471	1.3471	1.3471

TABLE 4-3 (Continued)

93.5000	1.2601	1.2601	1.2601
100.5000	1.1467	1.1467	1.1467
107.5000	1.0086	1.0086	1.0086
114.5000	.8489	.8489	.8489
121.5000	.6738	.6738	.6738
127.5000	.5206	.5206	.5205
131.5000	.4242	.4241	.4241
134.0000	.3729	.3728	.3728
135.6500	.3475	.3473	.3472
136.7300	.3381	.3377	.3377
137.1600	.3351	.3346	.3346

TABLE 4-3 (Continued)

THE FOLLOWING DATA ARRAY HAS BEEN PLOTTED FOR..... RADIAL CORE CENTER REGION P1  
 RELATIVE PHOTON SOURCE DISTRIBUTION RADIUS (CM)

0.	0.12129E+01
0.16111E+01	0.12124E+01
0.32222E+01	0.12110E+01
0.48333E+01	0.12088E+01
0.64444E+01	0.12056E+01
0.80556E+01	0.12012E+01
0.96667E+01	0.11957E+01
0.11278E+02	0.11892E+01
0.12889E+02	0.11814E+01
0.14500E+02	0.11722E+01
0.16111E+02	0.11617E+01
0.17722E+02	0.11498E+01
0.19333E+02	0.11365E+01
0.20944E+02	0.11218E+01
0.22556E+02	0.11055E+01
0.24167E+02	0.10877E+01
0.25778E+02	0.10684E+01
0.27389E+02	0.10474E+01
0.29000E+02	0.10251E+01
0.30611E+02	0.10014E+01
0.32222E+02	0.97657E+00
0.33833E+02	0.95057E+00
0.35444E+02	0.92352E+00
0.37056E+02	0.89600E+00
0.38667E+02	0.86846E+00
0.40278E+02	0.84136E+00
0.41889E+02	0.81557E+00
0.43500E+02	0.79245E+00

TABLE 4-3 (Continued)

THE FOLLOWING DATA ARRAY HAS BEEN PLOTTED FOR... RADIAL CORE CENTER REGION P1  
 RELATIVE NEUTRON SOURCE DISTRIBUTION RADIUS (CM)

0.	0.12130E+01
0.16111E+01	0.12125E+01
0.32222E+01	0.12111E+01
0.48333E+01	0.12099E+01
0.64444E+01	0.12057E+01
0.80556E+01	0.12013E+01
0.96667E+01	0.11958E+01
0.14278E+02	0.11893E+01
0.17889E+02	0.11814E+01
0.14500E+02	0.11723E+01
0.16111E+02	0.11618E+01
0.17722E+02	0.11499E+01
0.19333E+02	0.11366E+01
0.20944E+02	0.11218E+01
0.22556E+02	0.11056E+01
0.24167E+02	0.10877E+01
0.25778E+02	0.10684E+01
0.27389E+02	0.10474E+01
0.29000E+02	0.10251E+01
0.30611E+02	0.10014E+01
0.32222E+02	0.97656E+00
0.33833E+02	0.95055E+00
0.35444E+02	0.92349E+00
0.37056E+02	0.89596E+00
0.38667E+02	0.86841E+00
0.40278E+02	0.84130E+00
0.41889E+02	0.81549E+00
0.43500E+02	0.79236E+00

TABLE 4-3 (Continued)

THE FOLLOWING DATA ARRAY HAS BEEN PLOTTED FOR... RADIAL CORE CENTER REGION P1  
 RELATIVE PHOTON SOURCE DISTRIBUTION AXIAL DISTANCE FROM STATION-0" (CM)

0.	0.65551E-01
0.24063E+01	0.15840E+00
0.48126E+01	0.24933E+00
0.72189E+01	0.33686E+00
0.96253E+01	0.42100E+00
0.12032E+02	0.50217E+00
0.14438E+02	0.58037E+00
0.16844E+02	0.65513E+00
0.19251E+02	0.72640E+00
0.21657E+02	0.79431E+00
0.24063E+02	0.85888E+00
0.26469E+02	0.92011E+00
0.28876E+02	0.97792E+00
0.31282E+02	0.10323E+01
0.33688E+02	0.10832E+01
0.36095E+02	0.11308E+01
0.38501E+02	0.11750E+01
0.40907E+02	0.12158E+01
0.43314E+02	0.12534E+01
0.45720E+02	0.12876E+01
0.48126E+02	0.13184E+01
0.50533E+02	0.13459E+01
0.52939E+02	0.13700E+01
0.55345E+02	0.13907E+01
0.57752E+02	0.14080E+01
0.60158E+02	0.14219E+01
0.62564E+02	0.14323E+01
0.64971E+02	0.14393E+01
0.67377E+02	0.14428E+01
0.69783E+02	0.14428E+01
0.72189E+02	0.14394E+01
0.74596E+02	0.14325E+01
0.77002E+02	0.14222E+01
0.79408E+02	0.14085E+01
0.81815E+02	0.13914E+01
0.84221E+02	0.13709E+01
0.86627E+02	0.13472E+01
0.89034E+02	0.13200E+01
0.91440E+02	0.12898E+01
0.93846E+02	0.12564E+01
0.96253E+02	0.12197E+01
0.98659E+02	0.11801E+01
0.10107E+03	0.11375E+01
0.10347E+03	0.10919E+01
0.10588E+03	0.10436E+01

TABLE 4-3 (Continued)

0.10828E+03	0.99254E+00
0.11069E+03	0.93872E+00
0.11310E+03	0.88307E+00
0.11550E+03	0.82490E+00
0.11791E+03	0.76489E+00
0.12032E+03	0.70441E+00
0.12272E+03	0.64241E+00
0.12513E+03	0.58050E+00
0.12753E+03	0.52022E+00
0.12994E+03	0.46017E+00
0.13235E+03	0.40553E+00
0.13475E+03	0.36003E+00
0.13716E+03	0.33550E+00



TABLE 4-3 (Continued)

THE FOLLOWING DATA ARRAY HAS BEEN PLOTTED FOR.... RADIAL CORE CENTER REGION P1  
 RELATIVE NEUTRON SOURCE DISTRIBUTION AXIAL DISTANCE FROM S1ATION=0-(CM)

0*	0.64487E-01
0.24063E+01	0.15833E+00
0.48126E+01	0.24927E+00
0.72189E+01	0.33680E+00
0.96253E+01	0.42096E+00
0.12032E+02	0.50213E+00
0.14438E+02	0.58034E+00
0.16844E+02	0.65512E+00
0.19251E+02	0.72639E+00
0.21657E+02	0.79430E+00
0.24063E+02	0.85888E+00
0.26469E+02	0.92012E+00
0.28876E+02	0.97793E+00
0.31282E+02	0.10323E+01
0.33688E+02	0.10832E+01
0.36095E+02	0.11308E+01
0.38501E+02	0.11750E+01
0.40907E+02	0.12159E+01
0.43314E+02	0.12534E+01
0.45720E+02	0.12876E+01
0.48126E+02	0.13184E+01
0.50533E+02	0.13459E+01
0.52939E+02	0.13700E+01
0.55345E+02	0.13907E+01
0.57752E+02	0.14080E+01
0.60158E+02	0.14219E+01
0.62564E+02	0.14323E+01
0.64971E+02	0.14393E+01
0.67377E+02	0.14428E+01
0.69783E+02	0.14428E+01
0.72189E+02	0.14394E+01
0.74596E+02	0.14325E+01
0.77002E+02	0.14222E+01
0.79408E+02	0.14086E+01
0.81815E+02	0.13914E+01
0.84221E+02	0.13709E+01
0.86627E+02	0.13472E+01
0.89034E+02	0.13201E+01
0.91440E+02	0.12898E+01
0.93846E+02	0.12564E+01
0.96253E+02	0.12197E+01
0.98659E+02	0.11802E+01
0.10107E+03	0.11376E+01
0.10347E+03	0.10919E+01
0.10588E+03	0.10437E+01

TABLE 4-3 (Continued)

0.10828E+03	0.99256E+00
0.11069E+03	0.93873E+00
0.11310E+03	0.88308E+00
0.11550E+03	0.82491E+00
0.11791E+03	0.76489E+00
0.12032E+03	0.70442E+00
0.12272E+03	0.64241E+00
0.12513E+03	0.58050E+00
0.12753E+03	0.52020E+00
0.12994E+03	0.46013E+00
0.13235E+03	0.40545E+00
0.13475E+03	0.35986E+00
0.13716E+03	0.33498E+00

TABLE 4-3 (Continued)

THE FOLLOWING DATA ARRAY HAS BEEN PLOTTED FOR... RADIAL CORE CENTER REGION P1  
 RELATIVE FISSION SOURCE DISTRIBUTION RADIUS (CM)

0.	0.12130E+01
0.16111E+01	0.12125E+01
0.32222E+01	0.12111E+01
0.48333E+01	0.12089E+01
0.64444E+01	0.12057E+01
0.80555E+01	0.12013E+01
0.96667E+01	0.11958E+01
0.11278E+02	0.11893E+01
0.12889E+02	0.11815E+01
0.14500E+02	0.11723E+01
0.16111E+02	0.11618E+01
0.17722E+02	0.11499E+01
0.19333E+02	0.11366E+01
0.20944E+02	0.11219E+01
0.22556E+02	0.11056E+01
0.24167E+02	0.10878E+01
0.25778E+02	0.10684E+01
0.27389E+02	0.10474E+01
0.29000E+02	0.10251E+01
0.30611E+02	0.10014E+01
0.32222E+02	0.97656E+00
0.33833E+02	0.95054E+00
0.35444E+02	0.92348E+00
0.37056E+02	0.89595E+00
0.38667E+02	0.86840E+00
0.40278E+02	0.84129E+00
0.41889E+02	0.81549E+00
0.43500E+02	0.79236E+00

TABLE 4-3 (Continued)

THE FOLLOWING DATA ARRAY HAS BEEN PLOTTED FOR.... RADIAL CORE CENTER REGION P1  
 RELATIVE FISSION SOURCE DISTRIBUTION AXIAL DISTANCE FROM STATION-0-(CM)

0.	0.65476E-01
0.24063E+01	0.15832E+00
0.48126E+01	0.24925E+00
0.72189E+01	0.33679E+00
0.96253E+01	0.42094E+00
0.12032E+02	0.50212E+00
0.14438E+02	0.58033E+00
0.16844E+02	0.65511E+00
0.19251E+02	0.72639E+00
0.21657E+02	0.79430E+00
0.24063E+02	0.85887E+00
0.26469E+02	0.92011E+00
0.28876E+02	0.97793E+00
0.31282E+02	0.10323E+01
0.33688E+02	0.10832E+01
0.36095E+02	0.11308E+01
0.38501E+02	0.11750E+01
0.40907E+02	0.12159E+01
0.43314E+02	0.12534E+01
0.45720E+02	0.12876E+01
0.48126E+02	0.13184E+01
0.50533E+02	0.13459E+01
0.52939E+02	0.13700E+01
0.55345E+02	0.13907E+01
0.57752E+02	0.14080E+01
0.60158E+02	0.14219E+01
0.62564E+02	0.14323E+01
0.64971E+02	0.14393E+01
0.67377E+02	0.14428E+01
0.69783E+02	0.14428E+01
0.72189E+02	0.14394E+01
0.74596E+02	0.14325E+01
0.77002E+02	0.14222E+01
0.79408E+02	0.14086E+01
0.81815E+02	0.13914E+01
0.84221E+02	0.13709E+01
0.86627E+02	0.13472E+01
0.89034E+02	0.13201E+01
0.91440E+02	0.12898E+01
0.93846E+02	0.12564E+01
0.96253E+02	0.12197E+01
0.98659E+02	0.11802E+01
0.10107E+03	0.11376E+01
0.10347E+03	0.10919E+01
0.10588E+03	0.10437E+01

TABLE 4-3 (Continued)

0.10828E+03	0.99256E+00
0.11069E+03	0.93873E+00
0.11310E+03	0.88308E+00
0.11550E+03	0.82491E+00
0.11791E+03	0.76489E+00
0.12032E+03	0.70442E+00
0.12272E+03	0.64241E+00
0.12513E+03	0.58050E+00
0.12753E+03	0.52020E+00
0.12994E+03	0.46014E+00
0.13235E+03	0.40546E+00
0.13475E+03	0.35987E+00
0.13716E+03	0.33501E+00

TABLE 4-3 (Continued)

THE FOLLOWING CARDS WERE PUNCHED FOR KAP

15	46	REGION NO.	1	RADIAL	CORE	REGION	P1
21	75	14	29				
2	1	1.0		7.06993E+01			
50	1400	2.19500E-01	1.06229E+00	2.84372E+00	1.08886E+01	3.47655E+01	
50	1405	8.11039E+01	5.18017E+01	7.09806E+01	9.16528E+01	1.27231E+02	
30	1410	1.69694E+02	2.26820E+02	1.06278E+02			
10	5533	0.					
50	5534	3.50000E+00	9.50000E+00	1.40000E+01	1.80000E+01	2.20000E+01	
50	5539	2.60000E+01	3.00000E+01	3.35000E+01	3.65000E+01	3.90000E+01	
20	5544	4.10000E+01	4.27500E+01				
10	5546	4.35000E+01					
10	5544	0.					
50	5545	5.00000E-01	1.75000E+00	3.00000E+00	4.75000E+00	7.50000E+00	
50	5590	1.15000E+01	1.70000E+01	2.35000E+01	3.05000E+01	3.75000E+01	
50	5595	4.45000E+01	5.15000E+01	5.85000E+01	6.55000E+01	7.25000E+01	
50	5600	7.45000E+01	8.65000E+01	9.35000E+01	1.00500E+02	1.07500E+02	
50	5605	1.14500E+02	1.21500E+02	1.27500E+02	1.31500E+02	1.34000E+02	
20	5610	1.35650E+02	1.36730E+02				
10	5612	1.37160E+02					
10	5635	1.21191E+00					
50	5636	1.20966E+00	1.19536E+00	1.17422E+00	1.14668E+00	1.11040E+00	
50	5641	1.06475E+00	1.00980E+00	9.55354E-01	9.04914E-01	8.62141E-01	
20	5646	8.29020E-01	8.02164E-01				
10	5648	7.91809E-01					
10	5646	6.54802E-02					
50	5647	8.00218E-02	1.32116E-01	1.81346E-01	2.46740E-01	3.46490E-01	
50	5692	4.83907E-01	6.59146E-01	8.43143E-01	1.01392E+00	1.15576E+00	
50	5697	1.26926E+00	1.35450E+00	1.41116E+00	1.43879E+00	1.43717E+00	
50	5702	1.40642E+00	1.34707E+00	1.26007E+00	1.14666E+00	1.00860E+00	
50	5707	8.48870E-01	6.73758E-01	5.20570E-01	4.24208E-01	3.72909E-01	
20	5712	3.47486E-01	3.38055E-01				
10	5714	3.35139E-01					
10	5737	1.21201E+00					
50	5738	1.20976E+00	1.19545E+00	1.17429E+00	1.14674E+00	1.11045E+00	
50	5743	1.06478E+00	1.00980E+00	9.55334E-01	9.04873E-01	8.62084E-01	
20	5748	8.28950E-01	8.02081E-01				
10	5750	7.91719E-01					
10	5788	6.54169E-02					
50	5789	7.99553E-02	1.32050E-01	1.81282E-01	2.46681E-01	3.46439E-01	
50	5794	4.83871E-01	6.59129E-01	8.43142E-01	1.01393E+00	1.15577E+00	
50	5799	1.26928E+00	1.35453E+00	1.41118E+00	1.43882E+00	1.43720E+00	
50	5804	1.40645E+00	1.34710E+00	1.26009E+00	1.14668E+00	1.00862E+00	
50	5809	8.48880E-01	6.73758E-01	5.20549E-01	4.24144E-01	3.72769E-01	
20	5814	3.47237E-01	3.37672E-01				
11	5816	3.34619E-01					

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Astronuclear  
Laboratory

TABLE 4-3 (Continued)

TOTAL PHOTON SOURCE...	9.75341E+02
TOTAL FISSIONS.....	7.06993E+01
TOTAL NEUTRON SOURCE..	1.72115E+02

TABLE 4-3 (Continued)

NEUTRON SOURCE	GROUP NO. #								
	1	2	3	4	5	6	7	8	
	1.50	1.75	3.00	4.75	7.50	11.50	17.00	23.50	
1	3.50	2.0335E-05	3.3586E-05	4.6109E-05	6.2748E-05	8.8139E-05	1.2316E-04	1.6790E-04	2.1497E-04
2	9.50	2.0097E-05	3.3195E-05	4.5574E-05	6.2020E-05	8.7115E-05	1.2173E-04	1.6593E-04	2.1244E-04
3	14.00	1.9747E-05	3.2618E-05	4.4784E-05	6.0944E-05	8.5601E-05	1.1960E-04	1.6303E-04	2.0870E-04
4	18.00	1.9291E-05	3.1868E-05	4.3752E-05	5.9541E-05	8.3628E-05	1.1684E-04	1.5924E-04	2.0384E-04
5	22.00	1.8691E-05	3.0877E-05	4.2395E-05	5.7691E-05	8.1026E-05	1.1319E-04	1.5426E-04	1.9742E-04
6	26.00	1.7937E-05	2.9633E-05	4.0685E-05	5.5363E-05	7.7752E-05	1.0861E-04	1.4798E-04	1.8936E-04
7	30.00	1.7032E-05	2.8136E-05	3.8629E-05	5.2561E-05	7.3810E-05	1.0309E-04	1.4043E-04	1.7966E-04
8	33.50	1.6138E-05	2.6656E-05	3.6592E-05	4.9787E-05	6.9911E-05	9.7625E-05	1.3296E-04	1.7006E-04
9	36.50	1.5313E-05	2.5285E-05	3.4711E-05	4.7223E-05	6.6306E-05	9.2583E-05	1.2607E-04	1.6118E-04
10	39.00	1.4617E-05	2.4127E-05	3.3112E-05	4.5054E-05	6.3262E-05	8.8327E-05	1.2024E-04	1.5368E-04
11	41.00	1.4073E-05	2.3226E-05	3.1879E-05	4.3378E-05	6.0923E-05	8.5059E-05	1.1576E-04	1.4790E-04
12	42.75	1.3625E-05	2.2491E-05	3.0873E-05	4.2028E-05	5.9047E-05	8.2439E-05	1.1217E-04	1.4325E-04
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
	9	10	11	12	13	14	15	16	
	30.50	37.50	44.50	51.50	58.50	65.50	72.50	79.50	
1	3.50	2.5872E-04	2.9508E-04	3.2417E-04	3.4600E-04	3.6050E-04	3.6758E-04	3.5931E-04	
2	9.50	2.5566E-04	2.9158E-04	3.2032E-04	3.4189E-04	3.5622E-04	3.6321E-04	3.5504E-04	
3	14.00	2.5115E-04	2.8642E-04	3.1464E-04	3.3582E-04	3.4989E-04	3.5676E-04	3.4873E-04	
4	18.00	2.4527E-04	2.7970E-04	3.0724E-04	3.2792E-04	3.4165E-04	3.4835E-04	3.4052E-04	
5	22.00	2.3753E-04	2.7084E-04	2.9750E-04	3.1751E-04	3.3080E-04	3.3729E-04	3.2970E-04	
6	26.00	2.279E-04	2.5971E-04	2.8529E-04	3.0442E-04	3.1717E-04	3.2338E-04	3.1610E-04	
7	30.00	2.1607E-04	2.4631E-04	2.7051E-04	2.8868E-04	3.0076E-04	3.0665E-04	2.9975E-04	
8	33.50	2.0447E-04	2.3306E-04	2.5593E-04	2.7311E-04	2.8452E-04	2.9009E-04	2.8356E-04	



TABLE 4-3 (Continued)

9	36.50	1.9375E-04	2.2079E-04	2.4243E-04	2.5869E-04	2.6950E-04	2.7477E-04	2.7446E-04	2.6858E-04
10	39.00	1.8468E-04	2.1040E-04	2.3100E-04	2.4647E-04	2.5677E-04	2.6178E-04	2.6149E-04	2.5589E-04
11	41.00	1.7767E-04	2.0238E-04	2.2216E-04	2.3703E-04	2.4692E-04	2.5174E-04	2.5146E-04	2.4608E-04
12	42.75	1.7201E-04	1.9588E-04	2.1500E-04	2.2938E-04	2.3895E-04	2.4361E-04	2.4333E-04	2.3813E-04
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		17	18	19	20	21	22	23	24
		86.50	93.50	100.50	107.50	114.50	121.50	127.50	131.50
1	3.50	3.4414E-04	3.2190E-04	2.9291E-04	2.5763E-04	2.1685E-04	1.7220E-04	1.3314E-04	1.0849E-04
2	9.50	3.4005E-04	3.1807E-04	2.8943E-04	2.5457E-04	2.1428E-04	1.7017E-04	1.3159E-04	1.0726E-04
3	14.00	3.3401E-04	3.1242E-04	2.8429E-04	2.5005E-04	2.1048E-04	1.6716E-04	1.2929E-04	1.0543E-04
4	18.00	3.2614E-04	3.0506E-04	2.7759E-04	2.4416E-04	2.0552E-04	1.6323E-04	1.2628E-04	1.0303E-04
5	22.00	3.1578E-04	2.9538E-04	2.6878E-04	2.3641E-04	1.9900E-04	1.5806E-04	1.2230E-04	9.9839E-05
6	26.00	3.0276E-04	2.8320E-04	2.5770E-04	2.2667E-04	1.9080E-04	1.5154E-04	1.1727E-04	9.5769E-05
7	30.00	2.8710E-04	2.6855E-04	2.4438E-04	2.1495E-04	1.8092E-04	1.4367E-04	1.1116E-04	9.0780E-05
8	33.50	2.7160E-04	2.5406E-04	2.3120E-04	2.0336E-04	1.7115E-04	1.3586E-04	1.0505E-04	8.5735E-05
9	36.50	2.5725E-04	2.4064E-04	2.1899E-04	1.9263E-04	1.6210E-04	1.2861E-04	9.9318E-05	8.0924E-05
10	39.00	2.4510E-04	2.2928E-04	2.0866E-04	1.8355E-04	1.5444E-04	1.2246E-04	9.4399E-05	7.6724E-05
11	41.00	2.3570E-04	2.2049E-04	2.0067E-04	1.7653E-04	1.4852E-04	1.1767E-04	9.0527E-05	7.3331E-05
12	42.75	2.2809E-04	2.1338E-04	1.9421E-04	1.7085E-04	1.4373E-04	1.1379E-04	8.7329E-05	7.0456E-05
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		25	26	27	28	29	30	31	32
		134.00	135.65	136.73	137.58	138.50	139.35	140.30	142.40
1	3.50	9.5248E-05	8.8549E-05	8.5925E-05	0.	0.	0.	0.	0.
2	9.50	9.4205E-05	8.7618E-05	8.5055E-05	0.	0.	0.	0.	0.
3	14.00	9.2653E-05	8.6228E-05	8.3752E-05	0.	0.	0.	0.	0.
4	18.00	9.0606E-05	8.4388E-05	8.2020E-05	0.	0.	0.	0.	0.
5	22.00	8.7867E-05	8.1908E-05	7.9674E-05	0.	0.	0.	0.	0.
6	26.00	8.4345E-05	7.8695E-05	7.6613E-05	0.	0.	0.	0.	0.
7	30.00	7.9982E-05	7.4669E-05	7.2740E-05	0.	0.	0.	0.	0.
8	33.50	7.5512E-05	7.0497E-05	6.8687E-05	0.	0.	0.	0.	0.
9	36.50	7.1176E-05	6.6381E-05	6.4637E-05	0.	0.	0.	0.	0.
10	39.00	6.7320E-05	6.2669E-05	6.0940E-05	0.	0.	0.	0.	0.
11	41.00	6.4126E-05	5.9525E-05	5.7760E-05	0.	0.	0.	0.	0.
12	42.75	6.1334E-05	5.6717E-05	5.4877E-05	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		33	34	35	36	37	38	39	40
		145.90	149.90	153.42	155.00	155.13	155.26	155.39	155.52
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.
3	14.00	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.
6	26.00	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.71	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		41	42	43	44	45	46	47	48
		155.65	155.78	155.94	156.24	156.74	157.59	158.69	159.99
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.
3	14.00	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

6	26.00	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		49	50	51	52	53	54	55	56
		161.49	162.99	164.49	166.24	168.24	170.24	172.24	174.24
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.
3	14.00	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.
6	26.00	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		57	58	59	60	61	62	63	64
		176.24	178.24	180.24	182.24	184.24	185.92	187.49	188.74
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.
3	14.00	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.
6	26.00	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		<sup>65</sup> 189.74	<sup>66</sup> 190.59	<sup>67</sup> 191.29	<sup>68</sup> 191.84	<sup>69</sup> 192.14	<sup>70</sup> 192.34	<sup>71</sup> 192.54	<sup>72</sup> 192.74
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.
2	4.50	0.	0.	0.	0.	0.	0.	0.	0.
3	14.00	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.
6	26.00	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.50	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		<sup>73</sup> 192.89	<sup>74</sup> 192.99	<sup>75</sup> 195.52	<sup>76</sup> 201.00	<sup>77</sup> 207.00	<sup>78</sup> 212.95	<sup>79</sup> 216.70	<sup>80</sup> 217.97
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

3	14.00	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.
6	26.00	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

FISSION DENSITY	GROUP NO. = 1																
	1		2		3		4		5		6		7		8		
	3.50	8.3519E-06	1.3795E-05	1.8939E-05	2.5774E-05	3.6204E-05	5.0590E-05	6.8967E-05	8.8307E-05	0.50	1.75	3.00	4.75	7.50	11.50	17.00	23.50
1	3.50	8.3519E-06	1.3795E-05	1.8939E-05	2.5774E-05	3.6204E-05	5.0590E-05	6.8967E-05	8.8307E-05								
2	9.50	8.2543E-06	1.3635E-05	1.8719E-05	2.5475E-05	3.5783E-05	5.0001E-05	6.8160E-05	8.7264E-05								
3	14.00	8.1104E-06	1.3398E-05	1.8395E-05	2.5033E-05	3.5161E-05	4.9129E-05	6.6967E-05	8.5729E-05								
4	18.00	7.9231E-06	1.3089E-05	1.7971E-05	2.4456E-05	3.4351E-05	4.7993E-05	6.5412E-05	8.3730E-05								
5	22.00	7.6765E-06	1.2682E-05	1.7413E-05	2.3697E-05	3.3282E-05	4.6496E-05	6.3363E-05	8.1096E-05								
6	26.00	7.3669E-06	1.2171E-05	1.6711E-05	2.2740E-05	3.1937E-05	4.4611E-05	6.0785E-05	7.7782E-05								
7	30.00	6.9952E-06	1.1556E-05	1.5866E-05	2.1589E-05	3.0318E-05	4.2344E-05	5.7684E-05	7.3796E-05								
8	33.50	6.6281E-06	1.0948E-05	1.5029E-05	2.0450E-05	2.8716E-05	4.0100E-05	5.4616E-05	6.9853E-05								
9	36.50	6.2897E-06	1.0385E-05	1.4257E-05	1.9396E-05	2.7235E-05	3.8029E-05	5.1782E-05	6.6208E-05								
10	39.00	6.0030E-06	9.9094E-06	1.3600E-05	1.8505E-05	2.5985E-05	3.6281E-05	4.9390E-05	6.3127E-05								
11	41.00	5.7798E-06	9.5395E-06	1.3094E-05	1.7817E-05	2.5024E-05	3.4938E-05	4.7551E-05	6.0754E-05								
12	42.75	5.5958E-06	9.2377E-06	1.2681E-05	1.7263E-05	2.4253E-05	3.3862E-05	4.6075E-05	5.8841E-05								
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.								
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.								
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.								
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.								
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.								
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.								
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.								
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.								
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.								
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.								
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.								
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.								
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.								
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.								
27	55.14	0.	0.	0.	0.	0.	0.	0.	0.								
28	56.59	0.	0.	0.	0.	0.	0.	0.	0.								
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.								
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.								
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.								
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.								
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.								
34	65.57	0.	0.	0.	0.	0.	0.	0.	0.								
	9		10		11		12		13		14		15		16		
	30.50	37.50	44.50	51.50	58.50	65.50	72.50	79.50									
1	3.50	1.0627E-04	1.2121E-04	1.3316E-04	1.4213E-04	1.4809E-04	1.5099E-04	1.4760E-04									
2	9.50	1.0502E-04	1.1978E-04	1.3158E-04	1.4044E-04	1.4633E-04	1.4920E-04	1.4584E-04									
3	14.00	1.0317E-04	1.1765E-04	1.2925E-04	1.3795E-04	1.4373E-04	1.4655E-04	1.4325E-04									
4	18.00	1.0075E-04	1.1489E-04	1.2621E-04	1.3470E-04	1.4034E-04	1.4309E-04	1.3987E-04									
5	22.00	9.7569E-05	1.1125E-04	1.2220E-04	1.3042E-04	1.3588E-04	1.3855E-04	1.3543E-04									
6	26.00	9.3567E-05	1.0668E-04	1.1717E-04	1.2505E-04	1.3028E-04	1.3283E-04	1.2985E-04									
7	30.00	8.8754E-05	1.0118E-04	1.1112E-04	1.1858E-04	1.2354E-04	1.2596E-04	1.2313E-04									
8	33.50	8.3991E-05	9.5732E-05	1.0513E-04	1.1218E-04	1.1687E-04	1.1916E-04	1.1648E-04									

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Atomic Energy Establishment  
Cairo  
Laboratory



TABLE 4-3 (Continued)

9	36.50	7.9586E-05	9.0693E-05	9.9582E-05	1.0626E-04	1.1070E-04	1.1286E-04	1.1274E-04	1.1032E-04
10	39.00	7.5858E-05	8.6426E-05	9.4886E-05	1.0124E-04	1.0547E-04	1.0753E-04	1.0741E-04	1.0511E-04
11	41.00	7.2981E-05	8.3130E-05	9.1255E-05	9.7363E-05	1.0143E-04	1.0341E-04	1.0329E-04	1.0108E-04
12	42.75	7.0656E-05	8.0463E-05	8.8316E-05	9.4223E-05	9.8151E-05	1.0007E-04	9.9954E-05	9.7816E-05
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		17	18	19	20	21	22	23	24
		86.50	93.50	100.50	107.50	114.50	121.50	127.50	131.50
1	3.50	1.4136E-04	1.3223E-04	1.2032E-04	1.0583E-04	8.9077E-05	7.0737E-05	5.4691E-05	4.4567E-05
2	9.50	1.3968E-04	1.3066E-04	1.1889E-04	1.0457E-04	8.8020E-05	6.9901E-05	5.4053E-05	4.4060E-05
3	14.00	1.3720E-04	1.2833E-04	1.1678E-04	1.0271E-04	8.6458E-05	6.8664E-05	5.3108E-05	4.3309E-05
4	18.00	1.3397E-04	1.2531E-04	1.1403E-04	1.0029E-04	8.4423E-05	6.7052E-05	5.1873E-05	4.2323E-05
5	22.00	1.2972E-04	1.2133E-04	1.1041E-04	9.7112E-05	8.1743E-05	6.4925E-05	5.0239E-05	4.1011E-05
6	26.00	1.2437E-04	1.1633E-04	1.0586E-04	9.3109E-05	7.8373E-05	6.2246E-05	4.8171E-05	3.9339E-05
7	30.00	1.1793E-04	1.1031E-04	1.0038E-04	8.8296E-05	7.4317E-05	5.9015E-05	4.5660E-05	3.7290E-05
8	33.50	1.1156E-04	1.0436E-04	9.4967E-05	8.3532E-05	7.0303E-05	5.5808E-05	4.3151E-05	3.5218E-05
9	36.50	1.0567E-04	9.8848E-05	8.9955E-05	7.9126E-05	6.6587E-05	5.2830E-05	4.0796E-05	3.3241E-05
10	39.00	1.0068E-04	9.4181E-05	8.5711E-05	7.5395E-05	6.3440E-05	5.0300E-05	3.8776E-05	3.1516E-05
11	41.00	9.6818E-05	9.0572E-05	8.2429E-05	7.2511E-05	6.1007E-05	4.8336E-05	3.7185E-05	3.0122E-05
12	42.75	9.3692E-05	8.7649E-05	7.9773E-05	7.0178E-05	5.9040E-05	4.6740E-05	3.5872E-05	2.8941E-05
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		25	26	27	28	29	30	31	32
		134.00	135.65	136.73	137.58	138.50	139.35	140.30	142.40
1	3.50	3.9127E-05	3.6375E-05	3.5298E-05	0.	0.	0.	0.	0.
2	9.50	3.8698E-05	3.5993E-05	3.4941E-05	0.	0.	0.	0.	0.
3	14.00	3.8060E-05	3.5422E-05	3.4405E-05	0.	0.	0.	0.	0.
4	18.00	3.7219E-05	3.4666E-05	3.3694E-05	0.	0.	0.	0.	0.
5	22.00	3.6094E-05	3.3647E-05	3.2730E-05	0.	0.	0.	0.	0.
6	26.00	3.4647E-05	3.2327E-05	3.1472E-05	0.	0.	0.	0.	0.
7	30.00	3.2855E-05	3.0673E-05	2.9881E-05	0.	0.	0.	0.	0.
8	33.50	3.1019E-05	2.8960E-05	2.8216E-05	0.	0.	0.	0.	0.
9	36.50	2.9237E-05	2.7268E-05	2.6553E-05	0.	0.	0.	0.	0.
10	39.00	2.7654E-05	2.5744E-05	2.5034E-05	0.	0.	0.	0.	0.
11	41.00	2.6342E-05	2.4452E-05	2.3727E-05	0.	0.	0.	0.	0.
12	42.75	2.5195E-05	2.3299E-05	2.2543E-05	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

31	61.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.	0.
			<sup>33</sup>	<sup>34</sup>	<sup>35</sup>	<sup>36</sup>	<sup>37</sup>	<sup>38</sup>	<sup>39</sup>	<sup>40</sup>
			145.90	149.90	153.42	155.00	155.13	155.26	155.39	155.52
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	14.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	26.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.	0.
			<sup>41</sup>	<sup>42</sup>	<sup>43</sup>	<sup>44</sup>	<sup>45</sup>	<sup>46</sup>	<sup>47</sup>	<sup>48</sup>
			155.65	155.78	155.94	156.24	156.74	157.59	158.69	159.99
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	14.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

6	26.00	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		49	50	51	52	53	54	55	56
		161.49	162.99	164.49	166.24	168.24	170.24	172.24	174.24
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.
3	14.00	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.
6	26.00	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	55.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		57	58	59	60	61	62	63	64
		176.24	178.24	180.24	182.24	184.24	185.99	187.49	188.74
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.
3	14.00	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.
6	26.00	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		65	66	67	68	69	70	71	72
		189.74	190.59	191.29	191.84	192.14	192.34	192.54	192.74
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.
3	14.00	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.
6	26.00	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		73	74	75	76	77	78	79	80
		192.89	192.99	195.52	201.00	207.00	212.95	216.70	217.97
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

3	14.00	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.
6	26.00	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

PHOTON SOURCE	GROUP NO. = 1								
	1 1.50	2 1.75	3 3.00	4 4.75	5 7.50	6 11.50	7 17.00	8 23.50	
1	3.50	2.5939E-08	4.2802E-08	5.8738E-08	7.9906E-08	1.1221E-07	1.5675E-07	2.1366E-07	2.7354E-07
2	9.50	2.5637E-08	4.2306E-08	5.8057E-08	7.8980E-08	1.1090E-07	1.5493E-07	2.1116E-07	2.7033E-07
3	14.00	2.5192E-08	4.1572E-08	5.7052E-08	7.7612E-08	1.0898E-07	1.5223E-07	2.0747E-07	2.6558E-07
4	18.00	2.4613E-08	4.0619E-08	5.5743E-08	7.5830E-08	1.0647E-07	1.4872E-07	2.0266E-07	2.5940E-07
5	22.00	2.3850E-08	3.9362E-08	5.4020E-08	7.3483E-08	1.0317E-07	1.4409E-07	1.9633E-07	2.5126E-07
6	26.00	2.2894E-08	3.7784E-08	5.1851E-08	7.0531E-08	9.9021E-08	1.3828E-07	1.8838E-07	2.4104E-07
7	30.00	2.1748E-08	3.5887E-08	4.9248E-08	6.6985E-08	9.4032E-08	1.3129E-07	1.7882E-07	2.2876E-07
8	33.50	2.0618E-08	3.4018E-08	4.6675E-08	6.3482E-08	8.9107E-08	1.2440E-07	1.6940E-07	2.1664E-07
9	36.50	1.9579E-08	3.2293E-08	4.4309E-08	6.0257E-08	8.4576E-08	1.1806E-07	1.6073E-07	2.0549E-07
10	39.00	1.8707E-08	3.0844E-08	4.2310E-08	5.7546E-08	8.0773E-08	1.1275E-07	1.5346E-07	1.9612E-07
11	41.00	1.8033E-08	2.9730E-08	4.0787E-08	5.5478E-08	7.7891E-08	1.0872E-07	1.4794E-07	1.8901E-07
12	42.75	1.7487E-08	2.8837E-08	3.9565E-08	5.3842E-08	7.5623E-08	1.0556E-07	1.4361E-07	1.8339E-07
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.75	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		9 30.50	10 37.50	11 44.50	12 51.50	13 58.50	14 65.50	15 72.50	16 79.50
1	3.50	3.2921E-07	3.7549E-07	4.1251E-07	4.4029E-07	4.5875E-07	4.6776E-07	4.6724E-07	4.5724E-07
2	9.50	3.2533E-07	3.7104E-07	4.0761E-07	4.3507E-07	4.5331E-07	4.6220E-07	4.6169E-07	4.5181E-07
3	14.00	3.1959E-07	3.6448E-07	4.0039E-07	4.2735E-07	4.4526E-07	4.5400E-07	4.5349E-07	4.4378E-07
4	18.00	3.1212E-07	3.5594E-07	3.9099E-07	4.1731E-07	4.3479E-07	4.4332E-07	4.4283E-07	4.3335E-07
5	22.00	3.0230E-07	3.4470E-07	3.7863E-07	4.0410E-07	4.2103E-07	4.2928E-07	4.2880E-07	4.1962E-07
6	26.00	2.8995E-07	3.3059E-07	3.6310E-07	3.8751E-07	4.0373E-07	4.1165E-07	4.1118E-07	4.0238E-07
7	30.00	2.7512E-07	3.1363E-07	3.4445E-07	3.6759E-07	3.8297E-07	3.9047E-07	3.9003E-07	3.8168E-07
8	33.50	2.6048E-07	2.9689E-07	3.2603E-07	3.4792E-07	3.6246E-07	3.6956E-07	3.6914E-07	3.6124E-07

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TABLE 4-3 (Continued)

9	36.50	2.4700E-07	2.8148E-07	3.0907E-07	3.2980E-07	3.4358E-07	3.5030E-07	3.4990E-07	3.4242E-07
10	39.00	2.3567E-07	2.6851E-07	2.9480E-07	3.1455E-07	3.2768E-07	3.3409E-07	3.3371E-07	3.2657E-07
11	41.00	2.2705E-07	2.5862E-07	2.8391E-07	3.0291E-07	3.1555E-07	3.2172E-07	3.2135E-07	3.1448E-07
12	42.75	2.2022E-07	2.5078E-07	2.7526E-07	2.9367E-07	3.0592E-07	3.1190E-07	3.1154E-07	3.0488E-07
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.50	0.	0.	0.	0.	0.	0.	0.	0.
		17	18	19	20	21	22	23	24
		86.50	93.50	100.50	107.50	114.50	121.50	127.50	131.50
1	3.50	4.3793E-07	4.0963E-07	3.7273E-07	3.2785E-07	2.7600E-07	2.1934E-07	1.7023E-07	1.4020E-07
2	9.50	4.3273E-07	4.0476E-07	3.6831E-07	3.2396E-07	2.7273E-07	2.1675E-07	1.6824E-07	1.3861E-07
3	14.00	4.2505E-07	3.9758E-07	3.6177E-07	3.1822E-07	2.6789E-07	2.1292E-07	1.6530E-07	1.3625E-07
4	18.00	4.1504E-07	3.8823E-07	3.5327E-07	3.1074E-07	2.6160E-07	2.0793E-07	1.6147E-07	1.3315E-07
5	22.00	4.0191E-07	3.7594E-07	3.4209E-07	3.0090E-07	2.5332E-07	2.0195E-07	1.5639E-07	1.2903E-07
6	26.00	3.8540E-07	3.6050E-07	3.2804E-07	2.8855E-07	2.4292E-07	1.9307E-07	1.4997E-07	1.2378E-07
7	30.00	3.6558E-07	3.4196E-07	3.1118E-07	2.7372E-07	2.3042E-07	1.8310E-07	1.4220E-07	1.1736E-07
8	33.50	3.4600E-07	3.2366E-07	2.9453E-07	2.5908E-07	2.1807E-07	1.7323E-07	1.3444E-07	1.1087E-07
9	36.50	3.2797E-07	3.0680E-07	2.7920E-07	2.4559E-07	2.0670E-07	1.6411E-07	1.2719E-07	1.0471E-07
10	39.00	3.1280E-07	2.9261E-07	2.6629E-07	2.3425E-07	1.9713E-07	1.5641E-07	1.2100E-07	9.9355E-08
11	41.00	3.0122E-07	2.8178E-07	2.5645E-07	2.2560E-07	1.8983E-07	1.5050E-07	1.1619E-07	9.5071E-08
12	42.75	2.9202E-07	2.7319E-07	2.4864E-07	2.1874E-07	1.8404E-07	1.4579E-07	1.1228E-07	9.1488E-08
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

20	49.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.	0.
		25	26	27	28	29	30	31	32	
		134.00	135.65	136.73	137.58	138.50	139.35	140.30	142.40	
1	3.50	1.2555E-07	1.2005E-07	1.2033E-07	0.	0.	0.	0.	0.	0.
2	9.50	1.2417E-07	1.1878E-07	1.1909E-07	0.	0.	0.	0.	0.	0.
3	14.00	1.2213E-07	1.1689E-07	1.1725E-07	0.	0.	0.	0.	0.	0.
4	18.00	1.1942E-07	1.1438E-07	1.1480E-07	0.	0.	0.	0.	0.	0.
5	22.00	1.1581E-07	1.1101E-07	1.1150E-07	0.	0.	0.	0.	0.	0.
6	26.00	1.1118E-07	1.0665E-07	1.0719E-07	0.	0.	0.	0.	0.	0.
7	30.00	1.0544E-07	1.0119E-07	1.0176E-07	0.	0.	0.	0.	0.	0.
8	33.50	9.9570E-08	9.5554E-08	9.6089E-08	0.	0.	0.	0.	0.	0.
9	36.50	9.3894E-08	9.0006E-08	9.0450E-08	0.	0.	0.	0.	0.	0.
10	39.00	8.8867E-08	8.5023E-08	8.5326E-08	0.	0.	0.	0.	0.	0.
11	41.00	8.4735E-08	8.0832E-08	8.0951E-08	0.	0.	0.	0.	0.	0.
12	42.75	8.1156E-08	7.7113E-08	7.7011E-08	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.	0.

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TABLE 4-3 (Continued)

31	61.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.	0.
		<sup>33</sup>	<sup>34</sup>	<sup>35</sup>	<sup>36</sup>	<sup>37</sup>	<sup>38</sup>	<sup>39</sup>	<sup>40</sup>	
		145.90	149.90	153.42	155.00	155.13	155.26	155.39	155.52	
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	14.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	26.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.	0.
		<sup>41</sup>	<sup>42</sup>	<sup>43</sup>	<sup>44</sup>	<sup>45</sup>	<sup>46</sup>	<sup>47</sup>	<sup>48</sup>	
		155.65	155.78	155.94	156.24	156.74	157.59	158.69	159.99	
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	14.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

6	26.00	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		49	50	51	52	53	54	55	56
		161.49	162.99	164.49	166.24	168.24	170.24	172.24	174.24
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.
3	14.00	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.
6	26.00	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.

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TABLE 4-3 (Continued)

17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		57	58	59	60	61	62	63	64
		176.24	178.24	180.24	182.24	184.24	185.99	187.49	188.74
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.
3	14.00	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.
6	26.00	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		65	66	67	68	69	70	71	72
		189.74	190.59	191.29	191.84	192.14	192.34	192.54	192.74
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.
3	14.00	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.
6	26.00	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.14	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.
		73	74	75	76	77	78	79	80
		192.89	192.99	195.52	201.00	207.00	212.95	216.70	217.97
1	3.50	0.	0.	0.	0.	0.	0.	0.	0.
2	9.50	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (Continued)

3	14.00	0.	0.	0.	0.	0.	0.	0.	0.
4	18.00	0.	0.	0.	0.	0.	0.	0.	0.
5	22.00	0.	0.	0.	0.	0.	0.	0.	0.
6	26.00	0.	0.	0.	0.	0.	0.	0.	0.
7	30.00	0.	0.	0.	0.	0.	0.	0.	0.
8	33.50	0.	0.	0.	0.	0.	0.	0.	0.
9	36.50	0.	0.	0.	0.	0.	0.	0.	0.
10	39.00	0.	0.	0.	0.	0.	0.	0.	0.
11	41.00	0.	0.	0.	0.	0.	0.	0.	0.
12	42.75	0.	0.	0.	0.	0.	0.	0.	0.
13	44.25	0.	0.	0.	0.	0.	0.	0.	0.
14	45.50	0.	0.	0.	0.	0.	0.	0.	0.
15	46.50	0.	0.	0.	0.	0.	0.	0.	0.
16	47.37	0.	0.	0.	0.	0.	0.	0.	0.
17	48.12	0.	0.	0.	0.	0.	0.	0.	0.
18	48.75	0.	0.	0.	0.	0.	0.	0.	0.
19	49.25	0.	0.	0.	0.	0.	0.	0.	0.
20	49.75	0.	0.	0.	0.	0.	0.	0.	0.
21	50.20	0.	0.	0.	0.	0.	0.	0.	0.
22	50.60	0.	0.	0.	0.	0.	0.	0.	0.
23	51.05	0.	0.	0.	0.	0.	0.	0.	0.
24	51.65	0.	0.	0.	0.	0.	0.	0.	0.
25	52.50	0.	0.	0.	0.	0.	0.	0.	0.
26	53.75	0.	0.	0.	0.	0.	0.	0.	0.
27	55.19	0.	0.	0.	0.	0.	0.	0.	0.
28	56.69	0.	0.	0.	0.	0.	0.	0.	0.
29	58.25	0.	0.	0.	0.	0.	0.	0.	0.
30	59.75	0.	0.	0.	0.	0.	0.	0.	0.
31	61.25	0.	0.	0.	0.	0.	0.	0.	0.
32	62.75	0.	0.	0.	0.	0.	0.	0.	0.
33	64.25	0.	0.	0.	0.	0.	0.	0.	0.
34	65.52	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 4-3 (CONTINUED)

THE DISTRIBUTED PHOTON SOURCE FOR GROUPS 2 TO 13 IS PRINTED IN A SIMILAR MANNER



## 4.6 PROGRAM LOGIC

The general code logic used in the NAGS code is presented in this section. A description of each of the subroutines and their function in the overall code logic is described.

### 4.6.1 Subroutine Description and Computational Procedure

The FORTRAN structure of the NAGS code consists of a main control link subroutine (MAIN) and four basic calculation routines (subroutines NAGS 1 through NAGS 4) which individually perform steps in reducing the neutron and photon energy flux data into usable forms. The final output of a NAGS problem is dependent upon the route or options chosen.

A brief description of each FORTRAN routine is shown in Figure 4-3 . A description of each routine's function is as follows:

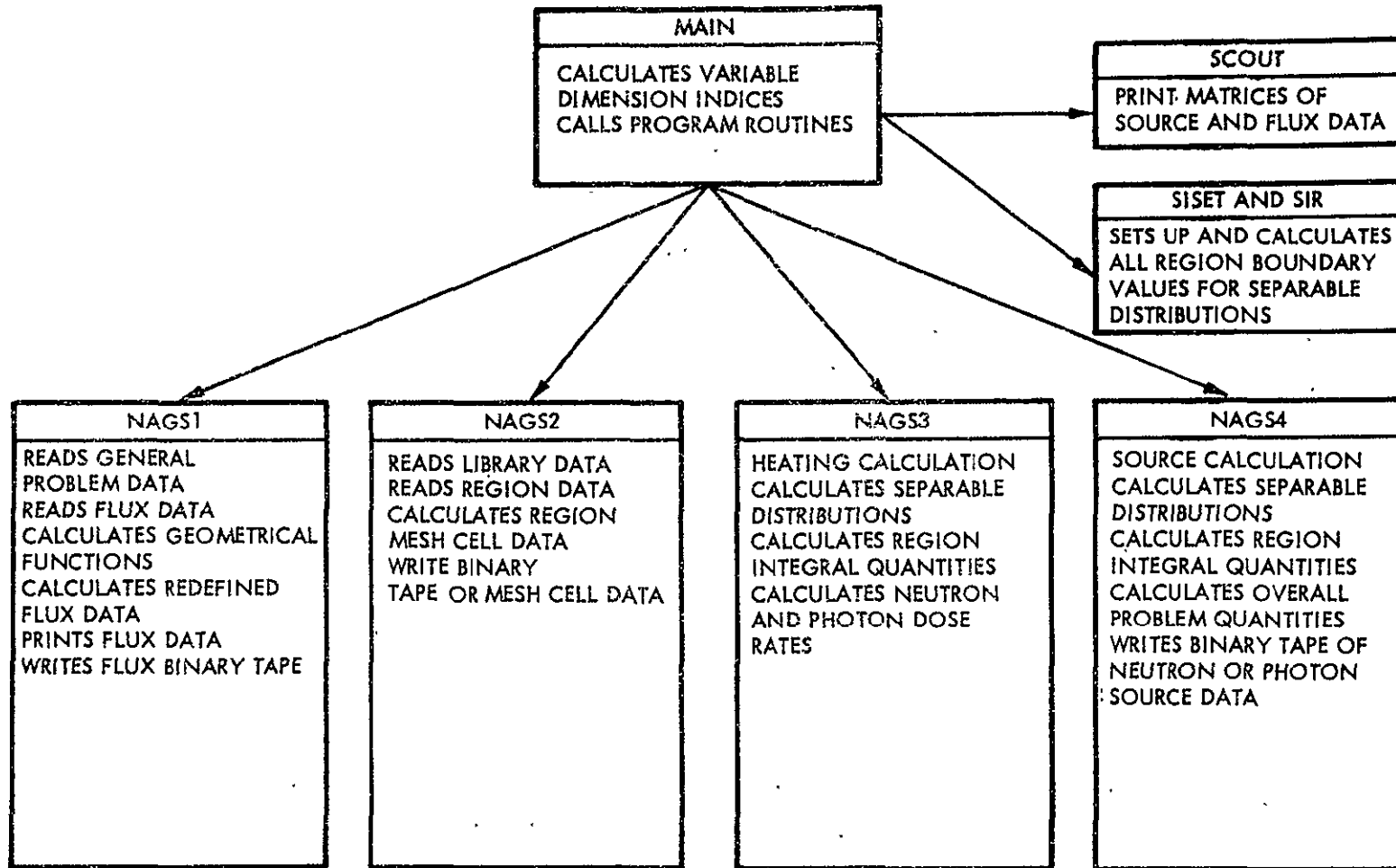
1) The MAIN subroutine initializes the problem by clearing out (set to 0.0) all data storage and allocates data storage on the basis of input pieces of data so that a variety of problems can be handled without program changes. This routine also handles the logical flow throughout the NAGS program system.

2) The NAGS1 subroutine processes all geometrical data and neutron and photon energy flux data to obtain a binary work tape containing the flux data in a usable form for subsequent use.

3) The NAGS2 subroutine processes the elementwise neutron and photon reaction rate and flux data to obtain a regionwise source function and/or response function binary work tape for subsequent use.

4) The NAGS3 subroutine calculates regionwise neutron and/or photon energy deposition distributions and integrals. In addition, NAGS 3 calculates neutron and photon dose rate throughout the two-dimensional mesh cell array.

5) The NAGS4 subroutine calculates regionwise photon source distributions and integrals for use in subsequent discrete ordinate transport, Monte Carlo or point kernel analyses.



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Figure 4-3. NAGS Basic Program Structure

In addition, a set of subroutines are included in the NAGS code to calculate the region distribution data (SISET and SIR), to process neutron and photon energy flux data in the separable R and Z mesh cell directions (COLR and COLZ), and to print matrices of flux data (SCOUT).

An SC-4020 plotting capability is achieved using the subroutines ARRAY, POINT, SORT, GRAB, FLAGSV, NXV, and NYV. The basic framework for plotting is controlled by subroutine AICRT4. In addition to these subroutines, another 20 to 30 subroutines for plotting are obtained from the EXEC 8 computer system.

#### 4.6.2 Overlay Structure

To obtain more problem data space in core storage, the OVERLAY feature of the MSFC UNIVAC-1108 computer system is used. OVERLAY is a programming technique that minimizes the core storage requirements of the FORTRAN program. By minimizing the core storage required for the source program, more problem data space becomes available in core storage.

The level structure used in the overlay of the NAGS code is shown in Figure 4-4. Levels are used to describe the sequence of loading overlays and to specify which sections of the source program overlay others. The main level of the overlay structure always resides in core storage. Only one primary level and its respective secondary levels can reside in core storage at one time.

An increase of approximately  $15,000_{10}$  core storage locations for NAGS problem data resulting in a total problem data storage of  $47,000_{10}$  is achieved using the OVERLAY feature of the MSFC UNIVAC-1108 computer.

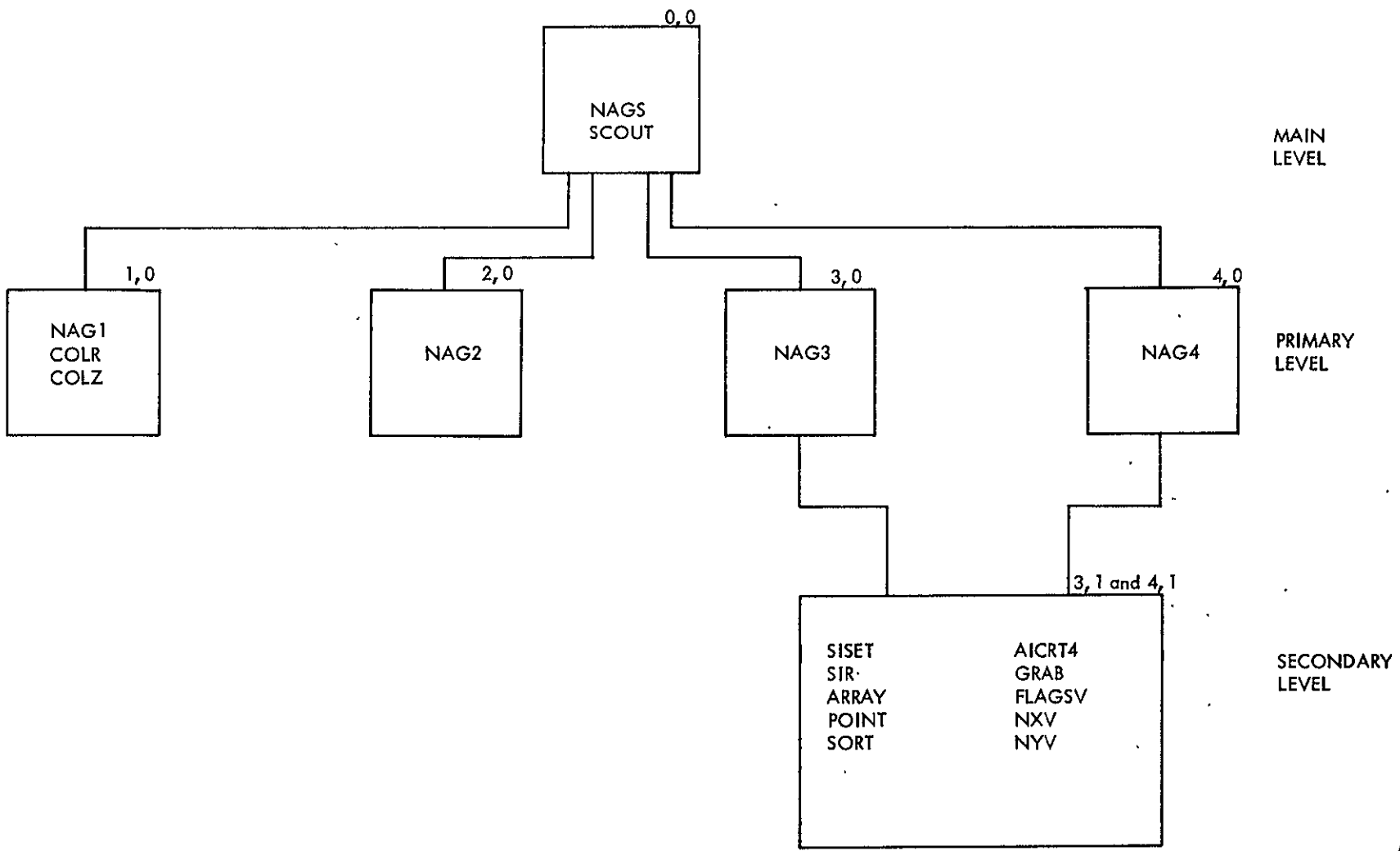


Figure 4-4. OVERLAY Structure of the NAGS Code

## 4.7 METHOD OF SOLUTION

### 4.7.1 Multigroup Flux Operations - Mesh Cell Deletion

The NAGS code is capable of redefining the radial or axial mesh cell description of the input problem geometry and fluxes by mesh deletion. This procedure is included, at user options, to increase the utility of the program by adjusting the mesh size in a NAGS problem to meet computer core memory limitations in subsequent problems. Redefinition of mesh cells is done in a manner to conserve mesh cell fluxes in the redefined mesh cells. This procedure is restricted to the deletion of mesh lines internal to region boundaries of the problem geometry. The user specifies in the general problem input data, the mesh cell dimensions (coordinates) of the original or input flux data solution, as well as the mesh cell coordinate identification numbers which will comprise the new (or redefined) mesh cell description. The average particle flux,  $\phi_{l,i}$ , in each group in each new (redefined) radial mesh cell is computed as:\*

$$\phi_{l,i} = \frac{\sum_{i=i_s}^{i_f} \phi_{ii} \cdot \Delta A_i}{i_f - i_s + 1}$$

where  $\phi_{l,i}$  is the centered average flux in the redefined radial mesh cell,  $l$ , for each axial mesh cell,  $i$ . The quantities  $i_s$  and  $i_f$  are the input flux mesh cell coordinate indices which form the left and right boundaries of the new or redefined radial mesh cell,  $l$ . The quantity,  $\Delta A_i$  is the cross sectional area,  $(R_{i+1}^2 - R_i^2)$ , of the mesh cell,  $i$ . The computed average flux data,  $\phi_{l,i}$ , is placed at the radial midpoint of the new mesh cell,  $R_l = 1/2 (R_{i_s} + R_{i_f})$ .

\* Note: The solution for the azimuthal variable,  $\theta$ , in the R- $\theta$  solution is the same as for the variable Z in the R-Z solution.

In a similar fashion, the average flux,  $\phi_{IJ}$ , in each new axial mesh cell is obtained as:

$$\phi_{IJ} = \frac{\sum_{i=i_s}^{i_f} \phi_{Ii} \cdot \Delta Z_i}{\sum_{i=i_s}^{i_f} \Delta Z_i}$$

where  $\phi_{IJ}$  is the centered average flux in each group in the redefined mesh cell, (I, J) and  $\phi_{Ii}$  is the centered average flux previously computed in the redefined radial mesh cell, I, for each axial mesh cell, i. The quantities,  $i_s$  and  $i_f$ , are the input flux mesh cell coordinate indices which form the bottom and top boundaries of the new (or redefined) axial mesh cell, J. The quantity,  $\Delta Z_i$ , is the height of each axial mesh cell, i. The computed average flux data,  $\phi_{IJ}$ , is placed at the axial midpoint of the redefined mesh cell,  $Z_J = 1/2 (Z_{i_s} + Z_{i_f})$ .

#### 4.7.2 Mesh Cell Calculations

The computation of the neutron and photon interactions in each mesh cell of each region of a NAGS problem geometry is carried out using fluxes obtained in the redefined mesh cell description. The interaction calculations and the resultant product (neutron source, photon source, or particle energy deposition) are summed over all groups, materials, and interactions to provide total interactions, source strength, or energy deposition on an individual mesh cell basis throughout the two dimensional model. Subsequent operations on the mesh cell data provide the region integral distributions, as well as the integrals over all mesh cells and all regions. These final data processing operations are performed without alteration of mesh cell data so that all mesh cell data can be used in subsequent photon transport calculations. The procedure for obtaining particle interaction data in the program is carried out on a regionwise basis.

The mesh cell calculations are based on the redefined mesh cell description and fluxes. These fluxes are processed on a groupwise basis to obtain the total source or energy deposition in each mesh cell of a region. Mesh cell calculations are performed at both internal and external mesh cells of a region and at adjacent external mesh cells. Internal mesh cells are designated in Figure 4-5 by O's; external mesh cells are designated by X's.

Calculations in mesh cells, external to and adjacent to the region being calculated, provide results for use in interpolation or extrapolation of distribution values at the region boundaries. This procedure provides a calculated source or energy deposition distribution value at each boundary of a region. This calculation is described in detail in Section . . . The calculation of photon source and associated quantities at each mesh cell follow as:

- 1) Neutron fission density:

$$F_{IJ} = \sum_{m=1}^{NEL} \sum_{g=1}^{NGN} N_m \sigma_{fm}^g \phi_{IJ}^g$$

- 2) Fission neutron source density:

$$Q_{IJ}^g = \sum_{m=1}^{NEL} \sum_{g=1}^{NGN} N_m \nu^g \sigma_{fm}^g \phi_{IJ}^g$$

- 3) Photon source density in photon group,  $k$ , from neutron fission (prompt and decay):

$$Q_{FIJ}^k = \left( \Gamma_p^k + \Gamma_d^k \right) \cdot F_{IJ}$$

- 4) Neutron radiative capture density for element,  $m$ :

$$C_{mIJ} = \sum_{g=1}^{NGN} N_m \sigma_{cm}^g \phi_{IJ}^g$$

- 5) Photon source density in group,  $k$ , from neutron radiative capture:

$$Q_{CIJ}^k = \sum_{m=1}^{NEL} \Gamma_{cm}^k C_{mIJ}$$

	X	X	X	
X	○	○	○	X
X	○	○	○	X
X	○	○	○	X
	X	X	X	

- INTERNAL MESH CELL
- × EXTERNAL MESH CELL
- REGION BOUNDARIES
- MESH CELL BOUNDARIES

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Figure 4-5. Region Mesh Cell Description



6) Neutron inelastic scattering density for neutron group,  $g$ , and element,  $m$ :

$$S_{IJ}^m = N_m \sigma_{Sm}^g \phi_{IJ}^g$$

7) Photon source density in photon group,  $k$ , from neutron inelastic scatter:

$$Q_{SIJ}^k = \sum_{g=1}^{NI} \sum_{m=1}^{NEL} S_{IJ}^m \Gamma_{sgm}^k$$

8) Total photon source density in photon group,  $k$ , from all sources:

$$Q_{TIJ}^k = Q_{FIJ}^k + Q_{CIJ}^k + Q_{SIJ}^k$$

The mesh cell calculations of energy deposition are performed for neutrons and photons on a groupwise basis. The calculations follow as:

1) Neutron kinetic energy deposition:

$$H_{IJ} = 1.603 \times 10^{-13} \sum_{m=1}^{NEL} \sum_{g=1}^{NFAST} \sigma_{el, eff}^g \left( \frac{N_m N_a \rho_n}{A_m} \right) \phi_{IJ}^g$$

2) Photon energy deposition:

$$H_{IJ} = 1.603 \times 10^{-13} \sum_{m=1}^{NEL} \sum_{k=1}^{NGG} N_m \rho_n \left( \frac{\mu_a}{\rho} \right)_m^k \phi_{IJ}^k$$

The quantity,  $N_a$ , is Avogadro's number  $0.602257 \times 10^{24}$ .

### 4.7.3 Region Operations

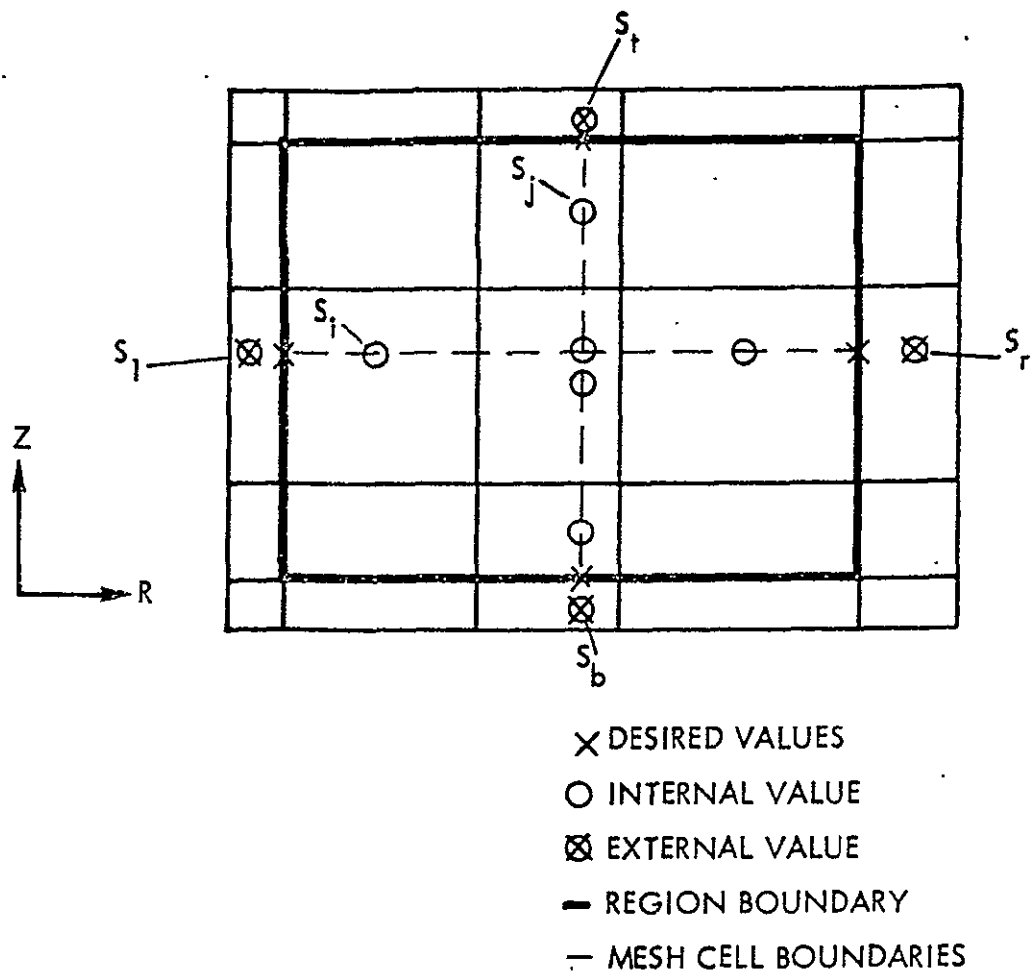
Region dependent quantities are calculated from the internal and external mesh cell data described in the previous section. These data are processed on a single region basis to obtain the total mesh cell photon source for photon transport, or the region source integral and energy, or spatial distribution data required for point kernel and/or Monte Carlo input, or region energy deposition integrals and distributions. The calculation of the photon source data and particle energy deposition data is discussed separately in the following sections. The region boundary mesh cell numbers  $I_S$ ,  $I_F$ ,  $J_S$ , and  $J_F$  define the NAGS region in the total mesh cell description. These values determine the limits of integration to be used in NAGS region calculations.

#### 4.7.3.1 Photon Source

The photon source mesh cell data, described in the previous section, are processed in conjunction with the region and mesh cell dimensions to obtain final region quantities of:

- 1) Total region volume.
- 2) Total region weight.
- 3) Region integrals of:
  - a) photon source
  - b) neutron induced fissions
  - c) neutron source
  - d) photon energy spectrum including volume averaged spectrum
- 4) Region separable radial and axial distributions for photon source, neutron induced fission, and neutron source.

Intermediate and final region data are calculated from the internal and external mesh cells as shown in Figure 4-6. The region boundary values calculated from these data are shown in Figure 4-7.



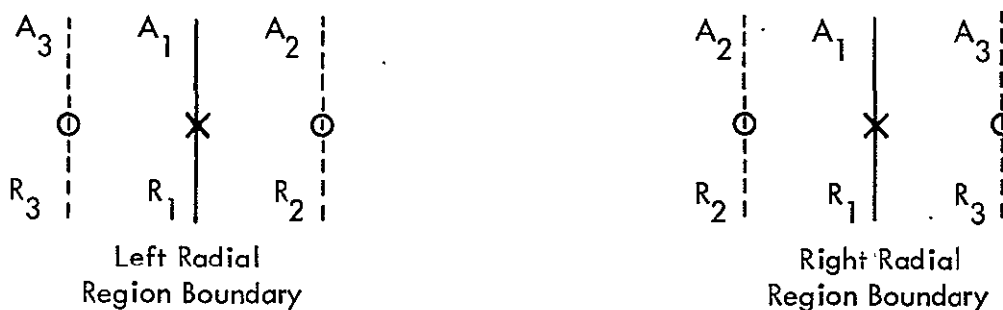
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Figure 4-6. Region Separable Distribution Description

## RADIAL OPERATIONS

Condition 1: Linear Interpolation at Internal Boundaries,  $R_1 \neq 0.0$   
or  $\neq$  Outer Radius of Reactor Geometry

The value at the radial boundaries  $R_1$  is found by linear interpolation of adjacent mesh cell values as shown below

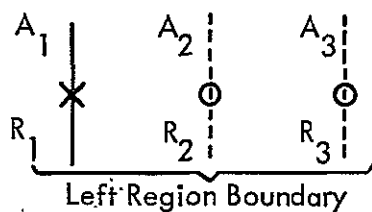


$$A_1 = \frac{A_2 R_2 + \frac{(A_3 R_3 - A_2 R_2)(R_1 - R_2)}{R_3 - R_2}}{R_1}$$

where:  $A_1$ ,  $A_2$ , and  $A_3$  are the values of the flux at the radial positions  $R_1$ ,  $R_2$ , and  $R_3$ , respectively.

Condition 2: Parabolic Extrapolation of Reactor Centerline,  $R_1 = 0.0$

The derivative of the distribution,  $S_1$ , must be zero at  $R_1 = 0.0$  (i.e.,  $\delta S_1 / \delta r = 0.0$ ). The geometry with the two mesh cell values internal to the geometry used for parabolic extrapolations is as follows:



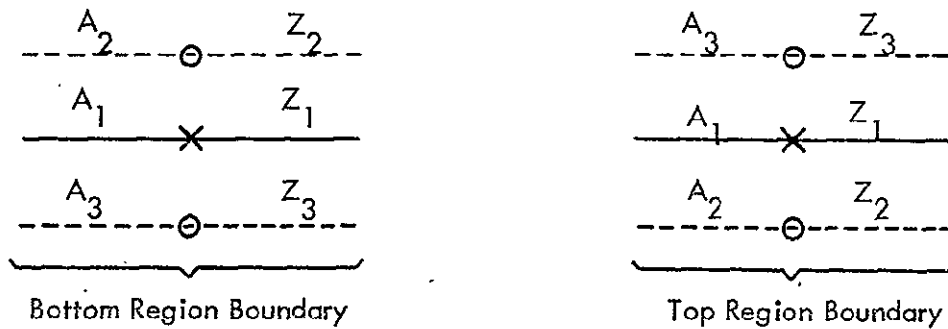
$$A_1 = \frac{A_3 R_2^2 - A_2 R_3^2}{R_2^2 - R_3^2}$$

Figure 4-7. Distribution Interpolation and Extrapolation Techniques

## AXIAL OPERATIONS

### Condition 1: Linear Interpolation Applies at Internal Boundaries, $Z_1 \neq$ Bottom or Top of Reactor Geometry

The value at the boundary  $Z_1$  is found by linear interpolation of adjacent mesh cell values as shown below:

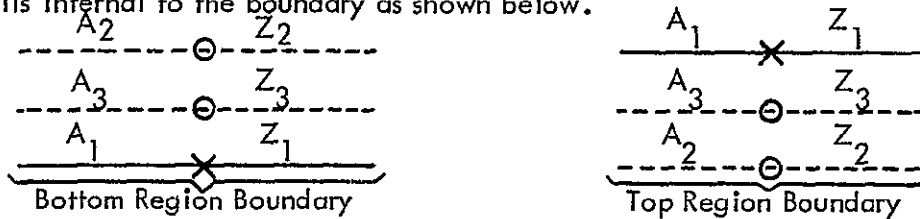


$$A_1 = A_2 + \frac{(A_3 - A_2)(Z_1 - Z_2)}{(Z_3 - Z_2)}$$

where:  $A_1$ ,  $A_2$ , and  $A_3$  are the values of the flux at the axial positions  $Z_1$ ,  $Z_2$ , and  $Z_3$ , respectively.

### Condition 2: Logarithmic Extrapolation at External Boundaries $Z_1 =$ Bottom or Top of Reactor Geometry

The value at the boundary  $Z_1$  is found by extrapolation from the two adjacent mesh cells internal to the boundary as shown below.



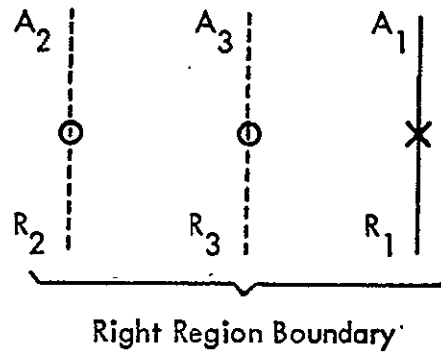
$$A_1 = A_3 \exp \left[ \frac{(Z_1 - Z_3) \ln \left( \frac{A_3}{A_2} \right)}{Z_3 - Z_2} \right]$$

Figure 4-7.(Continued) (2 of 3 sheets)

Condition 3: Logarithmic Extrapolation at the External Boundary,

$R_1$  = Outer Radius of Reactor Geometry

The value at the boundary  $R_1$  is found by logarithmic extrapolation from the two adjacent mesh cells internal to the boundary as shown below.



$$A_1 = A_3 \frac{R_3}{R_1} \exp \left[ \frac{(R_1 - R_3) \ln \left( \frac{A_3 R_3}{A_2 R_2} \right)}{R_3 - R_2} \right]$$

Figure 4-7. (Continued) (3 of 3 Sheets)

The initial operation to obtain region source or fission distributions separable in the radial and axial directions with values at the top, bottom, left, and right boundaries defining the exterior boundary of a region are as follows:

1) External mesh cell values

a) Top External

$$S_t = \sum_{I=I_S}^{I_F} \sum_{k=1}^{NGG} S_{tI}^k \Delta A_I$$

b) Bottom External

$$S_b = \sum_{I=I_S}^{I_F} \sum_{k=1}^{NGG} S_{bI}^k \Delta A_I$$

c) Left External

$$S_l = \sum_{J=J_S}^{J_F} \sum_{k=1}^{NGG} S_{lJ}^k \Delta Z_J$$

d) Right External

$$S_r = \sum_{J=J_S}^{J_F} \sum_{k=1}^{NGG} S_{rJ}^k \Delta Z_J$$

2) Internal mesh values

a) Radial

$$S_l = \sum_{J=J_S}^{J_F} \sum_{k=1}^{NGG} S_{lJ}^k \Delta Z_J$$

b) Axial

$$S_J = \sum_{I=I_S}^{I_F} \sum_{k=1}^{NGG} S_{IJ}^k \Delta A_I$$

3) Region areas and volumes

$$\Delta A = \sum_{I=I_S}^{I_F} \Delta A_I$$

$$\Delta Z = \sum_{J=J_S}^{J_F} \Delta Z_J$$

$$V_R = \Delta A \cdot \Delta Z$$

4) Region integral values

$$S_T = \sum_{I=I_S}^{I_F} \sum_{J=J_S}^{J_F} \sum_{k=1}^{NGG} S_{IJ}^k \Delta A_I \Delta Z_J$$

5) Normalized distribution values

a) Internal

$$S_{I, \text{ (normalized radial)}} = S_I \Delta A / S_T$$

$$S_{J, \text{ (normalized axial)}} = S_J \Delta Z / S_T$$

b) External

$$S_{t, b} = S_{t, b} \Delta A / S_T$$

$$S_{l, r} = S_{l, r} \Delta Z / S_T$$



The normalization operation is performed as above for photon source, neutron induced fission, and neutron source. The values  $S_{1r}$ ,  $S_{Jr}$ ,  $S_{Tr}$ ,  $S_{br}$ ,  $S_{lr}$  and  $S_{Tr}$  are used to calculate boundary values shown in Figure 4-6 using the techniques described in Section 4.7.2.

The remaining region quantities are obtained as follows:

- 1) Region Weight

$$W_R = V \cdot \sum_{m=1}^{NEL} \frac{N_m A_m}{N_a}$$

- 2) Region photon source

- a) Total Integrated Spectrum

$$Q_T^k = \sum_{J=J_S}^{J_F} \sum_{I=I_S}^{I_F} \sum_{k=1}^{NGG} Q_{TIJ}^k \Delta A_I \Delta Z_J$$

- b) Average Spectrum

$$Q_T^k = Q_T^k / V_R$$

- c) Total

$$Q_T^k = \sum_{k=1}^{NGG} Q_T^k$$

- 3) Region neutron induced fission

$$F = \sum_{J=J_S}^{J_F} \sum_{I=I_S}^{I_F} F_{IJ} \Delta A_I \Delta Z_J$$

- 4) Region neutron source

$$Q_T = \sum_{J=J_S}^{J_F} \sum_{I=I_S}^{I_F} \sum_{g=1}^{NGN} Q_{IJ}^g \Delta A_I \Delta Z_J$$

#### 4.7.3.2 Energy Deposition

The energy deposition mesh cell data described in Section 4.7.2 is used in a fashion similar to that described for processing of photon source data. The final region quantities calculated are:

- 1) Element or constituent quantities
  - a) Density in region in gms/cc
  - b) Total energy deposition in kilowatts
- 2) Region quantities for each material in the region
  - a) Density in lbs/in.<sup>3</sup>
  - b) Weight in lbs
  - c) Total energy deposition in kilowatts
  - d) Photon energy deposition in kilowatts
  - e) Neutron energy deposition in kilowatts
  - f) Total energy deposition in Btu/hour, watts/gram, watts/cm<sup>3</sup> in the solid material, Btu/lb-hour, and Btu/in.<sup>3</sup>-hour in the solid material
- 3) Region separable radial and axial energy deposition distributions (relative to a region volume average of 1.0 and region average energy deposition in Btu/in.<sup>3</sup>-hour).
- 4) Region mesh cell total energy deposition in Btu/in.<sup>3</sup>-hour.

These distribution quantities are calculated using the same techniques described for the photon source calculation. Region integrals are obtained as the summation of neutron and photon energy deposition or as separate quantities. The integrals are multiplied by appropriate conversion factors to obtain either metric or English units.

#### 4.7.3.3 Interpolation and Extrapolation Procedure

The procedures for calculating the end (or boundary) points of a radial or axial source or response distribution in a NAGS region are described in this section. The techniques are discussed in general terminology because the calculation of boundary values for neutron or photon source, fission, or energy deposition distributions are the same.

As defined earlier, a NAGS region is a set of adjacent mesh cells having the same material composition and a rectangular outer boundary. The separable radial and axial distributions are calculated at the midpoints of the redefined mesh cells of a region. These data are used for all interpolation or extrapolation operations. The additional data used in these operations are the external boundary sources (or response values) calculated with material properties of the region, but with particle fluxes at the mesh cells external and immediately adjacent to the region, as shown in Figure 4-7. Dependent upon the position of the region in the reactor geometry, the calculation of the boundary value assumes one of five types of interpolation or extrapolation techniques, as shown in Figure 4-7. The mesh cell data (internal and external to the NAGS region) are denoted by the dashed lines and the open O's. The boundary values to be calculated are denoted by the solid lines and by X's. The special case where the mesh cell lies at the reactor centerline, outer radius, top boundary, or bottom boundary of the reactor geometry requires special techniques to obtain the boundary value. In addition, the calculation of the boundary values of a region of only one mesh cell in width (or height) is based on the value at that mesh cell and at the two adjacent external mesh cell values. All values of external mesh cell data are calculated with the nuclear properties of the NAGS region and are relative to the internal mesh cell values.

#### 4.7.4 Overall Problem Operations

At the completion of the region data processing, the NAGS program performs calculations and operations for all mesh cells in the reactor geometry. These final operations are dependent upon whether the neutron or photon source or energy deposition calculation option is used.

##### 4.7.4.1 Neutron or Photon Source

The overall reactor geometry neutron and photon source calculations yield the integral photon source, neutron source, and fissions in the reactor. These integrations follow:

- 1) Total photon source

$$Q_{\text{Total}} = \sum_{J=1}^{\text{JCM}} \sum_{I=1}^{\text{ICM}} \sum_{k=1}^{\text{NGG}} Q_{\text{Tij}}^k \Delta A_I \Delta Z_J$$

- 2) Total fissions

$$F_{\text{Total}} = \sum_{J=1}^{\text{JCM}} \sum_{I=1}^{\text{ICM}} F_{\text{IJ}} \Delta A_I \Delta Z_J$$

- 3) Total neutron source

$$Q_{\text{Total}} = \sum_{J=1}^{\text{JCM}} \sum_{I=1}^{\text{ICM}} \sum_{g=1}^{\text{NGN}} Q_{\text{IJ}}^g \Delta A_I \Delta Z_J$$

In addition, the NAGS program will prepare a group dependent neutron or photon source binary tape. This tape will contain either neutron, total photon, or fission product decay photon source for all mesh cells in the reactor geometry. These data (with minor intermediate processing to generate a tape with one logical record instead of NGN or NGG logical records) are compatible with distributed fixed source input requirements of the ODD-K discrete ordinate transport program. The options available to the NAGS user are controlled by input integer NPUN (Card Type 3). The program prepares a binary tape containing one of the following sets of mesh cell data.

- 1) Total photon source for each group,  $k$ ,

$$Q_{Tij}^k$$

- 2) Fission product decay photon source for each group,  $k$ ,

$$Q_{DIJ}^k = \Gamma_d^k F_{IJ}$$

- 3) Total neutron source for each group,  $g$ ,

$$Q_{IJ}^g = \chi^g Q_{IJ}$$

Special features are included in the NAGS program for the generation of a binary tape of source data. The user can increase the size of the mesh cell source data of a reactor geometry by placing zeros on the tape to the left, right, or top of the reactor geometry. This option, which positions the NAGS calculated source data in a larger mesh cell description, is included to permit, for example, a detailed neutron source calculation in the reactor core for use in a subsequent coarse reactor geometry. The detailed source calculation in the coarse geometry may not be possible in NAGS because of limited memory core storage; hence, this option can be used to reduce the flux data and then expand the source data. Further, this option, in conjunction with the mesh cell and flux redefining options, provides the user with considerable flexibility in running a linked neutron and photon transport problem using the DOT-IIW discrete ordinate transport program.

#### 4.7.4.2 Neutron or Gamma Ray Dose Rates

At the completion of a NAGS mesh cell energy deposition calculation, the flux data at each mesh cell in the reactor geometry are used to calculate the neutron and photon dose rate at each of the mesh cells. This calculation of the neutron and photon dose rate follows:

1) Neutron dose rate

$$D_{NIJ} = \sum_{g=1}^{NGN} K_D^g \phi_{IJ}^g$$

2) Photon dose rate

$$D_{PIJ} = \sum_{k=1}^{NGG} K_D^k \phi_{IJ}^k$$

Since this operation is essentially a response function calculation, and is not stored in memory, the NAGS user can substitute other conversion factors in place of  $K_D^g$  or  $K_D^k$ , in the library to obtain mesh cell data as desired.

## 5.0 SATURN CODE

In certain calculations using the ANISN-W and DOT-IIW discrete ordinates transport codes with a large number of input cross section data, execution of the calculation is sometimes terminated because of insufficient core storage to process the cross section data. To alleviate this situation, the SATURN code was developed. SATURN processes  $P_{\ell}$  or transport corrected cross section data using a minimum amount of core storage to produce multigroup cross section data tapes in two formats for use in the ANISN-W or DOT-IIW codes. The two formats are the normal, group-dependent data tape or the specially prepared, group-independent data tape.

The data processing functions and options performed by the SATURN code are as follows:

- 1) Preparation of group-dependent and/or group-independent cross section data on magnetic tape or disk file and/or punched cards,
- 2) Inclusion of transverse leakage corrections to the macroscopic, cross section data,
- 3) Preparation of macroscopic cross sections using mixing table operations,
- 4) Adjoint reversal of the cross section data, and
- 5) Output tape labeling and relabeling.

These operations are performed in the SATURN code as a sequence of logical steps to minimize the core storage required to prepare cross section data.

The SATURN code is an auxiliary code and should only be used for those situations where the DOT-IIW or ANISN-W codes cannot process the cross section data or for problems that require special, transverse leakage corrections, or group-independent tapes.

## 5.1 COMPUTER CODE SYNOPSIS

1. Name: SATURN<sup>(1)</sup>

2. Computer: The code is designed for the UNIVAC-1108 computer.

3. Nature of Physical Problem Solved: SATURN processes  $P_g$  or transport corrected cross section data with a minimum computer core storage requirement to produce multigroup cross section data tapes in two formats for use in ANISN-W<sup>(2)</sup> or DOT-IIW.<sup>(3)</sup> The two formats are the normal, group dependent data tapes or the specially prepared, group independent data tape.

Options provided in the code include mixing table operations, selective transverse leakage corrections for  $P_g$  or transport corrected cross section data, and output tape labeling or relabeling capabilities. Cross section data are input to SATURN from up to two magnetic tapes and/or cards at user option.

4. Method of Solution:  $P_g$  or transport corrected cross section data are processed as group dependent data on a per set basis to produce a group independent data tape for subsequent processing. A diagonal transport correction for  $P_1$  cross section data is calculated for use in the calculation of the diffusion coefficient required for the transverse leakage correction. Mixtures of cross section data are formed by specification of the mixture set number, component set number, and component density (or abundance). The final output of the code are two tapes containing the macroscopic cross section data for mixtures in a group-independent and group-dependent cross section data tape format. The group-dependent data for mixtures are obtained as output only if sufficient core memory storage is available to contain all of these data.

5. Restrictions on the Complexity of the Problem: The SATURN computer code utilizes flexible dimensioning and magnetic tape or disk files to process the cross section data in a minimum core storage requirement mode. Because of the use



of the flexible dimensioning technique, no size restriction is imposed on any given array but the sum of the length of all data arrays is restricted by the available computer core memory. This limitation will restrict the use of SATURN on only a small fraction of problems. The user should only use SATURN for ANISN-W or DOT-IIW problems requiring either transverse leakage corrections, or group independent tapes.

6. Typical running time: SATURN will process approximately 10 cross section sets per minute of UNIVAC-1108 CPU time with each set containing 2000 entries. The large amount of input/output will require approximately a factor of 4-5 greater elapsed time for the majority of problems.

7. Unusual Features of the Code: Use of flexible dimensioning and the processing of data as group independent data provides for the use of small computer core memory for the majority of problems. Calculation of transverse leakage corrections for  $P_{\ell}$  and transport corrected cross sections is automatically handled by the code.

8. Related or Auxiliary Codes: Cross section data tapes may be supplied by the GAMBIT,<sup>(4)</sup> GAMLEG-W,<sup>(1)</sup> ANISN-W,<sup>(2)</sup> or APPROPOS<sup>(1)</sup> codes as well as other cross section generation codes which are compatible in format with ANISN-W. Output data tapes generated are admissible to ANISN-W or DOT-IIW.

9. Status: The code is in production use at the Marshall Space Flight Center (MSFC). Users at MSFC load the code from a tape with control cards followed by user's input data.

#### 10. References:

1. R. G. Soltesz, R. K. Disney, and S. L. Zeigler, WANL-PR(LL)-034 Volume 3, "Cross Section Generation and Data Processing Techniques," August 1970.
2. R. G. Soltesz and R. K. Disney, WANL-PR(LL)-034, Volume 4, "One-Dimensional, Discrete Ordinate Transport Technique", August 1970.

3. R. K. Disney, R. G. Soltesz, J. Jedruch, and S. L. Zeigler, WANL-PR(LL)-034, Volume 5, "Two-Dimensional, Discrete Ordinate Transport Techniques," August 1970.
4. G. Collier and G. Gibson, WANL-TME-1752, "GAMBIT Program," April 1968.

11. Machine Requirements: The SATURN code is in production at MSFC on the UNIVAC-1108 computer with 65K core storage locations. The program requires approximately 15K decimal locations for the program; the remaining 50K decimal locations are available for problem data storage.

12. Programming Language Used: The SATURN code is written in standard, USASI FORTRAN-IV.

13. Operating System or Monitor Under Which Program is Executed: The SATURN code is operational under the UNIVAC-1108, EXEC 8 Monitor System at MSFC.

14. Other Programming or Operating Information or Restrictions:  
None.

15. Name and Establishment of Authors:

R. G. Soltesz and R. K. Disney  
Westinghouse Astronuclear Laboratory  
P. O. Box 10864  
Pittsburgh, Pa. 15236

## 5.2 INPUT DATA DESCRIPTION

### 5.2.1 Input Format

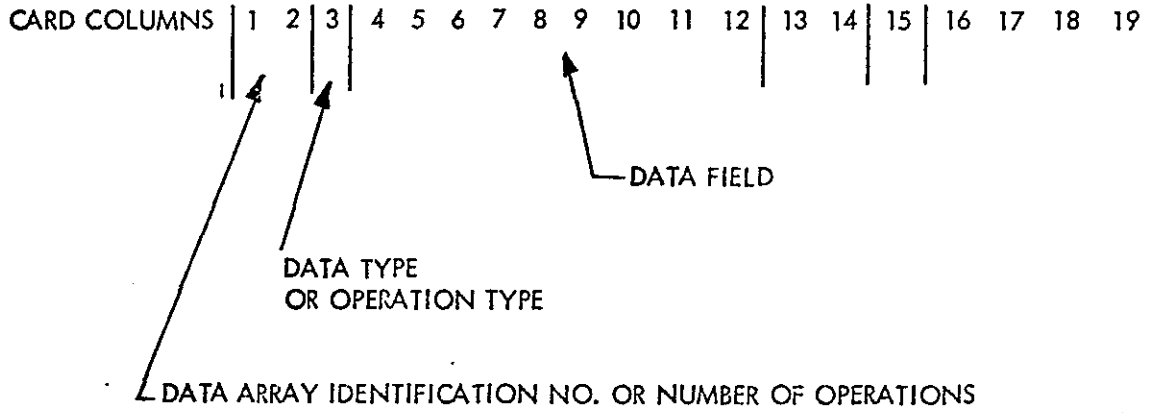
Input data for the SATURN code are subdivided into four data sets:

- 1) Overall problem storage allocation, problem descriptive title, and problem size specifications and options,
- 2) Problem data,
- 3) Output tape cross section set label data, and
- 4) Cross section data.

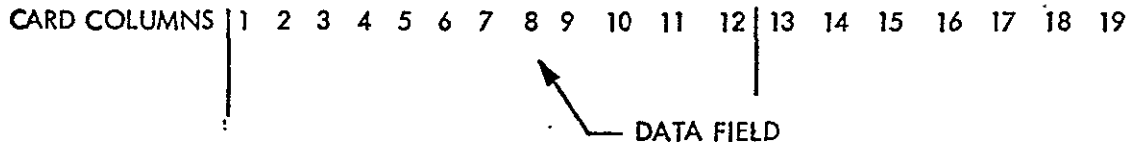
The first data set is entered as five cards of input under a fixed FORTRAN format for each card; the third data set is entered as three cards of input under a fixed, FORTRAN format for each card. The second and fourth data set are entered under FIDO input subroutine control and can be written in one of three FORTRAN type format capabilities with data operations. The integer data arrays (denoted by a dollar sign) must always be input in the standard FIDO format capability which consists of 6 fields of 12 columns in each field. Each field in the standard format is subdivided into three subfields as shown in Figure 5-1. Integer data must be entered as right adjusted in the third subfield of each data field. Real data (denoted by a \*, U or V) may be entered in the standard FIDO format or one of the non-standard

The non-standard SATURN input formats which are shown in Figure 5-1 are included for the user's convenience and can only be used for any real (floating point) data array. These non-standard formats cannot include any operation type (fill, skip, interpolate, repeat, etc.) but can include blank fields on a card that cause the input routine to ignore the rest of the card; i. e., if the punched cross section data for a material includes 117 entries (9 groups by 13 table positions), the set would be 19 full cards and a final card of three entries, using the U format. SATURN would skip the last three fields

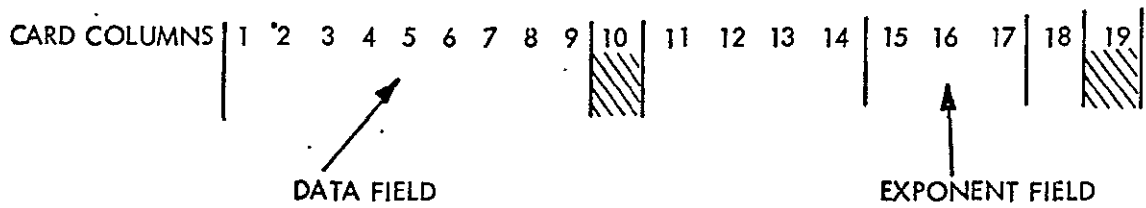
1. STANDARD: (6 (I2, A1, F9.0))



2. NON-STANDARD: (6E12.5), U DATA TYPE



3. NON-STANDARD: (4 (IX, E16 9, IX), V DATA TYPE



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Figure 5-1. SATURN Input Formats Using the FIDO Subroutine

and commence reading at the first data field of the next card. In the standard SATURN format, the second subfield may include one of the data type or operation type code letters. The following characters may be entered: \$, \*, U, V, R, I, T, S, F, A, ±, Z, E, Q, N, M, W, and X.

\$ indicates the beginning of an integer (fixed point) array. The first subfield identifies the data array.

\* indicates the beginning of a real (floating point) array in standard format. The first subfield identifies the array .

U indicates the beginning of a real (floating point) array in the non-standard format 6E12.5 and the data array beginning on the next physical card. The first subfield identifies the array.

V indicates the beginning of a real (floating point) array in the non-standard (ODD-K) format 4 (1X, E16.9, 1X). The first subfield identifies the data array beginning on the next physical card.

R indicates that the data contained in the third subfield are to be entered R times in succession. The first subfield defines the number of total successive entries or Repeats (e. g., a 16R 1.0 enters 16 1.0's).

I indicates linear Interpolation between the data in the associated third subfield and the following third subfield. The first subfield defines the number of interpolations between the two data entries (e. g., 4I 0.0, 10.0 enters 0.0, 2.0, 4.0, 6.0, 8.0, 10.0).

T indicates Termination of data reading for a particular subset of data. No further data reading for a subset of data is attempted and the program proceeds to the next subset and the next physical data card.

S indicates Skip. The first subfield defines the number of entries to be skipped. The third subfield may contain the first entry following the skips (e. g., 15S 1 enters a 1 in the 16th word of any array).

---

\* "Right Adjusted" means the last significant digit of a number is at the extreme right of a field.

F indicates that the remainder of the present array is to be Filled with the data entry in the third subfield. Any entry in the first subfield is ignored (e. g., F 1.0 will enter all values of 1.0 in the 6\* array).

A indicates Address modification. The next non-blank data entry is entered in the Nth location of the present array where N is an integer entry in the third subfield associated with the A. Any entry in the first subfield is ignored.

+ or - indicates exponentiation. The data entry in the third subfield is multiplied by  $10^{\pm N}$  where N is the entry in the first subfield. This option allows more significant digits if necessary.

Z indicates the entry of Zeros. The integer entry in the first plus the third subfield indicates the number of successive zeros to be entered, (e. g., 10Z enters 10 zeros, Z 20 enters 20 zeros, and 10Z 20 enters 30 zeros).

E indicates End array. This option skips to the end of an array without the need for specifying the number of skips.

Q indicates sequence repeat. The integer entry in the first plus the third subfield indicates the number of previous entries to be repeated.

N indicates inverted sequence repeat. This option is similar to the Q option except that the previous entries are repeated in reverse order, (e. g., 0, 2, 4, 2N enters 0, 2, 4, 4, 2).

M indicates inverted sequence repeat except that the signs of previous entries are reversed when they are repeated.

W indicates the array identified by the first subfield will be read according to the format on the following card.

X indicates the array identified by the first subfield will be read according to the last variable format read in. For example,

3W	Card 1 (remainder of card must be blank)
(7E10.3)	Card 2 (contains format only)
3X	Card 3 ( remainder of card must be blank)
	Cards 4 through N (contain the data according to the specified format. No blank fields are allowed.

Integer data in the third subfield must be right adjusted. Floating point data may be written with or without an exponent and with or without a decimal point. If the decimal point is not included, it is assumed to be immediately to the left of the exponent field. If there is no exponent, the decimal point is assumed to be at the extreme right of the nine-column subfield.

The following restrictions must be observed when writing input data for the SATURN program:

1) Floating point zeros must be written as 0. or 0.0, A .0 or -0.0 in either the standard or non-standard format is not acceptable.

2) Blanks are ignored and the reading of data commences on the next physical card for the non-standard format and on the next field after the blank field for the standard formats.

3) If an I is specified in any data field, the third subfield of that field and the following third subfield of the next field cannot be blank. In addition, the second subfield of the field following a field containing an I cannot contain an A.

4) If the third subfield of a data field containing a \$ or a \* contains an integer, N, the next data entry is assumed to be the  $(N + 1)$  th member of the array. Normally, this third subfield is blank and is interpreted as zero.

### 5.2.2 Input Data Instructions

This section is to be used as a guide in preparing problem input data for the SATURN code. Other sections present a more detailed description of the data presented here. The quantity in slashes represents the condition requiring that array or set of arrays. Arrays or sets of arrays with the corresponding terminate (T) card which are not required should not be entered. If no condition is specified, the array is required. Note that a T card must follow the data entered in data set 2.



TABLE 5-1 INPUT INSTRUCTIONS FOR THE SATURN CODE

 DATA SET 1 - OVERALL PROBLEM STORAGE ALLOCATION, PROBLEM TITLE,  
 PROBLEM SIZE SPECIFICATIONS, AND OPTIONS

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
1	(6X,16)	7 - 12	MAXCOR*	Maximum number of core locations available for SATURN data (i. e., MAXCOR = 35000 <sub>10</sub> on the UNIVAC-1108, EXEC8 computer with a 65K core memory storage available)
2	(18A4)	1 - 72	TITLE	Problem Title
3	(6I12)	---	---	<u>Problem Size Specifications and Options:</u>
		1 - 12	MTP	Number of input cross section sets from cards and tapes
		13 - 24	MTX	Number of mixtures to be formed
		25 - 36	IBUK	Number of mixtures to be excluded from transverse leakage calculation. If IBTY equal 0, then IBUK = 0, and the 2* and 3\$ array are not required; if IBUK equal to 0, then, the 1\$ data array is not required.
		37 - 48	IMIX	Mixing table length
4	(6I12)	---	---	<u>Cross Section Set Specifications:</u>
		1 - 12	IGM	Number of energy groups
		13 - 24	IHP	Table length without the total upscatter cross section position
		25 - 36	IHT	Position of total cross section, $\sigma_t$ , in cross section table
		37 - 48	IHS	Position of within-group (self-scatter) cross section, $\sigma_{gg}$ , in cross section table
		49 - 60	ISOL	Cross Section Output Format: (0/1; Forward/Adjoint)

\* The maximum value of MAXCOR is determined by the maximum size of blank common set at code compile time.

TABLE 5-1 INPUT INSTRUCTIONS FOR THE SATURN CODE  
(Continued)

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
5	(6I12)	---	---	<u>Calculation Options:</u>
		1 - 12	ICODE	Output data option: (0/1; ANISN-W/ DOT-IIW) Note: ANISN-W data option provides the total upscatter cross section in table position IHP + 1. DOT-IIW data option provides the total upscatter cross section in table position, IHT + 1.
		13 - 24	IBTY	Transverse Leakage (DB <sup>2</sup> ) Calculation Option: (0/1/2/3/4; None/Group and Material Independent/Group Dependent- Material Independent/Group Independent- Material Dependent/Group and Material Dependent)
		25 - 36	ITAPE	Card and Tape Input Cross Section Data Options:
			ITAPE =	1: Card input only.
			ITAPE =	2: Tape 16 and/or card input.
			ITAPE =	3: Tape 16, tape 18, and/or card input.
				If ITAPE > 0, cards are read with the FIDO Format.
				If ITAPE < 0, cards are read with a FORTRAN (6E12.5) Format.

TABLE 5-1 INPUT INSTRUCTIONS FOR THE SATURN CODE  
(Continued)

<u>Card Number</u>	<u>Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
		37 - 48	ITYPE	0/1; Group-independent tape only/group-independent tape and group dependent tape Note: Group-independent tape is generated on Tape 14, Group-dependent tape is generated on Tape 12 only if the memory core allocation, MAXCOR, is large enough to accept all MTP cross section sets (MTX = 0) or MTX cross section sets.
		49 - 60	ICARDS	Punched Card Output: (0/1; No/yes) Note: Punched card output is provided only if ITYPE = 1 and a group-dependent tape is successfully generated (Tape 12).
		61 - 72	ILABL	Tape Labeling or Relabeling Option: (0/1; No/Yes)

TABLE 5-1 (Continued)

DATA SET 2 - PROBLEM INPUT DATA (FIDO FORMAT)

Set Number	FIDO Format	Variable	Description
1	\$	IB	<p>/If IBUK <math>\neq</math> 0/            Cross section set numbers excluded from <math>DB^2</math> calculation. IBs must be entered in the same number sequence as the entries in the MT data array (9\$)            (IBUK Values)</p>
2	* or U	BK	<p>/If IBTY <math>\neq</math> 0/ <u>Transverse leakage data:</u>            /If IBTY = 1/  <math display="block">\left. \begin{array}{l} BK(1) = DY \\ BK(2) = DZ \\ BK(3) = BF \end{array} \right\} , \text{ Group and material independent}</math> <math display="block">B^2 = \left[ \frac{\pi}{DY + (BF/\Sigma_{tr})} \right]^2 + \left[ \frac{\pi}{DZ + (BF/\Sigma_{tr})} \right]^2</math>           (3 Values)              /If IBTY = 2/            BK(1) - BK(IGM), Group-dependent <math>B^2</math>            (IGM Values)              /If IBTY = 3/            BK(1) - BK(MTX), Material-dependent <math>B^2</math>            (MTX Values)              /If IBTY = 4/            BK(1) - BK(IGM*MTX), Group and material-dependent <math>B^2</math>            (MTX*IGM Values)</p>
3	\$	LPL	<p>/If IBTY <math>\neq</math> 0/  <math>P_l</math> scattering order of each macroscopic (input or mixture) cross section set (e. g., for a P3 set, enter a 3)            (MTP or MTX Values)</p>
4	\$	MB	<p>/If IMIX <math>\neq</math> 0/            Mixture material numbers in mixing table            (IMIX Values)</p>

TABLE 5-1 (Continued)

## DATA SET 2 - PROBLEM INPUT DATA (FIDO FORMAT)

<u>Set Number</u>	<u>FIDO Format</u>	<u>Variable</u>	<u>Description</u>
5	\$	MC	/If IMIX $\neq$ 0/ Component material numbers in mixing table (IMIX Values)
6	* or U	XD	/If IMIX $\neq$ 0/ Atom densities, partial densities, or fractions of component materials in mixing table. (IMIX Values)
9	\$	MT	Cross Section Set and Input Source Specifications: -M:Tape18, M = ID Number, 0: Cards, or +M:Tape16, M = ID Number (MTP Values)

Terminate Card (T in Column 3)

TABLE 5-1 (Continued)

## DATA SET 3 - LABEL DATA FOR OUTPUT TAPE AND CROSS SECTION SETS

<u>Card Number</u>	<u>FORTRAN Format</u>	<u>Column</u>	<u>Variable</u>	<u>Description</u>
1	(I6,A6)	---	---	/If ILABL = 1/ <u>Group dependent output tape label:</u>
		1 - 6	IA	Number of cross section sets to be placed on the output tape (Tape 12). IA = MTP
		7 - 12	B	A six character title for the output tape
2	(18X,I6,8A6)	---	---	/If ILABL = 1/ <u>Cross Section set label information:</u>
		19 - 24	JDT	Cross section set identification number to be placed on output tape
		25 - 72	IDT	Cross section set identification title. A 48 character descriptive title.

NOTE: If ILABL = 1, then card 2 is repeated for MTP cards.

3	(18X,I6,8A6)	---	---	/If IMIX > 0/ <u>Cross section set label information for mixtures formed in mixing table.</u>
		19 - 24	JDT	Cross section set identification number to be placed on group-dependent output tape (Tape 12).
		25 - 72	IDT	Cross section set identification title. A 48 character descriptive title.

NOTE: 1) If IMIX > 0, then card 3 is repeated for MTX cards  
2) If ILABL = 1, then IMIX and MTX must be equal to zero.

TABLE 5-1 (Continued)

## DATA SET 4 - CROSS SECTION DATA FOR COMPONENT MATERIAL ON CARDS

<u>Set Number</u>	<u>Format</u>	<u>Variable</u>	<u>Description</u>
/If ITAPE < 0/			
10	* or U	CRI	Cross Section data for each set in FIDO format. (IHP*IGM Values). Each set is preceded by a 10* or U and followed by a T card.
Terminate Card (T in Column 3)			
/If ITAPE > 0/			
---	(6E12.5)	CRI	Cross section data for each set in a fixed, FORTRAN format (IHP*IGM Values) Note: Cross Section data must be continuous on cards; no terminate card is required.

NOTE: Data Set 4 is repeated in the sequence of zeros (0s) for all values of MT = 0 in the 9\$ array in Data Set 2.

This concludes the required input for the SATURN code. Stacked problems would begin with card number 2 in Data Set 1; however, Tapes 12 and 14 are rewritten for stacked problems.

### 5.3 DETAILED INPUT DATA INFORMATION

This section presents a more detailed definition of selected parameters and arrays defined in Section 5.2.2. Examples are provided to illustrate the various ways of entering the data or the specific manner in which the data must be input.

#### 5.3.1 Mixing Table Calculations

The SATURN mixing table calculations are performed in a similar fashion to the ANISN-W and DOT-IIW codes. The mixing table is input as three sets of input data (i.e., mixture material, component material, and density) in the following form:

TABLE 5 - 2  
EXAMPLE OF MIXING TABLE OPERATIONS

<u>Number</u>	<u>Mixture Material Number, MB 4\$</u>	<u>Component Material Number, MC 5\$</u>	<u>Density, XD 6*</u>
1	6	0	0.0
2	6	1	0.10
3	6	3	0.0002
4	7	0	0.0
5	7	2	0.06
6	7	4	0.04
7	8	0	1.0

The combination of three values of input data in the 4\$, 5\$, and 6\* arrays specify the type of mixture calculation to be performed.

Mixing table operations assume that the cross section data, whether components or mixture materials, are referred to by a continuous sequence of material numbers. Operation on a set number, N, is specified in the 4\$ or 5\$ input data arrays.



The following explanation of mixing table operations uses a lower case  $\sigma$ , to illustrate microscopic or macroscopic cross sections; the group and cross section type indices are not included for simplicity.

The type of mixing table operations available are:

1. If the mixture material number, MB, is the number N, and the component material number is zero, 0, then all values of the cross section set, N are multiplied by the density, XD. This operation can be used to set all values of a set to zero (i.e., XD = 0.0) or to multiply all values by a constant (i.e., XD = C).

The operation performed is as follows:

$$\sigma_N(\text{New}) = \sigma_N(\text{Old}) * XD$$

2. If the mixture material number is the number, N, and the component material number is the number, M, then all values of the cross sections in set M are multiplied by the density, XD, and added to the corresponding values of the cross sections in set N. The operation performed is as follows:

$$\sigma_N(\text{New}) = \sigma_N(\text{Old}) + (\sigma_M * XD)$$

In the above mixing table operations, the mixture or component material may be made up of microscopic or macroscopic cross sections for a single element or isotope or mixture of elements or isotopes. By proper choice of the density (e.g., atom density, weight fraction, or volume fraction) the required macroscopic cross section data can be formed.

If the user specifies a set number, N, which is greater than the sum of the input values of the number of sets from cards and tape, MTP, and number of mixtures, MTX, the following error message is printed:

INPUT ERROR - INSUFFICIENT STORAGE FOR MIXTURES

Examples of the use of the mixing table are shown in Table 5-2. The seven operations performed in the table are:

1. Initialize the mixture material set 6 cross sections to zero by;

$$\sigma_6 = \sigma_6 * 0.0$$

2. Add cross sections of component material set 1 weighted by the density to mixture material set 6 by;

$$\sigma_6 = \sigma_6 + (\sigma_1 * 0.1)$$

3. Add cross sections of material set 3 weighted by the density to mixture material set 6 by;

$$\sigma_6 = \sigma_6 + (\sigma_3 * 0.002)$$

4. Same as Step 1 except for mixture material set 7.
5. Same as Step 2 except for mixture material set 7 and component material set 2.
6. Same as Step 3 except for mixture material set 7 and component material set 4.
7. Multiply the mixture (or component) material set 8 by 1.0 and store the result in mixture material set 8 by:

$$\sigma_8(\text{New}) = \sigma_8(\text{Old}) * 1.0$$

When the order of scatter for any material zone is greater than zero, both the ANISN-W and DOT-IIW codes expect the  $P_1$  cross sections to be material  $M + 1$ , the  $P_2$  cross sections to be  $M + 2$ , etc., where  $M$  is the  $P_0$  material number specified in the 9\$ array in these codes. Therefore, in generating the group-independent tape, the sequence of cross section data set mixture numbers must adhere to these requirements.

### 5.3.2 TRANSVERSE LEAKAGE CALCULATIONS

The option to calculate a transverse leakage correction as a fictitious absorption is included in SATURN for two purposes. The first purpose is to provide a capability to include a transverse leakage correction to macroscopic cross sections for use in  $x$ ,  $y$ , or  $r$ ,  $\theta$  DOT-IIW calculations. The second purpose is to provide the flexibility to include a transverse leakage correction which is group and/or material dependent to supplement the group and material independent transverse leakage correction in ANISN-W.

The generation of cross sections with transverse leakage corrections with the SATURN code assumes that the user will not perform mixing table, search, or density factor calculations in ANISN-W or DOT-IIW because these calculations do not allow the adjustment of the transverse leakage correction with these operations.

The inclusion of a transverse leakage correction using the SATURN code is based on a particular type of transport correction applied to  $P_g$  cross section data as well as the order or sequence of the  $P_g$  cross section sets. The transverse leakage correction applied to each macroscopic cross section set is the inclusion of a fictitious absorption cross section in the total and absorption cross section of; 1) the  $P_0$  cross section data of a  $P_1$  cross section set or 2) the transport and absorption cross section of a transport-corrected,  $P_0$  set. This transverse leakage correction term,  $D_{mg} B_{mg}^2$  (i.e., fictitious absorption cross section), is chosen from one of the following four forms:

1. Group and Material Independent:

$$D_{mg} B_{mg}^2 = \left( \frac{1}{3 \sigma_{tr, mg}} \right) * \left\{ \left[ \frac{\pi}{DY + \frac{BF}{\sigma_{tr, mg}}} \right]^2 + \left[ \frac{\pi}{DZ + \frac{BF}{\sigma_{tr, mg}}} \right]^2 \right\}$$

2. Group Dependent - Material Independent:

$$D_{mg} B_{mg}^2 = \left( \frac{1}{3 \sigma_{tr, mg}} \right) * B_g^2$$

3. Group Independent- Material Dependent:

$$D_{mg} B_{mg}^2 = \left( \frac{1}{3 \sigma_{tr_{mg}}} \right) * B_m^2$$

4. Group and Material Dependent

$$D_{mg} B_{mg}^2 = \left( \frac{1}{3 \sigma_{tr_{mg}}} \right) * B_{mg}^2$$

where:  $D_{mg} B_{mg}^2$  is the transverse leakage correction applied to the total (or transport corrected) cross section and absorption cross section of each group  $g$  of material  $m$ .

$\sigma_{tr_{mg}}$  is the macroscopic transport cross section of group  $g$  of material  $m$  (see the following discussion for additional information).

$DY, DZ$  are the input values of the transverse dimensions of the system.

$BF$  is the input constant,  $\frac{1.0}{0.71}$ , (Usually input as 1.4209) to define a group and material dependent extrapolation distance, if desired.

$B_g^2, B_m^2, B_{mg}^2$  are input values of the transverse buckling term for group dependent, material dependent, or group and material dependent calculations.

The calculation of a transverse leakage correction assumes that for  $P_0$  (transport corrected cross section data) the transport cross section,  $\sigma_{mg}^{tr}$ , is in position IHT in set  $m$  for all groups. If  $P_\ell$  cross section data are used, the user specifies, as input, the  $P_\ell$  order of the set  $m$ . The calculation of the transport correction using the diagonal transport approximation with  $P_\ell$  cross section data is defined by:

$$\sigma_{mg}^{tr} = \sigma_{mg}^t - \left[ \frac{1}{(2\ell + 1)} * \sum_{g'=1}^G \sigma_{mg'g} \right] \text{ (for } \ell = 1 \text{)}$$

where:

$\sigma_{mg}^{tr}$  is the macroscopic transport cross section used in the calculation of transverse leakage correction for group  $g$  and material  $m$ .

$\sigma_{mg}^t$  is the macroscopic total cross section for group  $g$  and material  $m$ .

$G$  is the total number of energy groups, IGM

$\sigma_{mg'g}$  is the  $P_1$  scatter cross section for transfer from group  $g$  to group  $g'$  and material  $m$ .

The operation performed in the SATURN code is to calculate the quantity:

$$\left[ \frac{1}{3} * \sum_{g'=1}^G \sigma_{mg'g} \right]$$

for each group of each input cross section set and place this quantity in the position of the absorption cross section (IHT-2) of the group,  $g$ . This calculation is not performed if the cross section in the total cross section position, IHT, is non-zero. Therefore, the user is cautioned in the input of cross section data (such as activities) because the total cross section position must be non-zero to delete the calculation of the sum of the  $P_1$  scattering data.

### 5.3.3 Labeling Option

The labeling option,  $ILABL = 1$  in Data Set 3 allows the user to generate a group-dependent cross section tape with cross section set identification supplied by the user. This cross section set identification consists of the material identification number on tape and a 48 character descriptive title for each set of cross section data input from magnetic tape or cards. The SATURN code produces a new magnetic tape containing the relabeled cross section data for MTP sets in the sequence specified by the input data. This output tape is group dependent, no transverse leakage correction or mixing table operations are permitted on this data.

The other labeling option in the SATURN code allows the user to label the mixtures formed in the calculation. This option is only permitted when  $ILABL = 0$  in Data Set 3. These labels must be provided and are used as part of the information on the group-dependent tape.

### 5.3.4 Limitations

In performing SATURN calculations, two types of limitations can be encountered; the first limitation occurs due to insufficient core data storage space, and the second limitation occurs due to insufficient Central Processor Unit (CPU) time.

The first limitation of insufficient core data storage space results from attempting to run too large a problem for the amount of data storage specified on the MAXCOR card. On the MSFC UNIVAC-1108 computer with the EXEC 8 Monitor-System, the maximum value of MAXCOR, or the amount of available problem data storage, is approximately  $35,000_{10}$  when used with  $65K_{10}$  core locations. Because the SATURN code is written in variable dimension, on any given data array no size restriction is imposed; a size restriction is only imposed on the length of the sum of all data arrays. For this reason, changing the code to use more core storage for data should it become available at MSFC, can be easily accomplished by changing only one FORTRAN card in the main program of the SATURN code.

This first limitation can sometimes be circumvented by splitting up the calculation into two calculations, in the case of the group-dependent tape, and combining the two tapes using system utility routines. For the group-independent tape, no simple solution is possible. The calculation must be reduced in complexity.

The second limitation of insufficient CPU time can be readily alleviated. By using the time estimate equation with an appropriate "safety factor," this limitation can be circumvented.

### 5.3.5 Problem Size Determination

To determine the number of core memory storage locations required for data of a given problem, each of the expressions below should be evaluated and summed as noted. The value of the sum, including the conditions imposed on the expressions, provides the value of the required input parameter, MAXCOR, on card 1 of Data Set 1. For a SATURN calculation to run successfully, the input value of MAXCOR must be greater than or equal to the calculated value of MAXCOR. All quantities in the expressions below are required input parameters defined in section 5.2.2 except where defined. The symbolism,  $\text{MAX}(x_1, x_2, \dots)$ , signifies the maximum value of the quantities or expressions,  $x_i$ , in the parenthesis is used in the calculation of the overall expression.

#### SATURN Flexible Dimension Data Storage Requirements:

$$\text{If } \text{ITYPE} = 0: \quad \text{MAXCOR} = A + (\text{IHP} * \text{IGM}) + \text{NR1}$$

$$\text{If } \text{ITYPE} = 1: \quad \text{MAXCOR} = \text{MAX}(A + (\text{IHP} * \text{IGM}) + \text{NR1}, A + \text{NR2})$$

Where the quantities, A, NR1, and NR2, are dependent on the parameter, MTX

$$\text{If } \text{MTX} = 0:$$

$$A = 50 + \text{IBUK} + \text{IBT} + (11 * \text{MTP})$$

$$\text{NR1} = \text{MAX}( \text{MTP} * \text{IH}, \text{IGM} * \text{IH} )$$

$$\text{NR2} = \text{IH} * \text{IGM} * \text{MTP}$$

where:

$IUP = IHS - IHT - 1$   
If  $IUP = 0$ ,  $IH = IHP$   
If  $IUP \neq 0$ ,  $IH = IHP + I$   
If  $IBTY = 0$ ,  $IBT = 0$   
If  $IBTY = 1$ ,  $IBT = 3$   
If  $IBTY = 2$ ,  $IBT = IGM$   
If  $IBTY = 3$ ,  $IBT = MTP$   
If  $IBTY = 4$ ,  $IBT = IGM * MTP$

If  $MTX \neq 0$ :

$A = 50 + IBUK + IBT + (10 * MTX) + (10 * MTP) + (3 * IMIX)$   
 $NR1 = (MAX (MTP + MTX, IGM) ) * IH$   
 $NR2 = IH * IGM * MTX$

where:

$IUP = IHS - IHT - 1$   
If  $IUP = 0$ ,  $IH = IHP$   
If  $IUP \neq 0$ ,  $IH = IHP + 1$   
If  $IBTY = 0$ ,  $IBT = 0$   
If  $IBTY = 1$ ,  $IBT = 3$   
If  $IBTY = 2$ ,  $IBT = IGM$   
If  $IBTY = 3$ ,  $IBT = MTX$   
If  $IBTY = 4$ ,  $IBT = IGM * MTX$



## 5.4 PROBLEM SETUP INFORMATION

This section describes the data deck setup for the SATURN code. Information on tape assignments, running time, error messages, and a sample problem, card input are provided.

### 5.4.1 Tape Assignments

The SATURN code requires a maximum of 7 tape or disk files. The specific number of files required is dependent upon the type of calculation. For many problems, only two tapes are required; all other files can be scratch disk devices (FASTRAND). The file assignments for the SATURN code are:

Tape 2	Intermediate Scratch Disk
Tape 5	Input Disk
Tape 6	Printed Output Disk
Tape 7	Punched Output Disk
Tape 8	Intermediate Scratch Disk
Tape 9	Intermediate Scratch Disk
Tape 12	Group-Dependent Output Tape
Tape 14	Group-Independent Output Tape
Tape 16	Input Cross-Section Library Tape
Tape 18	Input Cross-Section Library Tape

Generally, disk devices should be requested for tapes 2, 8, and 9 because of the large volume of data per record.

### 5.4.2 Running Time

The SATURN code will process approximately 10 cross section sets per minute of UNIVAC-1108 CPU time with each set containing approximately 2000 entries; the large

amount of tape and disk operations requires about 4 or 5 minutes of elapsed time (exclusive of roll out/roll in operations or disk access competition) for 10 cross section sets.

### 5.4.3 Error Messages

A number of SATURN code generated error messages may be encountered in running a SATURN problem. These messages are primarily due to incorrect problem input. The error messages are generally self explanatory.

<u>Message</u>	<u>Explanation</u>
STOP 1	Problems too large to fit on the computer or else the value of MAXCOR was input incorrectly.
STOP 2	An input error has occurred in reading the input data for Data Set 2.
STOP 3	An input error has occurred in reading the input data for Data Set 4.
Input Error-Insufficient Storage for Mixtures, STOP 4	MTX was input as zero and mixtures were input or else a set number, $n$ , was input which is greater than the sum of the input values of the number of sets from cards and tape, $MTP$ , plus the number of mixtures, $MTX$ .
End-of-file encounter on tape (16, for example), check input value of $(MT(M)$ , for example) for $(M$ , for example) = (2, for example), STOP 5	A tape ID number was improperly specified (out of sequence or non-existent) for input tapes 16 or 18.
Error, N entries required in (3\$, for example) array, data edit continues.	Too many or too few pieces of data were input to the specified array.

<u>Message</u>	<u>Explanation</u>
Warning, Interpolation used in the (9\$, for example) integer array, data edit continues.	The code is warning the user that integer interpolation, which involves computer integer arithmetic, is being used. Computers in performing integer arithmetic, drop any fractional remainder.
Fill Option ignored in (9\$, for example) array.	The code already has all the data it needs for the specified array. Most often, no entries are required for the input array.
Warning, Address _____ is beyond the limits of the (9\$, for example) array.	The user, in inputting data with the A format, has exceeded the storage area set aside for the specified array.

#### 5.4.4 Sample Problem Input

A listing of the input data for a SATURN sample problem has been included in Table 5-3 to illustrate the flexibility of the input data formats and the structure of a complete set of input data. The printout for this sample problem is presented in Section 5.5.1.

TABLE 5-3

SAMPLE PROBLEM CARD INPUT FOR THE SATURN CODE

	30000		SATURN FOR FULL PI (KRO215) FOR C,U235,AL		52GROUPS FOR RGS		HOLLEY	DATA 010
	6	2	0	8				DATA 020
	52	34	3	14	0			DATA 030
	0	1	2	1	0			DATA 040
2*	162.56	0.0	0.0					ODATA 050
3\$								DATA 060
	0	1						DATA 070
4\$								DATA 080
	7	7	7	7	8			DATA 090
	8	8						DATA 100
5\$								8DATA 110
	0	1	3	5	0			DATA 120
	4	6						DATA 130
6*								2DATA 140
	0.0	0.0037	0.06	0.0041	0.0	0.0037		DATA 150
	0.06	0.0041						DATA 160
9\$								DATA 170
	0120	0121	0620	0621	3520			DATA 180
T								DATA 190
			1 P0,52GROUPS, AL,C,U235					DATA 200
			2 P1,52GROUPS, AL,C,U235					DATA 210
								DATA 220
								DATA 230

## 5.5 DESCRIPTION OF OUTPUT

Computer output from a SATURN code calculation consists of printed output, punched output and two binary tapes. The following sections describe, in detail, each form of output.

### 5.5.1 Printed Output

The printed output from the sample problem input data presented in Section 5.4.4 is shown in Table 5-4. The first output section printed by the SATURN code is a description of the overall problem parameters contained in Data Set 1 consisting of set/mixture specifications, cross section set specifications, options, and core memory information. The second output section consists of a brief edit of the input data arrays contained in Data Set 2 consisting of the array identification and the number of entries found in that array. If the number of entries is incorrect, the entire array is printed. T's are printed when encountered. Several self-explanatory error messages may be printed in this section. If any data errors are found, the problem is terminated at this point.

The next section lists the transverse leakage data, if entered ( $IBTY > 0$ ). The code first lists which materials are to be excluded from the transverse leakage correction (1\$) and then the  $P_1$  order (3\$) of all the MTP or MTX sets to be processed. Next, the code lists the parameters  $DY$ ,  $DZ$ , and  $BF(2^*)$  if  $IBTY = 1$  (implying group-and region-independent data). If  $IBTY = 2$  (implying group-dependent data), or  $IBTY = 3$  (implying material-dependent data), IGM or MTX values of transverse leakage data(2\*), respectively, are printed. If  $IBTY = 4$  (implying group-and material-dependent data) a table of IGM x MTX values of transverse leakage data(2\*) are printed.

The next section lists the mixing table data (if  $IMIX > 0$ ) and the data source and identification number (9\$), whether from tape 18 (-M), from cards (0), or from tape 16 (+M). The mixing table data consists of the mixture material numbers (4\$), the component material numbers (5\$), and the component atom densities (6\*):

TABLE 5-4

SAMPLE PROBLEM COMPUTER PRINTOUT FOR THE SATURN CODE

SATURN FOR FULL P1 (KR0215) FOR C,U235,AL 52GROUPS FOR RGS HOLLEY

SETS/MIXTURES SPECIFICATIONS

NO. OF CROSS SECTION SETS FROM CARDS,TAPE16,TAPE18	6
NO. OF MIXTURES TO BE FORMED . . . . .	2
NO. OF MIXTURES (SETS) NOT IN 8**2 CALCULATION . .	0
NO. OF ENTRIES IN MIXTURE TABLE . . . . .	8

CROSS SECTION SET SPECIFICATIONS

NO. OF GROUPS . . . . .	52
NO. OF CROSS SECTION POS. (TABLE LENGTH W/UPS) . .	34
POSITION OF SIGMA (TOTAL) . . . . .	3
POSITION OF SIGMA (GG) . . . . .	14
THEORY (0/1,REGULAR/ADJOINT) . . . . .	0

OPTIONS

CODE FORMAT OUTPUT (0/1,ANIS/DOT) . . . . .	0
BUCKLING OPTION (0/1/2/3/4,NO/GRI/GD/MD/GMD) . . .	1
INPUT OPTION (-1,1/-2,2/-3,3ORC/C,16/C,16,18) . . .	2
OUTPUT TAPE OPTION (0/1,GROUP INDEP./GROUP DEP.) .	1
PUNCHED OUTPUT (0/1,NO/GROUP DEP.-YES) . . . . .	0
LABELING OPTION (0/1,NO/YES) . . . . .	0

CORE MEMORY ALLOCATION (0/1,GROUP DEP./GROUP IND.) .	1
CORE MEMORY LOCATIONS NEEDED . . . . .	3745
MAXIMUM CORE MEMORY ALLOCATED (INPUT VALUE) . . . .	30000

2* ARRAY	3 ENTRIES READ
3\$ ARRAY	2 ENTRIES READ
4\$ ARRAY	8 ENTRIES READ
5\$ ARRAY	8 ENTRIES READ
6* ARRAY	8 ENTRIES READ
9\$ ARRAY	6 ENTRIES READ

T

TABLE 5-4 (Continued)

TRANSVERSE LEAKAGE DATA

NO.	EXCL.	SET	MAT.	P(L)
1				0
2				1

NO.	DY, DZ, RF
1	1.62560E+02
2	0
3	0

TABLE 5-4 (Continued)

MIXING TABLE DATA AND DATA SOURCE (-/0/+.18/CARDS/16)

NO.	MIX. NO.	COMP. NO.	DENSITY	DATA SOURCE
1	7	0	0	120
2	7	1	3.70000E-03	121
3	7	3	6.00000E-02	620
4	7	5	4.10000E-03	621
5	8	0	0	3520
6	8	2	3.70000E-03	3521
7	8	4	6.00000E-02	
8	8	6	4.10000E-03	



TABLE 5-4 (Continued)

CROSS SECTION SET NO. = 120		ALUMINUM				P0 CORE EDGE			
POS.	GRP. 1	GRP. 2	GRP. 3	GRP. 4	GRP. 5	GRP. 6	GRP. 7	GRP. 8	
1	1.50600E-01	7.51300E-02	2.99000E-02	9.92000E-03	2.96000E-03	4.13000E-04	3.78609E-04	4.16237E-04	
2	0.	0.	0.	0.	0.	0.	0.	0.	
3	1.77742E+00	1.88442E+00	1.91892E+00	2.12169E+00	2.41494E+00	3.18175E+00	3.07461E+00	3.37416E+00	
4	0.	0.	0.	0.	0.	0.	0.	0.	
POS. 5 THRU POS. 13		SAME AS ABOVE							
14	6.60410E-01	8.52085E-01	9.59144E-01	1.13418E+00	1.47167E+00	2.28107E+00	2.57392E+00	2.82180E+00	
15	0.	9.64093E-02	1.37203E-01	1.59873E-01	4.97587E-01	5.60314E-01	7.50270E-01	3.98331E-01	
16	0.	0.	2.00000E-02	3.00000E-02	3.00000E-02	7.00000E-02	9.00000E-02	6.00000E-02	
17	0.	0.	0.	3.00000E-02	6.00000E-02	7.00000E-02	2.00000E-01	1.10000E-01	
18	0.	0.	0.	0.	7.00000E-02	9.00000E-02	1.80000E-01	1.20000E-01	
19	0.	0.	0.	0.	0.	1.00000E-01	2.10000E-01	1.90000E-01	
20	0.	0.	0.	0.	0.	0.	2.30000E-01	1.80000E-01	
21	0.	0.	0.	0.	0.	0.	0.	2.00000E-01	
22	0.	0.	0.	0.	0.	0.	0.	0.	
POS. 23 THRU POS. 34		SAME AS ABOVE							
POS.	GRP. 9	GRP. 10	GRP. 11	GRP. 12	GRP. 13	GRP. 14	GRP. 15	GRP. 16	
1	4.78944E-04	1.90831E-03	3.41203E-03	5.60469E-03	5.32298E-03	2.18265E-03	1.11739E-03	2.07944E-03	
2	0.	0.	0.	0.	0.	0.	0.	0.	
3	4.09855E+00	4.59892E+00	5.01087E+00	4.58998E+00	1.40339E+00	1.42108E+00	1.41112E+00	1.41208E+00	
4	0.	0.	0.	0.	0.	0.	0.	0.	
POS. 5 THRU POS. 13		SAME AS ABOVE							
14	3.71004E+00	4.34397E+00	4.68466E+00	4.51761E+00	1.25277E+00	1.32132E+00	1.33479E+00	1.33905E+00	
15	4.56890E-01	3.88031E-01	2.53043E-01	3.22798E-01	6.67710E-02	1.45291E-01	9.75741E-02	7.52249E-02	
16	1.01989E-01	9.50549E-02	0.	0.	0.	0.	0.	0.	
17	5.00000E-02	0.	0.	0.	0.	0.	0.	0.	
18	1.40000E-01	4.00000E-02	0.	0.	0.	0.	0.	0.	
19	6.00000E-02	4.00000E-02	0.	0.	0.	0.	0.	0.	
20	2.30000E-01	3.00000E-02	0.	0.	0.	0.	0.	0.	
21	2.00000E-01	7.00000E-02	0.	0.	0.	0.	0.	0.	
22	1.80000E-01	5.00000E-02	0.	0.	0.	0.	0.	0.	
23	0.	4.00000E-02	0.	0.	0.	0.	0.	0.	
24	0.	0.	0.	0.	0.	0.	0.	0.	
POS. 25 THRU POS. 34		SAME AS ABOVE							
POS.	GRP. 17	GRP. 18	GRP. 19	GRP. 20	GRP. 21	GRP. 22	GRP. 23	GRP. 24	
1	3.39430E-03	4.35000E-03	5.15000E-03	5.50000E-03	6.40000E-03	7.30000E-03	8.20000E-03	9.30000E-03	
2	0.	0.	0.	0.	0.	0.	0.	0.	
3	1.41340E+00	1.41435E+00	1.41515E+00	1.41550E+00	1.41640E+00	1.41730E+00	1.41820E+00	1.41930E+00	
4	0.	0.	0.	0.	0.	0.	0.	0.	
POS. 5 THRU POS. 13		SAME AS ABOVE							
14	1.27942E+00	1.00206E+00	1.00206E+00	1.00206E+00	1.00206E+00	1.00206E+00	1.00206E+00	1.00206E+00	
15	7.09517E-02	1.30584E-01	4.07943E-01	4.07943E-01	4.07943E-01	4.07942E-01	4.07943E-01	4.07942E-01	
16	0.	0.	0.	0.	0.	0.	0.	0.	

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TABLE 5-4 (Continued)

POS. 17 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 25	GRP. 26	GRP. 27	GRP. 28	GRP. 29	GRP. 30	GRP. 31	GRP. 32
1	1.06000E-02	1.21000E-02	1.38000E-02	1.50000E-02	1.71000E-02	2.03000E-02	2.23000E-02	2.52000E-02
2	0.	0.	0.	0.	0.	0.	0.	0.
3	1.42060E+00	1.42210E+00	1.42380E+00	1.42500E+00	1.42710E+00	1.43030E+00	1.43230E+00	1.43520E+00
4	0.	0.	0.	0.	0.	0.	0.	0.
POS. 5 THRU POS. 13 SAME AS ABOVE								
14	1.00206E+00	1.00206E+00	1.00206E+00	1.00206E+00	1.00206E+00	1.00206E+00	1.00206E+00	1.00206E+00
15	4.07942E-01	4.07942E-01	4.07943E-01	4.07943E-01	4.07942E-01	4.07943E-01	4.07943E-01	4.07943E-01
16	0.	0.	0.	0.	0.	0.	0.	0.
POS. 17 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 33	GRP. 34	GRP. 35	GRP. 36	GRP. 37	GRP. 38	GRP. 39	GRP. 40
1	2.73535E-02	2.98187E-02	3.27553E-02	3.53772E-02	3.99805E-02	4.95893E-02	6.11332E-02	6.85945E-02
2	0.	0.	0.	0.	0.	0.	0.	0.
3	1.42735E+00	1.42982E+00	1.43276E+00	1.43538E+00	1.43998E+00	1.44959E+00	1.46113E+00	1.46859E+00
4	0.	0.	0.	0.	0.	0.	0.	0.
POS. 5 THRU POS. 13 SAME AS ABOVE								
14	1.40000E+00	1.40000E+00	1.40000E+00	1.40000E+00	1.40000E+00	1.40000E+00	1.40000E+00	1.40000E+00
15	4.07943E-01	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
POS. 17 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 41	GRP. 42	GRP. 43	GRP. 44	GRP. 45	GRP. 46	GRP. 47	GRP. 48
1	7.57354E-02	8.51710E-02	9.63245E-02	1.07834E-01	1.20314E-01	1.36090E-01	1.59815E-01	1.88574E-01
2	0.	0.	0.	0.	0.	0.	0.	0.
3	1.47574E+00	1.48517E+00	1.49632E+00	1.50783E+00	1.52031E+00	1.53609E+00	1.55982E+00	1.58857E+00
4	0.	0.	0.	0.	0.	0.	0.	0.
POS. 5 THRU POS. 13 SAME AS ABOVE								
14	1.40000E+00	1.40000E+00	1.40000E+00	1.40000E+00	1.40000E+00	1.40000E+00	1.40000E+00	1.40000E+00
15	0.	0.	0.	0.	0.	0.	0.	0.
POS. 16 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 49	GRP. 50	GRP. 51	GRP. 52				
1	2.20100E-01	2.93559E-01	4.20619E-01	6.05651E-01				
2	0.	0.	0.	0.				
3	1.62010E+00	1.69356E+00	1.82062E+00	2.00565E+00				
4	0.	0.	0.	0.				
POS. 5 THRU POS. 13 SAME AS ABOVE								
14	1.40000E+00	1.40000E+00	1.40000E+00	1.40000E+00				
15	0.	0.	0.	0.				
POS. 16 THRU POS. 34 SAME AS ABOVE								

TABLE 5-4 (Continued)

CROSS SECTION SET NO. = 121		ALUMINUM				P1 CORE EDGE			
POS.	GRP. 1	GRP. 2	GRP. 3	GRP. 4	GRP. 5	GRP. 6	GRP. 7	GRP. 8	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 13 SAME AS ABOVE								
14	1.43574E+00	1.76999E+00	1.94919E+00	2.01003E+00	2.36545E+00	3.45767E+00	3.07275E+00	3.20410E+00	
15	0.	-4.28527E-02	-4.37885E-02	-7.76246E-03	-9.22028E-02	-1.59492E-01	-1.41313E-01	-8.91600E-02	
16	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 17 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 9	GRP. 10	GRP. 11	GRP. 12	GRP. 13	GRP. 14	GRP. 15	GRP. 16	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 13 SAME AS ABOVE								
14	2.75602E+00	1.02026E+00	1.02226E+00	-7.27167E-01	2.07329E-01	1.86906E-01	1.43946E-01	2.42439E-01	
15	-8.08015E-02	-2.80794E-01	-2.55192E-01	-2.43623E-01	-5.71722E-02	-1.31357E-01	-7.73441E-02	-3.93815E-02	
16	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 17 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 17	GRP. 18	GRP. 19	GRP. 20	GRP. 21	GRP. 22	GRP. 23	GRP. 24	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 13 SAME AS ABOVE								
14	2.30881E-01	4.92111E-01	4.92111E-01	4.92111E-01	4.92111E-01	4.92111E-01	4.92111E-01	4.92111E-01	
15	-1.37886E-01	-1.26290E-01	-3.87561E-01	-3.87514E-01	-3.87561E-01	-3.87534E-01	-3.87561E-01	-3.87534E-01	
16	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 17 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 25	GRP. 26	GRP. 27	GRP. 28	GRP. 29	GRP. 30	GRP. 31	GRP. 32	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 13 SAME AS ABOVE								
14	4.92111E-01	4.92111E-01	4.92111E-01	4.92111E-01	4.92111E-01	4.92111E-01	4.92111E-01	4.92111E-01	
15	-3.87534E-01	-3.87486E-01	-3.87561E-01	-3.87561E-01	-3.87534E-01	-3.87514E-01	-3.87561E-01	-3.87561E-01	
16	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 17 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 33	GRP. 34	GRP. 35	GRP. 36	GRP. 37	GRP. 38	GRP. 39	GRP. 40	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 14 SAME AS ABOVE								
15	-3.87570E-01	0.	0.	0.	0.	0.	0.	0.	
16	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 17 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 41	GRP. 42	GRP. 43	GRP. 44	GRP. 45	GRP. 46	GRP. 47	GRP. 48	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 49	GRP. 50	GRP. 51	GRP. 52					
1	0.	0.	0.	0.					

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TABLE 5-4 (Continued)

POS. 2 THRU POS. 34 SAME AS ABOVE

TABLE 5-4 (Continued)

CROSS SECTION SET NO. = 620		CARBON, 296 DEG. K				P0 CORE EDGE			
POS.	GRP. 1	GRP. 2	GRP. 3	GRP. 4	GRP. 5	GRP. 6	GRP. 7	GRP. 8	
1	4.81130E-02	2.89100E-03	0.	0.	0.	0.	0.	0.	
2	0.	0.	0.	0.	0.	0.	0.	0.	
3	1.33471E+00	1.16536E+00	1.19615E+00	1.88253E+00	2.01800E+00	1.65986E+00	1.93662E+00	2.60744E+00	
4	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 5 THRU POS. 13		SAME AS ABOVE						
14	5.70110E-01	4.82040E-01	5.34910E-01	9.08220E-01	8.21090E-01	6.39190E-01	1.30659E+00	1.78404E+00	
15	0.	3.17840E-01	3.43450E-01	5.52410E-01	8.02360E-01	1.05140E+00	1.02067E+00	6.30024E-01	
16	0.	0.	3.90460E-02	5.18260E-02	1.67310E-02	1.71950E-01	1.45910E-01	0.	
17	0.	0.	0.	1.25586E-01	0.	0.	0.	0.	
18	0.	0.	0.	0.	1.51049E-01	8.03257E-02	0.	0.	
19	0.	0.	0.	0.	0.	7.79267E-02	1.48877E-01	4.55768E-02	
20	0.	0.	0.	0.	0.	0.	1.17032E-03	5.59595E-02	
21	0.	0.	0.	0.	0.	0.	0.	2.63835E-03	
22	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 23 THRU POS. 34		SAME AS ABOVE						
POS.	GRP. 9	GRP. 10	GRP. 11	GRP. 12	GRP. 13	GRP. 14	GRP. 15	GRP. 16	
1	0.	0.	0.	7.24145E-07	8.71029E-06	1.02392E-05	1.75929E-05	3.32432E-05	
2	0.	0.	0.	0.	0.	0.	0.	0.	
3	3.27284E+00	4.03317E+00	4.57197E+00	4.59433E+00	4.66794E+00	4.69386E+00	4.70530E+00	4.70980E+00	
4	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 5 THRU POS. 13		SAME AS ABOVE						
14	2.58174E+00	3.54330E+00	3.86318E+00	3.88825E+00	3.95458E+00	3.98308E+00	4.15599E+00	4.19068E+00	
15	8.23402E-01	6.91103E-01	4.89878E-01	7.08784E-01	7.06082E-01	7.13354E-01	7.10774E-01	5.49292E-01	
16	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 17 THRU POS. 19		SAME AS ABOVE						
20	3.60374E-02	0.	0.	0.	0.	0.	0.	0.	
21	0.	9.75605E-03	0.	0.	0.	0.	0.	0.	
22	1.00855E-03	0.	6.63815E-04	0.	0.	0.	0.	0.	
23	0.	2.20833E-04	0.	3.44141E-05	0.	0.	0.	0.	
24	0.	0.	0.	0.	7.25406E-06	0.	0.	0.	
25	0.	0.	0.	0.	0.	2.41531E-06	0.	0.	
26	0.	0.	0.	0.	0.	0.	1.69863E-05	0.	
27	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 28 THRU POS. 34		SAME AS ABOVE						
POS.	GRP. 17	GRP. 18	GRP. 19	GRP. 20	GRP. 21	GRP. 22	GRP. 23	GRP. 24	
1	5.61386E-05	7.20000E-05	8.00000E-05	9.00000E-05	1.00000E-04	1.10000E-04	1.31000E-04	1.48000E-04	
2	0.	0.	0.	0.	0.	0.	0.	0.	
3	4.71005E+00	4.71005E+00	4.71007E+00	4.71008E+00	4.71003E+00	4.71010E+00	4.71013E+00	4.71014E+00	
4	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 5 THRU POS. 13		SAME AS ABOVE						
14	3.75677E+00	1.90720E+00	1.91760E+00	1.90990E+00	1.90340E+00	1.91320E+00	1.91020E+00	1.90830E+00	
15	5.19087E-01	8.98938E-01	2.62280E+00	2.62010E+00	2.63430E+00	2.63100E+00	2.62420E+00	2.62910E+00	

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TABLE 5-4 (Continued)

16	0.	0.	5.42896E-02	1.79980E-01	1.72290E-01	1.65790E-01	1.75530E-01	1.72580E-01	
17	0.	0.	0.	0.	0.	0.	0.	0.	
	POS.	18 THRU POS.	34	SAME AS ABOVE					
POS.	GRP. 25	GRP. 26	GRP. 27	GRP. 28	GRP. 29	GRP. 30	GRP. 31	GRP. 32	
1	1.61000E-04	1.95000E-04	2.17000E-04	2.48000E-04	2.86000E-04	3.22000E-04	3.58000E-04	4.09000E-04	
2	0.	0.	0.	0.	0.	0.	0.	0.	
3	4.71016E+00	4.71013E+00	4.71028E+00	4.71022E+00	4.71025E+00	4.71028E+00	4.71035E+00	4.71038E+00	
4	0.	0.	0.	0.	0.	0.	0.	0.	
	POS.	5 THRU POS.	13	SAME AS ABOVE					
14	1.91450E+00	1.91160E+00	1.91070E+00	1.90500E+00	1.91560E+00	1.90950E+00	1.90500E+00	1.92520E+00	
15	2.62480E+00	2.62150E+00	2.62530E+00	2.63200E+00	2.62700E+00	2.62250E+00	2.63310E+00	2.61740E+00	
16	1.70700E-01	1.76890E-01	1.74000E-01	1.73040E-01	1.67360E-01	1.77970E-01	1.71860E-01	1.67360E-01	
17	0.	0.	0.	0.	0.	0.	0.	0.	
	POS.	18 THRU POS.	34	SAME AS ABOVE					
POS.	GRP. 33	GRP. 34	GRP. 35	GRP. 36	GRP. 37	GRP. 38	GRP. 39	GRP. 40	
1	4.11734E-04	4.45918E-04	4.86977E-04	5.28422E-04	5.95770E-04	7.42951E-04	9.18212E-04	1.02327E-03	
2	0.	0.	0.	0.	0.	0.	0.	0.	
3	4.85061E+00	4.58338E+00	4.52947E+00	4.47309E+00	4.66878E+00	4.64915E+00	4.65578E+00	4.66514E+00	
4	1.17955E-41	1.13019E-35	2.58093E-30	1.19263E-27	9.70710E-16	1.51945E-08	8.80860E-07	3.40443E-06	
5	3.89718E-39	2.35985E-33	5.46433E-29	3.07520E-26	1.76190E-14	3.12394E-08	1.27098E-06	3.85377E-06	
6	4.71656E-36	4.28957E-31	6.64270E-27	5.29904E-25	2.97568E-13	8.88025E-08	2.49602E-06	6.10749E-06	
7	6.33786E-34	2.36997E-28	7.43498E-25	4.51705E-23	1.03037E-12	2.18328E-07	6.47792E-06	1.56007E-05	
8	3.98852E-30	1.97118E-26	2.17865E-22	2.22604E-20	2.74806E-12	5.42391E-07	1.89501E-05	6.98710E-05	
9	4.53793E-21	4.41019E-23	1.22526E-20	1.15722E-17	8.76453E-12	2.51995E-06	7.61356E-05	2.14041E-04	
10	1.99050E-14	4.38833E-15	1.19211E-17	8.62226E-16	1.36670E-10	1.92551E-05	3.91808E-04	4.57149E-04	
11	4.73820E-11	3.78730E-09	1.71215E-10	3.73261E-13	2.05102E-09	3.25640E-04	2.24730E-03	1.81051E-03	
12	4.64071E-07	4.65262E-06	4.51188E-05	2.09185E-07	1.51231E-07	2.65812E-03	2.46392E-02	1.04766E-02	
13	6.12404E-03	2.39127E-02	3.72445E-02	2.71947E-02	2.93493E-02	1.14777E-01	2.54644E-01	1.58184E-01	
14	1.77351E+00	1.68789E+00	1.74869E+00	1.52956E+00	2.90597E+00	3.61376E+00	3.20337E+00	2.89643E+00	
15	1.71264E+00	1.94428E+00	1.90388E+00	1.50346E+00	2.52401E+00	1.65474E+00	7.02525E-01	5.38081E-01	
16	1.58472E-01	8.51640E-01	9.11447E-01	6.84778E-01	1.17721E+00	3.78200E-01	6.402A5E-02	1.39345E-01	
17	0.	2.73671E-02	1.99360E-01	1.81448E-01	2.94332E-01	7.56622E-02	3.46507E-03	7.90430E-03	
18	0.	0.	1.71124E-03	1.89682E-02	3.93235E-02	5.93561E-03	4.98286E-05	6.95569E-05	
19	0.	0.	0.	3.82712E-05	2.15524E-03	2.00902E-04	6.10412E-07	5.46771E-07	
20	0.	0.	0.	0.	1.12730E-06	2.61372E-06	2.36572E-09	3.01814E-09	
21	0.	0.	0.	0.	0.	0.	0.	4.56757E-12	
22	0.	0.	0.	0.	0.	0.	0.	0.	
	POS.	23 THRU POS.	34	SAME AS ABOVE					
POS.	GRP. 41	GRP. 42	GRP. 43	GRP. 44	GRP. 45	GRP. 46	GRP. 47	GRP. 48	
1	1.13268E-03	1.27815E-03	1.45103E-03	1.63237E-03	1.80588E-03	2.04882E-03	2.42604E-03	2.89223E-03	
2	0.	0.	0.	0.	0.	0.	0.	0.	
3	4.67123E+00	4.66567E+00	4.70380E+00	4.72814E+00	4.72343E+00	4.88346E+00	4.84587E+00	4.84123E+00	
4	9.36946E-05	9.03819E-04	0.	0.	0.	0.	0.	0.	
5	1.22745E-04	6.33161E-04	3.25868E-03	0.	0.	0.	0.	0.	

TABLE 5-4 (Continued)

6	1.97667E-04	6.22336E-04	2.71700E-03	4.91872E-03	0.	0.	0.	0.
7	2.87304E-04	7.79200E-04	3.09541E-03	3.87805E-03	8.34669E-03	0.	0.	0.
8	4.87923E-04	1.11780E-03	3.92263E-03	3.64524E-03	7.27997E-03	1.97819E-02	0.	0.
9	1.09001E-03	2.19049E-03	5.24752E-03	5.27225E-03	8.44639E-03	1.80288E-02	3.79479E-02	0.
10	2.61389E-03	4.83169E-03	1.01988E-02	8.12403E-03	1.37344E-02	2.11597E-02	3.07905E-02	2.71587E-02
11	6.09465E-03	1.16738E-02	2.90847E-02	1.96265E-02	2.20829E-02	2.80825E-02	3.92509E-02	2.70275E-02
12	2.76114E-02	3.31599E-02	7.82465E-02	4.94159E-02	4.40920E-02	4.65190E-02	7.98139E-02	4.62527E-02
13	2.28899E-01	1.93228E-01	2.68709E-01	1.93229E-01	1.71109E-01	1.44879E-01	1.45271E-01	6.96594E-02
14	3.42844E+00	3.51621E+00	3.83943E+00	3.80848E+00	3.97686E+00	4.31553E+00	4.45032E+00	4.48141E+00
15	8.97760E-01	5.42190E-01	5.40068E-01	2.84301E-01	3.23310E-01	2.70986E-01	2.10545E-01	8.97588E-02
16	4.60238E-01	2.79675E-01	2.64829E-01	1.35093E-01	1.56113E-01	1.42659E-01	1.10094E-01	4.39795E-02
17	1.10514E-01	1.82751E-01	1.76911E-01	8.48510E-02	8.77245E-02	9.65894E-02	8.80626E-02	3.61703E-02
18	5.01740E-03	2.92664E-02	1.01155E-01	6.52145E-02	6.31800E-02	6.33657E-02	5.49730E-02	2.38692E-02
19	6.04950E-06	1.71065E-03	1.42457E-02	2.44924E-02	5.04010E-02	4.72971E-02	4.32819E-02	1.88457E-02
20	6.26519E-08	9.11996E-08	1.10721E-03	3.91349E-03	1.27941E-02	2.53801E-02	3.28646E-02	1.42123E-02
21	2.30513E-10	9.76655E-10	1.77991E-09	3.29746E-04	2.55873E-03	7.94829E-03	9.30851E-03	1.09284E-02
22	2.19231E-13	1.91906E-12	3.13121E-11	3.25125E-11	1.30635E-04	1.65599E-03	5.02362E-03	2.49468E-03
23	0.	8.71806E-16	3.77923E-14	4.03622E-13	3.24727E-12	1.42352E-05	7.96999E-04	1.70050E-03
24	0.	0.	9.68671E-18	2.85330E-16	3.28967E-14	2.09531E-13	9.73331E-07	2.42480E-04
25	0.	0.	0.	3.86288E-20	1.71486E-17	1.68168E-15	7.62242E-15	3.82206E-18
26	0.	0.	0.	0.	1.62260E-21	6.17918E-19	4.69520E-17	1.04106E-16
27	0.	0.	0.	0.	0.	3.86352E-23	1.16006E-20	4.73753E-19
28	0.	0.	0.	0.	0.	0.	4.52554E-25	7.41046E-23
29	0.	0.	0.	0.	0.	0.	0.	1.66775E-27
30	0.	0.	0.	0.	0.	0.	0.	0.
POS.	31 THRU POS.	34	SAME AS ABOVE					

POS.	GRP. 49	GRP. 50	GRP. 51	GRP. 52
1	3.41953E-03	4.47556E-03	6.43611E-03	9.80514E-03
2	0.	0.	0.	0.
3	5.08886E+00	4.56780E+00	4.35369E+00	3.82814E+00
4	0.	0.	0.	0.
POS.	5 THRU POS.	10	SAME AS ABOVE	
11	4.53810E-02	0.	0.	0.
12	4.70885E-02	5.14268E-02	0.	0.
13	5.53799E-02	4.32253E-02	9.69283E-03	0.
14	4.81548E+00	4.36828E+00	4.16129E+00	3.60952E+00
15	7.34039E-02	5.25385E-02	1.03993E-02	5.20580E-03
16	5.02757E-02	4.50117E-02	1.05622E-02	6.66386E-03
17	2.87823E-02	2.38457E-02	6.39567E-03	5.39514E-03
18	2.31340E-02	2.04414E-02	4.62134E-03	3.46095E-03
19	1.60776E-02	1.37941E-02	4.07935E-03	3.13181E-03
20	1.45994E-02	1.08456E-02	2.83172E-03	2.43975E-03
21	1.07224E-02	1.06938E-02	2.80380E-03	1.75503E-03
22	7.22476E-03	8.55075E-03	2.28395E-03	1.90436E-03
23	1.68544E-03	4.04215E-03	2.08713E-03	1.47972E-03
24	1.25883E-03	1.14395E-03	7.02662E-04	1.43565E-03

TABLE 5-4 (Continued)

25	1.34678E-04	9.12920E-04	2.48010E-04	4.03085E-04
26	0.	7.63590E-05	2.12192E-04	1.62391E-04
27	7.36376E-18	0.	1.47982E-05	1.43515E-04
28	2.76345E-20	2.95005E-19	0.	1.04822E-05
29	3.24155E-24	8.92268E-22	1.56653E-21	0.
30	5.17310E-29	7.60295E-26	3.46664E-24	8.89349E-23
31	0.	8.29858E-31	1.84980E-28	1.64997E-25
32	0.	0.	1.14686E-33	6.78523E-30
33	0.	0.	0.	3.08049E-35
34	0.	0.	0.	0.



TABLE 5-4 (Continued)

CROSS SECTION SET NO. = 621		CARBON, 296 DEG. K				P1 CORE EDGE			
POS.	GRP. 1	GRP. 2	GRP. 3	GRP. 4	GRP. 5	GRP. 6	GRP. 7	GRP. 8	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 13		SAME AS ABOVE						
14	1.36730E+00	1.04940E+00	1.16360E+00	1.90360E+00	1.84810E+00	1.17810E+00	1.04799E+00	1.56773E+00	
15	0.	4.92950E-02	-2.42390E-01	-3.25120E-01	-7.39580E-01	-1.28820E+00	-1.11267E+00	-4.57000E-01	
16	0.	0.	-9.96640E-02	-1.29650E-01	-3.92600E-02	-4.42330E-01	-3.67000E-01	0.	
17	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 18 THRU POS. 34		SAME AS ABOVE						
POS.	GRP. 9	GRP. 10	GRP. 11	GRP. 12	GRP. 13	GRP. 14	GRP. 15	GRP. 16	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 13		SAME AS ABOVE						
14	1.58327E+00	1.29766E+00	1.35493E+00	1.34775E+00	1.35840E+00	1.32252E+00	1.07051E+00	1.68109E+00	
15	-5.64956E-01	-4.92884E-01	-3.71120E-01	-5.82947E-01	-5.82279E-01	-5.80535E-01	-5.40317E-01	-2.86991E-01	
16	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 17 THRU POS. 34		SAME AS ABOVE						
POS.	GRP. 17	GRP. 18	GRP. 19	GRP. 20	GRP. 21	GRP. 22	GRP. 23	GRP. 24	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 13		SAME AS ABOVE						
14	1.65630E+00	2.99510E+00	2.97190E+00	2.98900E+00	3.00350E+00	2.98170E+00	2.98840E+00	2.99250E+00	
15	-8.96136E-01	-7.33528E-01	-1.76410E+00	-1.75810E+00	-1.78970E+00	-1.78250E+00	-1.76730E+00	-1.77800E+00	
16	0.	0.	-1.37783E-01	-4.45960E-01	-4.28820E-01	-4.14280E-01	-4.36030E-01	-4.29480E-01	
17	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 18 THRU POS. 34		SAME AS ABOVE						
POS.	GRP. 25	GRP. 26	GRP. 27	GRP. 28	GRP. 29	GRP. 30	GRP. 31	GRP. 32	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 13		SAME AS ABOVE						
14	2.97870E+00	2.98520E+00	2.98730E+00	3.00010E+00	2.97630E+00	2.98990E+00	3.00010E+00	2.95510E+00	
15	-1.76850E+00	-1.76110E+00	-1.76970E+00	-1.78450E+00	-1.77360E+00	-1.76350E+00	-1.78720E+00	-1.75230E+00	
16	-4.25330E-01	-4.39070E-01	-4.32610E-01	-4.30520E-01	-4.17810E-01	-4.41540E-01	-4.27870E-01	-4.17760E-01	
17	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 18 THRU POS. 34		SAME AS ABOVE						
POS.	GRP. 33	GRP. 34	GRP. 35	GRP. 36	GRP. 37	GRP. 38	GRP. 39	GRP. 40	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 3		SAME AS ABOVE						
4	-1.03171E-40	-9.43337E-35	-1.83703E-29	-8.26378E-27	-2.60579E-15	-1.18906E-08	-7.32993E-07	-2.26953E-06	
5	-2.70538E-38	-1.43611E-32	-3.30666E-28	-1.73954E-25	-4.42273E-14	-3.02155E-08	-1.22496E-06	-3.97744E-06	
6	-2.47806E-35	-2.12000E-30	-3.02827E-26	-2.58341E-24	-1.58727E-13	-8.39124E-08	-2.79085E-06	-6.94809E-06	
7	-2.92281E-33	-9.27848E-28	-2.85238E-24	-1.71293E-22	-2.70212E-13	-2.35659E-07	-8.04292E-06	-1.76121E-05	
8	-1.37201E-29	-6.99727E-26	-6.98544E-22	-6.46301E-20	-1.85771E-12	-6.41452E-07	-2.37350E-05	-6.04649E-05	
9	-1.05042E-20	-1.25703E-22	-3.67296E-20	-3.23288E-17	-1.54238E-11	-3.16628E-06	-7.41064E-05	-1.70002E-04	
10	-4.25299E-14	-8.90688E-15	-3.01869E-17	-2.34055E-15	-2.78644E-10	-2.38636E-05	-3.35623E-04	-3.86895E-04	

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TABLE 5-4 (Continued)

11	-8.14889E-11	-5.64749E-09	-2.89375E-10	-4.62293E-13	-3.55665E-09	-2.80443E-04	-1.86344E-03	-1.49100E-03
12	-3.48554E-07	-3.17992E-06	-2.07133E-05	-2.31188E-07	-1.87409E-07	-2.03243E-03	-1.71327E-02	-8.31330E-03
13	5.38829E-03	2.66786E-02	3.49163E-02	1.54230E-02	1.32396E-03	-3.85277E-02	-1.20327E-01	-8.43774E-02
14	2.99309E+00	2.31920E+00	2.21831E+00	2.06035E+00	1.99672E+00	1.53922E+00	1.71524E+00	1.85768E+00
15	-4.29657E-01	3.70999E-02	-8.68152E-02	9.97229E-02	-7.64665E-01	-1.19234E+00	-5.17465E-01	-3.18117E-01
16	-3.76642E-01	-1.25020E+00	-1.16764E+00	-8.51153E-01	-1.39552E+00	-6.31420E-01	-9.80707E-02	-1.39815E-01
17	0.	-8.02837E-02	-4.35010E-01	-3.50342E-01	-5.57638E-01	-1.63570E-01	-5.81046E-03	-1.36672E-02
18	0.	0.	-5.67105E-03	-4.91315E-02	-8.86782E-02	-1.48877E-02	-1.41991E-04	-1.96991E-04
19	0.	0.	0.	-1.38953E-04	-6.09666E-03	-5.34438E-04	-1.98043E-06	-1.76202E-06
20	0.	0.	0.	0.	-4.37668E-06	-8.53080E-06	-8.60541E-09	-1.16566E-08
21	0.	0.	0.	0.	0.	0.	0.	-2.11379E-11
22	0.	0.	0.	0.	0.	0.	0.	0.
POS.	23 THRU POS.	34	SAME AS ABOVE					

POS.	GRP. 41	GRP. 42	GRP. 43	GRP. 44	GRP. 45	GRP. 46	GRP. 47	GRP. 48
1	0.	0.	0.	0.	0.	0.	0.	0.
POS.	2 THRU POS.	3	SAME AS ABOVE					
4	-3.94191E-05	-2.06420E-04	0.	0.	0.	0.	0.	0.
5	-6.68458E-05	-2.47539E-04	-1.02009E-03	0.	0.	0.	0.	0.
6	-1.22270E-04	-3.36332E-04	-1.18692E-03	-1.53104E-03	0.	0.	0.	0.
7	-1.95556E-04	-5.18351E-04	-1.77071E-03	-1.77326E-03	-2.62185E-03	0.	0.	0.
8	-3.71276E-04	-8.17886E-04	-2.71091E-03	-2.29141E-03	-3.49049E-03	-6.87943E-03	0.	0.
9	-8.89017E-04	-1.70439E-03	-4.05009E-03	-3.94116E-03	-5.54568E-03	-8.99797E-03	-1.58623E-02	0.
10	-2.17000E-03	-4.02333E-03	-8.48353E-03	-6.59228E-03	-1.04786E-02	-1.42067E-02	-1.81276E-02	-1.32547E-02
11	-5.12234E-03	-9.98073E-03	-2.43547E-02	-1.62612E-02	-1.80048E-02	-2.26314E-02	-2.88572E-02	-1.79684E-02
12	-2.17769E-02	-2.71941E-02	-6.48015E-02	-4.20746E-02	-3.77718E-02	-3.97901E-02	-6.51091E-02	-3.57235E-02
13	-1.45426E-01	-1.34052E-01	-2.03395E-01	-1.50271E-01	-1.39153E-01	-1.21311E-01	-1.22992E-01	-5.75697E-02
14	1.55546E+00	1.46988E+00	1.17428E+00	1.16347E+00	1.09327E+00	4.93014E-01	3.18751E-01	3.06004E-01
15	-5.47935E-01	-3.76411E-01	-3.99214E-01	-2.22096E-01	-2.55456E-01	-2.23917E-01	-1.79214E-01	-7.63062E-02
16	-3.54462E-01	-2.25542E-01	-2.17668E-01	-1.13066E-01	-1.30984E-01	-1.22677E-01	-9.53764E-02	-3.78705E-02
17	-1.29143E-01	-1.59042E-01	-1.51312E-01	-7.17746E-02	-7.55076E-02	-8.25265E-02	-7.37863E-02	-2.95087E-02
18	-8.08703E-03	-4.11959E-02	-9.80172E-02	-5.43108E-02	-5.35367E-02	-5.26875E-02	-4.59152E-02	-1.93670E-02
19	-1.80336E-05	-1.88292E-03	-1.99438E-02	-2.73741E-02	-4.09764E-02	-3.83207E-02	-3.40844E-02	-1.43996E-02
20	-2.20519E-07	-2.89525E-07	-7.69176E-04	-5.16864E-03	-1.63060E-02	-2.36911E-02	-2.48733E-02	-1.04856E-02
21	-1.00223E-09	-4.10825E-09	-7.25225E-09	-1.63529E-04	-3.14914E-03	-9.62383E-03	-1.08990E-02	-7.77457E-03
22	-1.17547E-12	-1.05102E-11	-1.58615E-10	-1.65002E-10	-1.09308E-04	-1.72266E-03	-5.30010E-03	-2.83001E-03
23	0.	-6.14471E-15	-2.57989E-13	-2.62999E-12	-1.92913E-11	-3.79651E-05	-8.60777E-04	-1.51970E-03
24	0.	0.	-8.69370E-17	-2.58541E-15	-2.54292E-13	-1.53030E-12	-2.82367E-06	-1.82867E-04
25	0.	0.	0.	-4.67584E-19	-1.86021E-16	-1.61663E-14	-7.29574E-14	-1.15411E-17
26	0.	0.	0.	0.	-2.35319E-20	-8.38600E-18	-5.95880E-16	-1.42127E-15
27	0.	0.	0.	0.	0.	-6.99669E-22	-2.07985E-19	-8.61912E-18
28	0.	0.	0.	0.	0.	0.	-1.07599E-23	-1.90145E-21
29	0.	0.	0.	0.	0.	0.	0.	-5.63169E-26
30	0.	0.	0.	0.	0.	0.	0.	0.
POS.	31 THRU POS.	34	SAME AS ABOVE					
POS.	GRP. 49	GRP. 50	GRP. 51	GRP. 52				

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TABLE 5-4 (Continued)

1	0.	0.	0.	0.
	POS.	2 THRU POS.	10	SAME AS ABOVE
11	-2.43313E-02	0.	0.	0.
12	-3.34186E-02	-3.23939E-02	0.	0.
13	-4.56991E-02	-3.46165E-02	-7.51416E-03	0.
14	-8.54049E-01	-1.03779E+00	-1.00021E+00	-1.81687E+00
15	-6.06087E-02	-4.33278E-02	-8.26922E-03	-3.90382E-03
16	-4.15525E-02	-3.52256E-02	-7.50909E-03	-4.00943E-03
17	-2.31201E-02	-1.77136E-02	-4.25975E-03	-2.81175E-03
18	-1.77780E-02	-1.37496E-02	-2.70035E-03	-1.62679E-03
19	-1.20816E-02	-9.07906E-03	-2.04683E-03	-1.23560E-03
20	-1.00431E-02	-6.79009E-03	-1.36243E-03	-8.12773E-04
21	-7.10942E-03	-6.14580E-03	-1.26968E-03	-5.28579E-04
22	-4.84128E-03	-4.51368E-03	-9.94420E-04	-5.66562E-04
23	-1.71331E-03	-2.45650E-03	-7.93682E-04	-4.39223E-04
24	-9.59565E-04	-9.32456E-04	-3.46045E-04	-3.43494E-04
25	-8.42031E-05	-5.40104E-04	-1.44402E-04	-1.38875E-04
26	0.	-3.30957E-05	-8.59790E-05	-6.08014E-05
27	-1.30571E-16	0.	-6.59677E-07	-3.64644E-05
28	-6.51652E-19	-7.31617E-18	0.	-6.69816E-08
29	-1.07105E-22	-2.92237E-20	-6.98846E-20	0.
30	-2.22952E-27	-3.44683E-24	-2.02937E-22	-6.27944E-21
31	0.	-4.83985E-29	-1.48121E-26	-1.50937E-23
32	0.	0.	-1.16490E-31	-8.34837E-28
33	0.	0.	0.	-4.72920E-33
34	0.	0.	0.	0.

TABLE 5-4 (Continued)

CROSS SECTION SET NO. = 3520		URANIUM-235				P0 CORE EDGE			
POS.	GRP. 1	GRP. 2	GRP. 3	GRP. 4	GRP. 5	GRP. 6	GRP. 7	GRP. 8	
1	1.81440E+00	1.59740E+00	1.18640E+00	1.25210E+00	1.30940E+00	1.35960E+00	1.33630E+00	1.32216E+00	
2	6.88644E+00	5.48213E+00	3.73511E+00	3.66097E+00	3.59450E+00	3.58538E+00	3.35503E+00	3.13771E+00	
3	5.05439E+00	6.44741E+00	8.10138E+00	8.68906E+00	8.32439E+00	7.71465E+00	6.91584E+00	6.78324E+00	
4	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 5 THRU POS. 13	SAME AS ABOVE							
14	2.93662E+00	3.73691E+00	4.93298E+00	5.36573E+00	4.95888E+00	4.34913E+00	4.07783E+00	4.28206E+00	
15	0.	1.36039E-02	1.54315E-02	2.67629E-02	5.53210E-02	8.01920E-02	2.27957E-01	3.87585E-01	
16	0.	0.	1.28190E-03	9.85820E-03	3.20300E-02	5.48480E-02	2.33871E-01	4.20580E-01	
17	0.	0.	0.	4.72600E-03	2.95970E-02	8.01150E-02	3.05650E-01	4.81710E-01	
18	0.	0.	0.	0.	1.18210E-02	6.29420E-02	3.60940E-01	5.20820E-01	
19	0.	0.	0.	0.	0.	2.17660E-02	2.35430E-01	5.18920E-01	
20	0.	0.	0.	0.	0.	0.	6.91780E-02	2.90730E-01	
21	0.	0.	0.	0.	0.	0.	0.	7.45710E-02	
22	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 23 THRU POS. 34	SAME AS ABOVE							
POS.	GRP. 9	GRP. 10	GRP. 11	GRP. 12	GRP. 13	GRP. 14	GRP. 15	GRP. 16	
1	1.34446E+00	1.70506E+00	2.31837E+00	3.78252E+00	5.53547E+00	7.40187E+00	1.26489E+01	2.35652E+01	
2	2.96691E+00	3.43988E+00	4.32945E+00	6.75434E+00	1.02005E+01	1.24999E+01	2.09274E+01	3.99437E+01	
3	7.68654E+00	1.04588E+01	1.23122E+01	1.43415E+01	1.60357E+01	1.79023E+01	2.31493E+01	3.40656E+01	
4	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 5 THRU POS. 13	SAME AS ABOVE							
14	5.27002E+00	8.37999E+00	9.87877E+00	1.04682E+01	1.04143E+01	1.04152E+01	1.04347E+01	1.04384E+01	
15	7.16801E-01	8.87079E-01	3.18475E-01	1.12389E-01	9.01313E-02	8.59256E-02	8.52554E-02	6.57277E-02	
16	6.71776E-01	3.57038E-01	1.36469E-01	4.41546E-02	2.55575E-03	4.85520E-04	0.	0.	
17	7.43040E-01	3.95995E-01	8.52791E-02	3.10663E-02	8.60490E-03	1.36075E-04	8.16774E-05	0.	
18	7.27580E-01	5.30859E-01	3.90558E-02	1.38565E-02	1.13768E-02	1.75082E-03	2.13377E-05	8.30131E-06	
19	6.84550E-01	4.64269E-01	7.05661E-02	6.25478E-03	3.95334E-03	4.20782E-03	7.09709E-04	2.85440E-06	
20	6.02960E-01	3.94997E-01	5.80507E-02	1.10822E-02	9.00946E-04	1.45623E-03	1.71242E-03	6.46137E-05	
21	3.02862E-01	3.18129E-01	4.67664E-02	8.95980E-03	1.58466E-03	1.24767E-04	5.85494E-04	1.52111E-04	
22	7.05170E-02	1.47570E-01	3.58794E-02	7.10840E-03	1.27300E-03	2.18849E-04	1.80937E-05	5.50465E-05	
23	0.	3.20163E-02	1.59395E-02	5.38004E-03	1.00416E-03	1.75370E-04	3.16851E-05	1.48447E-06	
24	0.	0.	3.32800E-03	2.36162E-03	7.56231E-04	1.38067E-04	2.53818E-05	2.85513E-06	
25	0.	0.	0.	4.87901E-04	3.30484E-04	1.03768E-04	1.99581E-05	2.27186E-06	
26	0.	0.	0.	0.	6.80071E-05	4.52833E-05	1.49809E-05	1.79229E-06	
27	0.	0.	0.	0.	0.	9.30399E-06	6.52414E-06	1.34726E-06	
28	0.	0.	0.	0.	0.	0.	1.33747E-06	5.98330E-07	
29	0.	0.	0.	0.	0.	0.	0.	1.25321E-07	
30	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 31 THRU POS. 34	SAME AS ABOVE							
POS.	GRP. 17	GRP. 18	GRP. 19	GRP. 20	GRP. 21	GRP. 22	GRP. 23	GRP. 24	
1	3.30311E+01	2.74258E+01	7.46175E+01	5.09852E+01	7.97733E+01	6.20426E+01	8.57120E+01	4.91342E+01	
2	5.00043E+01	4.73065E+01	1.26572E+02	8.01334E+01	1.15341E+02	1.03410E+02	1.24229E+02	7.66018E+01	

TABLE 5-4 (Continued)

3	4.35315E+01	3.79262E+01	9.16673E+01	6.22154E+01	9.51928E+01	7.32128E+01	9.84121E+01	5.97537E+01
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13 SAME AS ABOVE							
14	1.03863E+01	1.01440E+01	1.64710E+01	1.08490E+01	1.48960E+01	1.07910E+01	1.22690E+01	1.02590E+01
15	6.19940E-02	1.14098E-01	3.56440E-01	5.78790E-01	3.81220E-01	5.23460E-01	3.79180E-01	4.31120E-01
16	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 17 THRU POS. 18 SAME AS ABOVE							
19	8.09770E-07	0.	0.	0.	0.	0.	0.	0.
20	4.14753E-07	1.19962E-07	0.	0.	0.	0.	0.	0.
21	0.	7.42119E-08	8.41204E-08	0.	0.	0.	0.	0.
22	0.	0.	5.59741E-08	5.98584E-08	0.	0.	0.	0.
23	0.	0.	0.	4.24899E-08	4.31803E-08	0.	0.	0.
24	1.36726E-07	0.	0.	0.	3.24223E-08	3.15415E-08	0.	0.
25	0.	0.	0.	0.	0.	2.48456E-08	2.32984E-08	0.
26	0.	0.	0.	0.	0.	0.	1.90997E-08	1.73743E-08
27	0.	0.	0.	0.	0.	0.	0.	1.47300E-08
28	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 29 THRU POS. 34 SAME AS ABOVE							
	GRP. 25	GRP. 26	GRP. 27	GRP. 28	GRP. 29	GRP. 30	GRP. 31	GRP. 32
1	9.38692E+01	1.12811E+02	3.08793E+01	6.17679E+01	2.40312E+01	4.54999E+01	1.68122E+01	2.73894E+01
2	9.24914E+01	2.02613E+02	3.18601E+01	6.22251E+01	1.25236E+01	7.40597E+01	3.30946E+01	3.50244E+01
3	1.06729E+02	1.25431E+02	4.14594E+01	7.27177E+01	3.57314E+01	5.67995E+01	2.89119E+01	3.98898E+01
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13 SAME AS ABOVE							
14	1.24230E+01	1.21920E+01	1.02210E+01	1.05780E+01	1.13030E+01	1.09160E+01	1.16890E+01	1.25003E+01
15	3.60510E-01	4.36550E-01	4.28410E-01	3.59160E-01	3.71720E-01	3.97180E-01	3.83600E-01	4.10750E-01
16	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 17 THRU POS. 26 SAME AS ABOVE							
27	1.30648E-08	0.	0.	0.	0.	0.	0.	0.
28	1.13784E-08	9.89200E-09	0.	0.	0.	0.	0.	0.
29	0.	8.80631E-09	7.53091E-09	0.	0.	0.	0.	0.
30	0.	0.	6.82588E-09	5.76064E-09	0.	0.	0.	0.
31	0.	0.	0.	1.37575E-06	4.42218E-09	0.	0.	0.
32	0.	0.	0.	0.	0.	3.40705E-09	0.	0.
33	0.	0.	0.	0.	0.	0.	1.75715E-07	0.
34	0.	0.	0.	0.	0.	0.	0.	0.
	GRP. 33	GRP. 34	GRP. 35	GRP. 36	GRP. 37	GRP. 38	GRP. 39	GRP. 40
1	1.76852E+01	2.13664E+01	6.79183E+01	9.90114E+01	6.20517E+01	8.79110E+01	1.85945E+02	2.36532E+02
2	3.45879E+01	4.17601E+01	1.21581E+02	2.02411E+02	1.35982E+02	1.90764E+02	3.74625E+02	4.61678E+02
3	2.86852E+01	3.23664E+01	7.89183E+01	1.10011E+02	7.30517E+01	9.89110E+01	1.96945E+02	2.47532E+02
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13 SAME AS ABOVE							
14	1.10000E+01	1.10000E+01	1.10000E+01	1.10000E+01	1.10000E+01	1.10000E+01	1.10000E+01	1.10000E+01
15	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 16 THRU POS. 34 SAME AS ABOVE							

TABLE 5-4 (Continued)

POS.	GRP. 41	GRP. 42	GRP. 43	GRP. 44	GRP. 45	GRP. 46	GRP. 47	GRP. 48
1	2.14724E+02	2.14590E+02	2.39692E+02	2.75068E+02	3.13002E+02	3.67740E+02	4.55840E+02	5.62508E+02
2	4.23098E+02	4.36082E+02	4.94965E+02	5.69799E+02	6.48315E+02	7.61769E+02	9.44279E+02	1.16525E+03
3	2.25724E+02	2.25590E+02	2.50692E+02	2.86068E+02	3.24002E+02	3.78740E+02	4.66840E+02	5.73508E+02
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13 SAME AS ABOVE							
14	1.10000E+01	1.10000E+01	1.10000E+01	1.10000E+01	1.10000E+01	1.10000E+01	1.10000E+01	1.10000E+01
15	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 16 THRU POS. 34 SAME AS ABOVE							
POS.	GRP. 49	GRP. 50	GRP. 51	GRP. 52				
1	6.84213E+02	9.22161E+02	1.35805E+03	2.05283E+03				
2	1.41748E+03	1.91026E+03	2.81300E+03	4.25161E+03				
3	6.95213E+02	9.33161E+02	1.36905E+03	2.06383E+03				
4	0.	0.	0.	0.				
	POS. 5 THRU POS. 13 SAME AS ABOVE							
14	1.10000E+01	1.10000E+01	1.10000E+01	1.10000E+01				
15	0.	0.	0.	0.				
	POS. 16 THRU POS. 34 SAME AS ABOVE							

TABLE 5-4 (Continued)

CROSS SECTION SET NO. #3521				URANIUM-235				P1 CORE EDGE	
POS.	GRP. 1	GRP. 2	GRP. 3	GRP. 4	GRP. 5	GRP. 6	GRP. 7	GRP. 8	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 13 SAME AS ABOVE								
14	9.80680E+00	1.17820E+01	1.67880E+01	2.04350E+01	1.58160E+01	1.27220E+01	6.39232E+00	5.22097E+00	
15	0.	-2.16040E+00	-1.73550E+00	-3.57150E+00	-7.54020E+00	-5.01640E+00	-5.06610E+00	-9.54862E-01	
16	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 17 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 9	GRP. 10	GRP. 11	GRP. 12	GRP. 13	GRP. 14	GRP. 15	GRP. 16	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 13 SAME AS ABOVE								
14	4.93090E+00	3.96814E+00	3.22098E+00	1.45468E+00	5.38740E-01	1.55498E-01	1.22579E-01	1.96453E-01	
15	-1.08981E+00	-7.39779E-01	-1.80775E-01	-3.49622E-01	-1.73315E-01	-6.67588E-02	-6.61623E-02	-3.32389E-02	
16	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 17 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 17	GRP. 18	GRP. 19	GRP. 20	GRP. 21	GRP. 22	GRP. 23	GRP. 24	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 13 SAME AS ABOVE								
14	1.95939E-01	3.90410E-01	6.76230E-01	4.40720E-01	5.73340E-01	4.43020E-01	5.03700E-01	4.21210E-01	
15	-1.07114E-01	-1.06599E-01	-3.01070E-01	-5.31170E-01	-3.45170E-01	-4.42150E-01	-3.47990E-01	-3.95650E-01	
16	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 17 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 25	GRP. 26	GRP. 27	GRP. 28	GRP. 29	GRP. 30	GRP. 31	GRP. 32	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 13 SAME AS ABOVE								
14	4.78160E-01	5.00530E-01	3.97790E-01	4.34290E-01	4.35030E-01	4.43460E-01	4.54940E-01	1.06350E-01	
15	-3.30850E-01	-3.68740E-01	-3.93160E-01	-3.07780E-01	-3.41130E-01	-3.35480E-01	-3.47320E-01	-3.52000E-01	
16	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 17 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 33	GRP. 34	GRP. 35	GRP. 36	GRP. 37	GRP. 38	GRP. 39	GRP. 40	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 41	GRP. 42	GRP. 43	GRP. 44	GRP. 45	GRP. 46	GRP. 47	GRP. 48	
1	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 2 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 49	GRP. 50	GRP. 51	GRP. 52					
1	0.	0.	0.	0.					
	POS. 2 THRU POS. 34 SAME AS ABOVE								

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 1

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	1.50600E-01	4.64296E-01	4.81130E-02	4.38977E-01	1.81440E+00	2.54880E+00	1.20424E-02	3.85066E-02
2	0.	0.	0.	0.	6.88644E+00	0.	2.82344E-02	0.
3	1.77742E+00	0.	1.33471E+00	0.	5.05439E+00	0.	1.08541E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13 SAME AS ABOVE							
14	6.60410E-01	1.43574E+00	5.70110E-01	1.36730E+00	2.93662E+00	9.80680E+00	4.86902E-02	1.27558E-01
15	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 16 THRU POS. 35 SAME AS ABOVE							



TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 2

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	7.51300E-02	5.75400E-01	2.88100E-03	2.25787E-01	1.59740E+00	3.34883E+00	8.20503E-03	2.94064E-02
2	0.	0.	0.	0.	5.48213E+00	0.	2.24767E-02	0.
3	1.88442E+00	0.	1.16536E+00	0.	6.44741E+00	0.	1.04593E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
14	8.52085E-01	1.76999E+00	4.82040E-01	1.04940E+00	3.73691E+00	1.17820E+01	4.73964E-02	1.17819E-01
15	9.64093E-02	-4.28527E-02	3.17840E-01	4.92950E-02	1.36039E-02	-2.16040E+00	1.94829E-02	-6.05849E-03
16	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13		SAME AS ABOVE					
	POS. 17 THRU POS. 35		SAME AS ABOVE					

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 3

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	2.99000E-02	6.47143E-01	0.	2.66407E-01	1.18640E+00	4.40550E+00	6.08589E-03	3.64414E-02
2	0.	0.	0.	0.	3.73511E+00	0.	1.53139E-02	0.
3	1.91892E+00	0.	1.19615E+00	0.	8.10138E+00	0.	1.13195E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13 SAME AS ABOVE							
14	9.59144E-01	1.94919E+00	5.34910E-01	1.16360E+00	4.93298E+00	1.67880E+01	5.58687E-02	1.45859E-01
15	1.37203E-01	-4.37885E-02	3.43450E-01	-2.42390E-01	1.54315E-02	-1.73550E+00	2.11779E-02	-2.18210E-02
16	2.00000E-02	0.	3.90460E-02	-9.96640E-02	1.28190E-03	0.	2.42202E-03	-5.97984E-03
17	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 18 THRU POS. 35 SAME AS ABOVE							

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	9.92000E-03	6.39276E-01	0.	2.40563E-01	1.25210E+00	4.29827E+00	5.96618E-03	3.44220E-02
2	0.	0.	0.	0.	3.66097E+00	0.	1.50100E-02	0.
3	2.12169E+00	0.	1.88253E+00	0.	8.68906E+00	0.	1.57223E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
POS. 5 THRU POS. 13	SAME AS ABOVE							
14	1.13418E+00	2.01003E+00	9.08220E-01	1.90360E+00	5.36573E+00	2.04350E+01	8.06892E-02	2.05437E-01
15	1.59873E-01	-7.76246E-03	5.52410E-01	-3.25120E-01	2.67629E-02	-3.57150E+00	3.38459E-02	-3.41791E-02
16	3.00000E-02	0.	5.18260E-02	-1.29650E-01	9.85820E-03	0.	3.26098E-03	-7.77900E-03
17	3.00000E-02	0.	1.25586E-01	0.	4.72600E-03	0.	7.66554E-03	0.
18	0.	0.	0.	0.	0.	0.	0.	0.
POS. 19 THRU POS. 35	SAME AS ABOVE							

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 5

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	2.96000E-03	7.35319E-01	0.	6.43000E-02	1.30940E+00	3.59987E+00	6.13793E-03	2.13381E-02
2	0.	0.	0.	0.	3.59450E+00	0.	1.47374E-02	0.
3	2.41494E+00	0.	2.01800E+00	0.	8.32439E+00	0.	1.64904E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
POS. 5 THRU POS. 13 SAME AS ABOVE								
14	1.47167E+00	2.36545E+00	8.21090E-01	1.84810E+00	4.95888E+00	1.58160E+01	7.50420E-02	1.84484E-01
15	4.97587E-01	-9.22028E-02	8.02360E-01	-7.39580E-01	5.53210E-02	-7.54020E+00	5.02095E-02	-7.56308E-02
16	3.00000E-02	0.	1.67310E-02	-3.92600E-02	3.20300E-02	0.	1.24618E-03	-2.35560E-03
17	6.00000E-02	0.	0.	0.	2.95970E-02	0.	3.43348E-04	0.
18	7.00000E-02	0.	1.51049E-01	0.	1.18210E-02	0.	9.37041E-03	0.
19	0.	0.	0.	0.	0.	0.	0.	0.
POS. 20 THRU POS. 35 SAME AS ABOVE								

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 6

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	4.13000E-04	1.10545E+00	0.	2.18100E-02	1.35960E+00	2.55197E+00	6.44652E-03	1.58618E-02
2	0.	0.	0.	0.	3.58538E+00	0.	1.47001E-02	0.
3	3.18175E+00	0.	1.65986E+00	0.	7.71465E+00	0.	1.43865E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13	SAME AS ABOVE						
14	2.28107E+00	3.45767E+00	6.39190E-01	1.17810E+00	4.34913E+00	1.27220E+01	6.46228E-02	1.35640E-01
15	5.60314E-01	-1.59492E-01	1.05140E+00	-1.28820E+00	8.01920E-02	-5.01640E+00	6.54859E-02	-9.84494E-02
16	7.00000E-02	0.	1.71950E-01	-4.42330E-01	5.48480E-02	0.	1.08009E-02	-2.65398E-02
17	7.00000E-02	0.	0.	0.	8.01150E-02	0.	5.87471E-04	0.
18	9.00000E-02	0.	8.03257E-02	0.	6.29420E-02	0.	5.41060E-03	0.
19	1.00000E-01	0.	7.79267E-02	0.	2.17660E-02	0.	5.13484E-03	0.
20	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 21 THRU POS. 35	SAME AS ABOVE						

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 7

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	3.78639E-04	9.94531E-01	0.	1.96996E-01	1.33630E+00	1.81249E+00	6.27864E-03	2.29307E-02
2	0.	0.	0.	0.	3.35503E+00	0.	1.37556E-02	0.
3	3.07461E+00	0.	1.93662E+00	0.	6.91584E+00	0.	1.56727E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
POS. 5 THRU POS. 13	SAME AS ABOVE							
14	2.57392E+00	3.07275E+00	1.30659E+00	1.04799E+00	4.07783E+00	6.39232E+00	1.04638E-01	1.00457E-01
15	7.50270E-01	-1.41313E-01	1.02067E+00	-1.11267E+00	2.27957E-01	-5.06610E+00	6.49507E-02	-8.80541E-02
16	9.00000E-02	0.	1.45510E-01	-3.67000E-01	2.33871E-01	0.	1.00225E-02	-2.20200E-02
17	2.00000E-01	0.	0.	0.	3.05650E-01	0.	1.99316E-03	0.
18	1.80000E-01	0.	0.	0.	3.60940E-01	0.	2.14585E-03	0.
19	2.10000E-01	0.	1.48877E-01	0.	2.35430E-01	0.	1.06749E-02	0.
20	2.30000E-01	0.	1.17032E-03	0.	6.91780E-02	0.	1.20485E-03	0.
21	0.	0.	0.	0.	0.	0.	0.	0.
POS. 22 THRU POS. 35	SAME AS ABOVE							

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 8

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	4.16237E-04	1.04110E+00	0.	3.34259E-01	1.32216E+00	1.37705E+00	6.05517E-03	2.95535E-02
2	0.	0.	0.	0.	3.13771E+00	0.	1.28646E-02	0.
3	3.37416E+00	0.	2.60744E+00	0.	6.78324E+00	0.	1.97375E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU	POS. 13	SAME AS ABOVE					
14	2.82180E+00	3.20410E+00	1.78404E+00	1.56773E+00	4.28206E+00	5.22097E+00	1.35039E-01	1.27325E-01
15	3.98331E-01	-8.91600E-02	6.30024E-01	-4.57000E-01	3.87585E-01	-9.54862E-01	4.08643E-02	-3.16649E-02
16	6.00000E-02	0.	0.	0.	4.20580E-01	0.	1.94638E-03	0.
17	1.10000E-01	0.	0.	0.	4.81710E-01	0.	2.38201E-03	0.
18	1.20000E-01	0.	0.	0.	5.20820E-01	0.	2.57936E-03	0.
19	1.90000E-01	0.	4.55768E-02	0.	5.18920E-01	0.	5.56518E-03	0.
20	1.80000E-01	0.	5.59595E-02	0.	2.90730E-01	0.	5.21556E-03	0.
21	2.00000E-01	0.	2.63835E-03	0.	7.45710E-02	0.	1.20404E-03	0.
22	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 23 THRU	POS. 35	SAME AS ABOVE					

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 9

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	4.78944E-04	8.25077E-01	0.	3.63462E-01	1.34446E+00	1.39704E+00	6.02628E-03	3.05883E-02
2	0.	0.	0.	0.	2.96691E+00	0.	1.21643E-02	0.
3	4.09855E+00	0.	3.27284E+00	0.	7.68654E+00	0.	2.43562E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13 SAME AS ABOVE							
14	3.71004E+00	2.75602E+00	2.58174E+00	1.58327E+00	5.27002E+00	4.93090E+00	1.90239E-01	1.25410E-01
15	4.56890E-01	-8.08015E-02	8.23402E-01	-5.64956E-01	7.16801E-01	-1.08981E+00	5.40335E-02	-3.86645E-02
16	1.01989E-01	0.	0.	0.	6.71776E-01	0.	3.13164E-03	0.
17	5.00000E-02	0.	0.	0.	7.43040E-01	0.	3.23146E-03	0.
18	1.40000E-01	0.	0.	0.	7.27580E-01	0.	3.50108E-03	0.
19	6.00000E-02	0.	0.	0.	6.84550E-01	0.	3.02865E-03	0.
20	2.30000E-01	0.	3.60374E-02	0.	6.02960E-01	0.	5.48538E-03	0.
21	2.00000E-01	0.	0.	0.	3.02862E-01	0.	1.98173E-03	0.
22	1.80000E-01	0.	1.00855E-03	0.	7.05170E-02	0.	1.01563E-03	0.
23	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 24 THRU POS. 35 SAME AS ABOVE							



TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 10

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	1.90631E-03	2.55023E-01	0.	3.08847E-01	1.70506E+00	1.26246E+00	7.41018E-03	2.46505E-02
2	0.	0.	0.	0.	3.43988E+00	0.	1.41035E-02	0.
3	4.59892E+00	0.	4.03317E+00	0.	1.04588E+01	0.	3.02300E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
POS. 5 THRU POS. 13	SAME AS ABOVE							
14	4.34397E+00	1.02026E+00	3.54330E+00	1.29766E+00	8.37999E+00	3.96814E+00	2.63028E-01	9.79041E-02
15	3.88031E-01	-2.80794E-01	6.91103E-01	-4.92884E-01	8.87079E-01	-7.39779E-01	4.65389E-02	-3.36451E-02
16	9.50549E-02	0.	0.	0.	3.57038E-01	0.	1.81556E-03	0.
17	0.	0.	0.	0.	3.95995E-01	0.	1.62358E-03	0.
18	4.00000E-02	0.	0.	0.	5.30859E-01	0.	2.32452E-03	0.
19	4.00000E-02	0.	0.	0.	4.64269E-01	0.	2.05150E-03	0.
20	1.00000E-02	0.	0.	0.	3.94997E-01	0.	1.73049E-03	0.
21	7.00000E-02	0.	9.75605E-03	0.	3.18129E-01	0.	2.14869E-03	0.
22	5.00000E-02	0.	0.	0.	1.47570E-01	0.	7.90037E-04	0.
23	4.00000E-02	0.	2.20833E-04	0.	3.20163E-02	0.	2.92517E-04	0.
24	0.	0.	0.	0.	0.	0.	0.	0.
POS. 25 THRU POS. 35	SAME AS ABOVE							

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 11

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	3.41203E-03	2.59546E-01	0.	2.57327E-01	2.31837E+00	9.57120E-01	9.85053E-03	2.03241E-02
2	0.	0.	0.	0.	4.32945E+00	0.	1.77507E-02	0.
3	5.01087E+00	0.	4.57197E+00	0.	1.23122E+01	0.	3.43701E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5 THRU POS. 13	SAME AS ABOVE							
14	4.68466E+00	1.02226E+00	3.86318E+00	1.35493E+00	9.87877E+00	3.22098E+00	2.89627E-01	9.82841E-02
15	2.53043E-01	-2.55192E-01	4.89878E-01	-3.71120E-01	3.18475E-01	-1.80775E-01	3.16347E-02	-2.39526E-02
16	0.	0.	0.	0.	1.36469E-01	0.	5.59522E-04	0.
17	0.	0.	0.	0.	8.52791E-02	0.	3.49644E-04	0.
18	0.	0.	0.	0.	3.90558E-02	0.	1.60129E-04	0.
19	0.	0.	0.	0.	7.05661E-02	0.	2.89321E-04	0.
20	0.	0.	0.	0.	5.80507E-02	0.	2.38008E-04	0.
21	0.	0.	0.	0.	4.67664E-02	0.	1.91742E-04	0.
22	0.	0.	6.63815E-04	0.	3.58794E-02	0.	1.86934E-04	0.
23	0.	0.	0.	0.	1.59395E-02	0.	6.53519E-05	0.
24	0.	0.	0.	0.	3.32800E-03	0.	1.36446E-05	0.
25	0.	0.	0.	0.	0.	0.	0.	0.
POS. 26 THRU POS. 35	SAME AS ABOVE							

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 12

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	5.60469E-03	-2.61446E-01	7.24145E-07	2.55155E-01	3.78252E+00	4.27123E-01	1.58834E-02	1.60932E-02
2	0.	0.	0.	0.	6.75434E+00	0.	2.76928E-02	0.
3	4.58998E+00	0.	4.59433E+00	0.	1.43415E+01	0.	3.51797E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13		SAME AS ABOVE					
14	4.51761E+00	-7.27157E-01	3.88825E+00	1.34775E+00	1.04682E+01	1.45468E+00	2.92930E-01	8.41384E-02
15	3.22798E-01	-2.43623E-01	7.08784E-01	-5.82947E-01	1.12389E-01	-3.49622E-01	4.41822E-02	-3.73117E-02
16	0.	0.	0.	0.	4.41546E-02	0.	1.81034E-04	0.
17	0.	0.	0.	0.	3.10663E-02	0.	1.27372E-04	0.
18	0.	0.	0.	0.	1.38565E-02	0.	5.68115E-05	0.
19	0.	0.	0.	0.	6.25478E-03	0.	2.56446E-05	0.
20	0.	0.	0.	0.	1.10822E-02	0.	4.54370E-05	0.
21	0.	0.	0.	0.	8.95980E-03	0.	3.67352E-05	0.
22	0.	0.	0.	0.	7.10840E-03	0.	2.91444E-05	0.
23	0.	0.	3.44141E-05	0.	5.38004E-03	0.	2.41230E-05	0.
24	0.	0.	0.	0.	2.36162E-03	0.	9.68264E-06	0.
25	0.	0.	0.	0.	4.87901E-04	0.	2.00039E-06	0.
26	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 27 THRU POS. 35		SAME AS ABOVE					

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 13

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	5.32298E-03	2.53237E-02	8.71029E-06	2.59288E-01	5.53547E+00	1.57327E-01	2.30703E-02	1.62960E-02
2	0.	0.	0.	0.	1.02005E+01	0.	4.18219E-02	0.
3	1.40339E+00	0.	4.66794E+00	0.	1.60357E+01	0.	3.51370E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
POS. 5 THRU POS. 13	SAME AS ABOVE							
14	1.25277E+00	2.07329E-01	3.95458E+00	1.35840E+00	1.04143E+01	5.38740E-01	2.84609E-01	8.44799E-02
15	6.67710E-02	-5.71722E-02	7.06082E-01	-5.82279E-01	9.01313E-02	-1.73315E-01	4.29815E-02	-3.58589E-02
16	0.	0.	0.	0.	2.55575E-03	0.	1.04786E-05	0.
17	0.	0.	0.	0.	8.60490E-03	0.	3.52801E-05	0.
18	0.	0.	0.	0.	1.13768E-02	0.	4.66451E-05	0.
19	0.	0.	0.	0.	3.95334E-03	0.	1.62087E-05	0.
20	0.	0.	0.	0.	9.00946E-04	0.	3.69388E-06	0.
21	0.	0.	0.	0.	1.58466E-03	0.	6.49711E-06	0.
22	0.	0.	0.	0.	1.27300E-03	0.	5.21930E-06	0.
23	0.	0.	0.	0.	1.00416E-03	0.	4.11706E-06	0.
24	0.	0.	7.25406E-06	0.	7.56231E-04	0.	3.53579E-06	0.
25	0.	0.	0.	0.	3.30484E-04	0.	1.35498E-06	0.
26	0.	0.	0.	0.	6.80071E-05	0.	2.78829E-07	0.
27	0.	0.	0.	0.	0.	0.	0.	0.
POS. 28 THRU POS. 35	SAME AS ABOVE							

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 14

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	2.18265E-03	3.65206E-02	1.02392E-05	2.60733E-01	7.40187E+00	2.97784E-02	3.07019E-02	1.59012E-02
2	0.	0.	0.	0.	1.24999E+01	0.	5.12495E-02	0.
3	1.42108E+00	0.	4.69386E+00	0.	1.79023E+01	0.	3.60635E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13	SAME AS ABOVE						
14	1.32132E+00	1.86906E-01	3.98308E+00	1.32252E+00	1.04152E+01	1.55498E-01	2.86576E-01	8.06801E-02
15	1.45291E-01	-1.31357E-01	7.13354E-01	-5.80535E-01	8.59256E-02	-6.67588E-02	4.36911E-02	-3.55919E-02
16	0.	0.	0.	0.	4.85520E-04	0.	1.99063E-06	0.
17	0.	0.	0.	0.	1.36079E-04	0.	5.57908E-07	0.
18	0.	0.	0.	0.	1.75082E-03	0.	7.17838E-06	0.
19	0.	0.	0.	0.	4.20782E-03	0.	1.72521E-05	0.
20	0.	0.	0.	0.	1.45623E-03	0.	5.97054E-06	0.
21	0.	0.	0.	0.	1.24767E-04	0.	5.11543E-07	0.
22	0.	0.	0.	0.	2.18849E-04	0.	8.97281E-07	0.
23	0.	0.	0.	0.	1.75370E-04	0.	7.19017E-07	0.
24	0.	0.	0.	0.	1.38067E-04	0.	5.66075E-07	0.
25	0.	0.	2.41531E-06	0.	1.03768E-04	0.	5.70367E-07	0.
26	0.	0.	0.	0.	4.52833E-05	0.	1.85662E-07	0.
27	0.	0.	0.	0.	9.30399E-06	0.	3.81464E-08	0.
28	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 29 THRU POS. 35	SAME AS ABOVE						

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 15

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	1.11739E-03	3.48547E-02	1.75929E-05	2.61372E-01	1.26489E+01	2.97800E-02	5.21912E-02	1.59334E-02
2	0.	0.	0.	0.	2.09274E+01	0.	8.58022E-02	0.
3	1.41112E+00	0.	4.70530E+00	0.	2.31493E+01	0.	3.82777E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13	SAME AS ABOVE						
14	1.33478E+00	1.43946E-01	4.15599E+00	1.07051E+00	1.04347E+01	1.22579E-01	2.97080E-01	6.52655E-02
15	9.75741E-02	-7.73441E-02	7.10774E-01	-5.40317E-01	8.52554E-02	-6.61623E-02	4.33570E-02	-3.29764E-02
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	8.16774E-05	0.	3.34877E-07	0.
18	0.	0.	0.	0.	2.13377E-05	0.	8.74845E-08	0.
19	0.	0.	0.	0.	7.09709E-04	0.	2.90981E-06	0.
20	0.	0.	0.	0.	1.71242E-03	0.	7.02093E-06	0.
21	0.	0.	0.	0.	5.85494E-04	0.	2.40053E-06	0.
22	0.	0.	0.	0.	1.80937E-05	0.	7.41842E-08	0.
23	0.	0.	0.	0.	3.16851E-05	0.	1.29909E-07	0.
24	0.	0.	0.	0.	2.53818E-05	0.	1.04065E-07	0.
25	0.	0.	0.	0.	1.99581E-05	0.	8.18282E-08	0.
26	0.	0.	1.69853E-05	0.	1.49809E-05	0.	1.08054E-06	0.
27	0.	0.	0.	0.	6.52414E-06	0.	2.67490E-08	0.
28	0.	0.	0.	0.	1.33747E-06	0.	5.48364E-09	0.
29	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 30 THRU POS. 35	SAME AS ABOVE						

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 16

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	2.07944E-03	3.48513E-02	3.32432E-05	2.61653E-01	2.35652E+01	2.97795E-02	9.69182E-02	1.59502E-02
2	0.	0.	0.	0.	3.99437E+01	0.	1.63769E-01	0.
3	1.41208E+00	0.	4.70980E+00	0.	3.40656E+01	0.	4.27773E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	POS. 5 THRU POS. 13 SAME AS ABOVE							
14	1.33905E+00	2.42439E-01	4.19068E+00	1.68109E+00	1.04384E+01	1.96453E-01	2.99193E-01	1.02568E-01
15	7.52249E-02	-3.93815E-02	5.49292E-01	-2.86391E-01	6.57277E-02	-3.32389E-02	3.35054E-02	-1.74655E-02
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	8.30131E-06	0.	3.40354E-08	0.
19	0.	0.	0.	0.	2.85440E-06	0.	1.17031E-08	0.
20	0.	0.	0.	0.	6.46137E-05	0.	2.64916E-07	0.
21	0.	0.	0.	0.	1.52111E-04	0.	6.23654E-07	0.
22	0.	0.	0.	0.	5.50465E-05	0.	2.25691E-07	0.
23	0.	0.	0.	0.	1.48447E-06	0.	6.08633E-09	0.
24	0.	0.	0.	0.	2.85513E-06	0.	1.17060E-08	0.
25	0.	0.	0.	0.	2.27186E-06	0.	9.31463E-09	0.
26	0.	0.	0.	0.	1.79229E-06	0.	7.34839E-09	0.
27	0.	0.	0.	0.	1.34726E-06	0.	5.52377E-09	0.
28	0.	0.	0.	0.	5.98330E-07	0.	2.45315E-09	0.
29	0.	0.	0.	0.	1.25321E-07	0.	5.13816E-10	0.
30	0.	0.	0.	0.	0.	0.	0.	0.
31	POS. 31 THRU POS. 35 SAME AS ABOVE							

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 17

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	3.39430E-03	3.48635E-02	5.61386E-05	2.61663E-01	3.30311E+01	2.97800E-02	1.35710E-01	1.59509E-02
2	0.	0.	0.	0.	5.00043E+01	0.	2.05018E-01	0.
3	1.41340E+00	0.	4.71005E+00	0.	4.35315E+01	0.	4.66579E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13 SAME AS ABOVE							
14	1.27942E+00	2.30881E-01	3.75677E+00	1.65630E+00	1.03863E+01	1.95939E-01	2.72724E-01	1.01036E-01
15	7.09517E-02	-1.37886E-01	5.19087E-01	-8.96136E-01	6.19940E-02	-1.07114E-01	3.16619E-02	-5.47175E-02
16	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 17 THRU POS. 18 SAME AS ABOVE							
19	0.	0.	0.	0.	8.09770E-07	0.	3.32006E-09	0.
20	0.	0.	0.	0.	4.14753E-07	0.	1.70049E-09	0.
21	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 22 THRU POS. 23 SAME AS ABOVE							
24	0.	0.	0.	0.	1.36726E-07	0.	5.60576E-10	0.
25	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 26 THRU POS. 35 SAME AS ABOVE							



TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 18

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	4.35000E-03	3.48500E-02	7.20000E-05	2.61680E-01	2.74258E+01	2.97800E-02	1.12747E-01	1.59518E-02
2	0.	0.	0.	0.	4.73065E+01	0.	1.93956E-01	0.
3	1.41435E+00	0.	4.71005E+00	0.	3.79262E+01	0.	4.43615E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13 SAME AS ABOVE							
14	1.00206E+00	4.92111E-01	1.90720E+00	2.99510E+00	1.01440E+01	3.90410E-01	1.59730E-01	1.83127E-01
15	1.30584E-01	-1.26290E-01	8.98938E-01	-7.33528E-01	1.14098E-01	-1.06599E-01	5.48873E-02	-4.49160E-02
16	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 17 THRU POS. 19 SAME AS ABOVE							
20	0.	0.	0.	0.	1.19962E-07	0.	4.91843E-10	0.
21	0.	0.	0.	0.	7.42119E-08	0.	3.04269E-10	0.
22	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 23 THRU POS. 35 SAME AS ABOVE							

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 19

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	5.15000E-03	3.48657E-02	8.00000E-05	2.61660E-01	7.46175E+01	4.83533E-02	3.06143E-01	1.60269E-02
2	0.	0.	0.	0.	1.26572E+02	0.	5.18947E-01	0.
3	1.41515E+00	0.	4.71007E+00	0.	9.16673E+01	0.	6.63864E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13	SAME AS ABOVE						
14	1.00206E+00	4.92111E-01	1.91760E+00	2.97190E+00	1.64710E+01	6.76230E-01	1.86295E-01	1.82907E-01
15	4.07943E-01	-3.87561E-01	2.62280E+00	-1.76410E+00	3.56440E-01	-3.01070E-01	1.60339E-01	-1.08514E-01
16	0.	0.	5.42896E-02	-1.37783E-01	0.	0.	3.25738E-03	-8.26697E-03
17	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 18 THRU POS. 20	SAME AS ABOVE						
21	0.	0.	0.	0.	8.41204E-08	0.	3.44894E-10	0.
22	0.	0.	0.	0.	5.59741E-08	0.	2.29494E-10	0.
23	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 24 THRU POS. 35	SAME AS ABOVE						

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 20

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	5.50000E-03	3.48500E-02	9.00000E-05	2.61673E-01	5.09852E+01	3.18500E-02	2.09294E-01	1.59599E-02
2	0.	0.	0.	0.	8.01334E+01	0.	3.28547E-01	0.
3	1.41550E+00	0.	4.71008E+00	0.	6.22154E+01	0.	5.43155E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13 SAME AS ABOVE							
14	1.00206E+00	4.92111E-01	1.90990E+00	2.98900E+00	1.08490E+01	4.40720E-01	1.62783E-01	1.82968E-01
15	4.07943E-01	-3.87514E-01	2.62010E+00	-1.75810E+00	5.78790E-01	-5.31170E-01	1.61088E-01	-1.09098E-01
16	0.	0.	1.79980E-01	-4.45960E-01	0.	0.	1.07988E-02	-2.67576E-02
17	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 18 THRU POS. 21 SAME AS ABOVE							
22	0.	0.	0.	0.	5.98584E-08	0.	2.45419E-10	0.
23	0.	0.	0.	0.	4.24899E-08	0.	1.74209E-10	0.
24	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 25 THRU POS. 35 SAME AS ABOVE							

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP		21							
POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8	
1	6.40000E-03	3.48590E-02	1.04000E-04	2.61657E-01	7.97733E+01	4.37300E-02	3.27284E-01	1.60077E-02	
2	0.	0.	0.	0.	1.15341E+02	0.	4.72898E-01	0.	
3	1.41640E+00	0.	4.71003E+00	0.	9.51928E+01	0.	6.78317E-01	0.	
4	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 5 THRU POS. 13	SAME AS ABOVE							
14	1.00206E+00	4.92111E-01	1.90340E+00	3.00350E+00	1.48960E+01	5.73340E-01	1.78985E-01	1.84382E-01	
15	4.07942E-01	-3.87561E-01	2.63430E+00	-1.78970E+00	3.81220E-01	-3.45170E-01	1.61130E-01	-1.10231E-01	
16	0.	0.	1.72290E-01	-4.28820E-01	0.	0.	1.03374E-02	-2.57292E-02	
17	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 18 THRU POS. 22	SAME AS ABOVE							
23	0.	0.	0.	0.	4.31803E-08	0.	1.77039E-10	0.	
24	0.	0.	0.	0.	3.24223E-08	0.	1.32931E-10	0.	
25	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 26 THRU POS. 35	SAME AS ABOVE							

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 22

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	7.30000E-03	3.48500E-02	1.18000E-04	2.61640E-01	6.20426E+01	3.16767E-02	2.54621E-01	1.59572E-02
2	0.	0.	0.	0.	1.03410E+02	0.	4.23981E-01	0.
3	1.41730E+00	0.	4.71010E+00	0.	7.32128E+01	0.	5.88234E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13	SAME AS ABOVE						
14	1.00206E+00	4.92111E-01	1.91320E+00	2.98170E+00	1.07910E+01	4.43020E-01	1.62743E-01	1.82539E-01
15	4.07942E-01	-3.87534E-01	2.63100E+00	-1.78250E+00	5.23460E-01	-4.42150E-01	1.61516E-01	-1.10197E-01
16	0.	0.	1.65790E-01	-4.14280E-01	0.	0.	9.94740E-03	-2.48568E-02
17	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 18 THRU POS. 23	SAME AS ABOVE						
24	0.	0.	0.	0.	3.15415E-08	0.	1.29320E-10	0.
25	0.	0.	0.	0.	2.48456E-08	0.	1.01867E-10	0.
26	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 27 THRU POS. 35	SAME AS ABOVE						

TABLE 5-4 (Continued)

## CROSS SECTIONS FOR GROUP 23

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	8.20000E-03	3.48590E-02	1.31000E-04	2.61690E-01	8.57120E+01	3.60167E-02	3.51637E-01	1.59780E-02
2	0.	0.	0.	0.	1.24229E+02	0.	5.09338E-01	0.
3	1.41820E+00	0.	4.71013E+00	0.	9.84121E+01	0.	6.91525E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13	SAME AS ABOVE						
14	1.00206E+00	4.92111E-01	1.91020E+00	2.98840E+00	1.22690E+01	5.03700E-01	1.68623E-01	1.83190E-01
15	4.07943E-01	-3.87561E-01	2.62420E+00	-1.76730E+00	3.79180E-01	-3.47990E-01	1.60516E-01	-1.08899E-01
16	0.	0.	1.75530E-01	-4.36030E-01	0.	0.	1.05318E-02	-2.61618E-02
17	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 18 THRU POS. 24	SAME AS ABOVE						
25	0.	0.	0.	0.	2.32964E-08	0.	9.55233E-11	0.
26	0.	0.	0.	0.	1.90997E-08	0.	7.83087E-11	0.
27	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 28 THRU POS. 35	SAME AS ABOVE						

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 24

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	9.30000E-03	3.48590E-02	1.48000E-04	2.61643E-01	4.91342E+01	3.01200E-02	2.01727E-01	1.59511E-02
2	0.	0.	0.	0.	7.66018E+01	0.	3.14067E-01	0.
3	1.41930E+00	0.	4.71014E+00	0.	5.97537E+01	0.	5.33084E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13	SAME AS ABOVE						
14	1.00206E+00	4.92111E-01	1.90830E+00	2.99250E+00	1.02590E+01	4.21210E-01	1.60268E-01	1.83098E-01
15	4.07942E-01	-3.87534E-01	2.62910E+00	-1.77800E+00	4.31120E-01	-3.95650E-01	1.61023E-01	-1.09736E-01
16	0.	0.	1.72580E-01	-4.29480E-01	0.	0.	1.03548E-02	-2.57688E-02
17	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 18 THRU POS. 25	SAME AS ABOVE						
26	0.	0.	0.	0.	1.73743E-08	0.	7.12344E-11	0.
27	0.	0.	0.	0.	1.47300E-08	0.	6.03932E-11	0.
28	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 29 THRU POS. 35	SAME AS ABOVE						

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 25

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	1.06000E-02	3.48750E-02	1.61000E-04	2.61663E-01	9.38692E+01	3.64733E-02	3.85084E-01	1.59784E-02
2	0.	0.	0.	0.	9.24914E+01	0.	3.79215E-01	0.
3	1.42060E+00	0.	4.71016E+00	0.	1.06729E+02	0.	7.25625E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13	SAME AS ABOVE						
14	1.00206E+00	4.92111E-01	1.91450E+00	2.97870E+00	1.24230E+01	4.78160E-01	1.69512E-01	1.82503E-01
15	4.07942E-01	-3.87534E-01	2.62480E+00	-1.76850E+00	3.60510E-01	-3.30850E-01	1.60475E-01	-1.08900E-01
16	0.	0.	1.70700E-01	-4.25330E-01	0.	0.	1.02420E-02	-2.55198E-02
17	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 18 THRU POS. 26	SAME AS ABOVE						
27	0.	0.	0.	0.	1.30648E-08	0.	5.35658E-11	0.
28	0.	0.	0.	0.	1.13784E-08	0.	4.66513E-11	0.
29	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 30 THRU POS. 35	SAME AS ABOVE						



TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 26

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	1.21000E-02	3.48500E-02	1.95000E-04	2.61660E-01	1.12811E+02	3.57900E-02	4.62736E-01	1.59753E-02
2	0.	0.	0.	0.	2.02613E+02	0.	8.30712E-01	0.
3	1.42210E+00	0.	4.71013E+00	0.	1.25431E+02	0.	8.02293E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
14	1.00206E+00	4.92111E-01	1.91160E+00	2.98520E+00	1.21920E+01	5.00530E-01	1.68391E-01	1.82985E-01
15	4.07942E-01	-3.87486E-01	2.62150E+00	-1.76110E+00	4.36550E-01	-3.68740E-01	1.60589E-01	-1.08612E-01
16	0.	0.	1.76890E-01	-4.39070E-01	0.	0.	1.06134E-02	-2.63442E-02
17	0.	0.	0.	0.	0.	0.	0.	0.
28	0.	0.	0.	0.	9.89200E-09	0.	4.05572E-11	0.
29	0.	0.	0.	0.	8.80631E-09	0.	3.61059E-11	0.
30	0.	0.	0.	0.	0.	0.	0.	0.
POS. 5 THRU POS. 13	SAME AS ABOVE							
POS. 18 THRU POS. 27	SAME AS ABOVE							
POS. 31 THRU POS. 35	SAME AS ABOVE							

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 27

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	1.38000E-02	3.48500E-02	2.17000E-04	2.61663E-01	3.08793E+01	3.00033E-02	1.26941E-01	1.59518E-02
2	0.	0.	0.	0.	3.18601E+01	0.	1.30626E-01	0.
3	1.42380E+00	0.	4.71028E+00	0.	4.14594E+01	0.	4.58140E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13 SAME AS ABOVE							
14	1.00206E+00	4.92111E-01	1.91070E+00	2.98730E+00	1.02210E+01	3.97790E-01	1.60256E-01	1.82690E-01
15	4.07943E-01	-3.87561E-01	2.62530E+00	-1.76970E+00	4.28410E-01	-3.93160E-01	1.60784E-01	-1.09228E-01
16	0.	0.	1.74000E-01	-4.32610E-01	0.	0.	1.04400E-02	-2.59566E-02
17	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 18 THRU POS. 28 SAME AS ABOVE							
29	0.	0.	0.	0.	7.53091E-09	0.	3.08767E-11	0.
30	0.	0.	0.	0.	6.82588E-09	0.	2.79861E-11	0.
31	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 32 THRU POS. 35 SAME AS ABOVE							

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 28

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	1.50000E-02	3.48590E-02	2.48000E-04	2.61653E-01	6.17679E+01	3.10533E-02	2.53531E-01	1.59555E-02
2	0.	0.	0.	0.	6.22251E+01	0.	2.55123E-01	0.
3	1.42500E+00	0.	4.71022E+00	0.	7.27177E+01	0.	5.86240E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13 SAME AS ABOVE							
14	1.00206E+00	4.92111E-01	1.90500E+00	3.00010E+00	1.05780E+01	4.34290E-01	1.61377E-01	1.83607E-01
15	4.07943E-01	-3.87561E-01	2.63200E+00	-1.78450E+00	3.59160E-01	-3.07780E-01	1.60902E-01	-1.09766E-01
16	0.	0.	1.73040E-01	-4.30520E-01	0.	0.	1.03824E-02	-2.58312E-02
17	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 18 THRU POS. 29 SAME AS ABOVE							
30	0.	0.	0.	0.	5.76064E-09	0.	2.36186E-11	0.
31	0.	0.	0.	0.	1.37575E-06	0.	5.64059E-09	0.
32	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 33 THRU POS. 35 SAME AS ABOVE							

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 29

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	1.71000E-02	3.48657E-02	2.86000E-04	2.61643E-01	2.40312E+01	3.31833E-02	9.88951E-02	1.59637E-02
2	0.	0.	0.	0.	1.25236E+01	0.	5.13469E-02	0.
3	1.42710E+00	0.	4.71025E+00	0.	3.57314E+01	0.	4.34680E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13 SAME AS ABOVE							
14	1.00206E+00	4.92111E-01	1.91560E+00	2.97630E+00	1.13030E+01	4.35030E-01	1.64986E-01	1.82182E-01
15	4.07942E-01	-3.87534E-01	2.62700E+00	-1.77360E+00	3.71720E-01	-3.41130E-01	1.60653E-01	-1.09249E-01
16	0.	0.	1.67360E-01	-4.17810E-01	0.	0.	1.00416E-02	-2.50686E-02
17	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 18 THRU POS. 30 SAME AS ABOVE							
31	0.	0.	0.	0.	4.42218E-09	0.	1.81309E-11	0.
32	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 33 THRU POS. 35 SAME AS ABOVE							

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 30

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	2.03000E-02	3.48500E-02	3.22000E-04	2.61647E-01	4.54999E+01	3.20467E-02	1.86883E-01	1.59591E-02
2	0.	0.	0.	0.	7.40597E+01	0.	3.03645E-01	0.
3	1.43030E+00	0.	4.71028E+00	0.	5.67995E+01	0.	5.21026E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13	SAME AS ABOVE						
14	1.00206E+00	4.92111E-01	1.90950E+00	2.98990E+00	1.09160E+01	4.43460E-01	1.63033E-01	1.83033E-01
15	4.07943E-01	-3.87514E-01	2.62250E+00	-1.76350E+00	3.97180E-01	-3.35480E-01	1.60488E-01	-1.08619E-01
16	0.	0.	1.77970E-01	-4.41540E-01	0.	0.	1.06782E-02	-2.64924E-02
17	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 18 THRU POS. 31	SAME AS ABOVE						
32	0.	0.	0.	0.	3.40705E-09	0.	1.39689E-11	0.
33	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 34 THRU POS. 35	SAME AS ABOVE						

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 31

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	2.23000E-02	3.48500E-02	3.58000E-04	2.61673E-01	1.68122E+01	3.43133E-02	6.93401E-02	1.59700E-02
2	0.	0.	0.	0.	3.30946E+01	0.	1.35688E-01	0.
3	1.43230E+00	0.	4.71035E+00	0.	2.89119E+01	0.	4.06765E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
POS. 5 THRU POS. 13 SAME AS ABOVE								
14	1.00206E+00	4.92111E-01	1.90500E+00	3.00010E+00	1.16890E+01	4.54940E-01	1.65933E-01	1.83692E-01
15	4.07943E-01	-3.87561E-01	2.63310E+00	-1.78720E+00	3.83600E-01	-3.47320E-01	1.61068E-01	-1.10090E-01
16	0.	0.	1.71860E-01	-4.27870E-01	0.	0.	1.03116E-02	-2.56722E-02
17	0.	0.	0.	0.	0.	0.	0.	0.
POS. 18 THRU POS. 32 SAME AS ABOVE								
33	0.	0.	0.	0.	1.75715E-07	0.	7.20493E-10	0.
34	0.	0.	0.	0.	0.	0.	0.	0.
35	0.	0.	0.	0.	0.	0.	0.	0.

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 32

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	2.52000E-02	3.48470E-02	4.09000E-04	2.61667E-01	2.73894E+01	3.54500E-02	1.12690E-01	1.59743E-02
2	0.	0.	0.	0.	3.50244E+01	0.	1.43600E-01	0.
3	1.43520E+00	0.	4.71038E+00	0.	3.98898E+01	0.	4.51757E-01	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13 SAME AS ABOVE							
14	1.00206E+00	4.92111E-01	1.92520E+00	2.95510E+00	1.25003E+01	1.06350E-01	1.70471E-01	1.79563E-01
15	4.07943E-01	-3.87561E-01	2.61740E+00	-1.75230E+00	4.10750E-01	-3.52000E-01	1.60237E-01	-1.08015E-01
16	0.	0.	1.67360E-01	-4.17760E-01	0.	0.	1.00416E-02	-2.50656E-02
17	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 18 THRU POS. 35 SAME AS ABOVE							

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 33

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	2.73535E-02	0.	4.11734E-04	4.74334E-01	1.76852E+01	0.	7.29362E-02	2.84601E-02
2	0.	0.	0.	0.	3.45879E+01	0.	1.41810E-01	0.
3	1.42735E+00	0.	4.85061E+00	0.	2.86852E+01	0.	4.14228E-01	0.
4	0.	0.	1.17955E-41	-1.03171E-40	0.	0.	7.07728E-43	-6.19026E-42
5	0.	0.	3.89718E-39	-2.70538E-38	0.	0.	2.33831E-40	-1.62323E-39
6	0.	0.	4.71656E-36	-2.47806E-35	0.	0.	2.82993E-37	-1.48684E-36
7	0.	0.	6.33786E-34	-2.92281E-33	0.	0.	3.80271E-35	-1.75369E-34
8	0.	0.	3.98852E-30	-1.37201E-29	0.	0.	2.39311E-31	-8.23203E-31
9	0.	0.	4.53793E-21	-1.05042E-20	0.	0.	2.72276E-22	-6.30254E-22
10	0.	0.	1.99050E-14	-4.25299E-14	0.	0.	1.19430E-15	-2.55179E-15
11	0.	0.	4.73820E-11	-8.14889E-11	0.	0.	2.84282E-12	-4.88933E-12
12	0.	0.	4.64071E-07	-3.48554E-07	0.	0.	2.78442E-08	-2.09133E-08
13	0.	0.	6.12404E-03	5.38829E-03	0.	0.	3.67442E-04	3.23297E-04
14	1.40000E+00	0.	1.77351E+00	2.99309E+00	1.10000E+01	0.	1.56690E-01	1.79586E-01
15	4.07943E-01	-3.87570E-01	1.71264E+00	-4.29657E-01	0.	0.	1.04268E-01	-2.72134E-02
16	0.	0.	1.58472E-01	-3.76682E-01	0.	0.	9.50834E-03	-2.26009E-02
17	0.	0.	0.	0.	0.	0.	0.	0.

POS. 18 THRU POS. 35 SAME AS ABOVE



TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 34

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8	
1	2.98187E-02	0.	4.45918E-04	2.71364E-01	2.13664E+01	0.	8.80409E-02	1.62818E-02	
2	0.	0.	0.	0.	4.17601E+01	0.	1.71217E-01	0.	
3	1.42982E+00	0.	4.58338E+00	0.	3.23664E+01	0.	4.13297E-01	0.	
4	0.	0.	1.13019E-35	-9.43337E-35	0.	0.	6.78112E-37	-5.66002E-36	
5	0.	0.	2.35985E-33	-1.43611E-32	0.	0.	1.41591E-34	-8.61669E-34	
6	0.	0.	4.28957E-31	-2.12000E-30	0.	0.	2.57374E-32	-1.27200E-31	
7	0.	0.	2.36997E-28	-9.27848E-28	0.	0.	1.42198E-29	-5.56709E-29	
8	0.	0.	1.97118E-26	-6.99727E-26	0.	0.	1.18271E-27	-4.19836E-27	
9	0.	0.	4.41019E-23	-1.25703E-22	0.	0.	2.64611E-24	-7.54216E-24	
10	0.	0.	4.38833E-15	-8.90688E-15	0.	0.	2.63300E-16	-5.34413E-16	
11	0.	0.	3.78730E-09	-5.64749E-09	0.	0.	2.27238E-10	-3.38850E-10	
12	0.	0.	4.65262E-06	-3.17992E-06	0.	0.	2.79157E-07	-1.90795E-07	
13	0.	0.	2.39127E-02	2.66786E-02	0.	0.	1.43476E-03	1.60071E-03	
14	1.40000E+00	0.	1.68789E+00	2.31920E+00	1.10000E+01	0.	1.51553E-01	1.39152E-01	
15	0.	0.	1.94428E+00	3.70999E-02	0.	0.	1.16657E-01	2.22599E-03	
16	0.	0.	8.51640E-01	-1.25020E+00	0.	0.	5.10984E-02	-7.50118E-02	
17	0.	0.	2.73671E-02	-8.02837E-02	0.	0.	1.64203E-03	-4.81702E-03	
18	0.	0.	0.	0.	0.	0.	0.	0.	
POS.	19 THRU POS.	34	SAME AS ABOVE						
35	0.	0.	6.12404E-03	5.38829E-03	0.	0.	3.67442E-04	3.23297E-04	

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 35

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	3.27553E-02	0.	4.86977E-04	2.61826E-01	6.79183E+01	0.	2.78823E-01	1.57096E-02
2	0.	0.	0.	0.	1.21581E+02	0.	4.98483E-01	0.
3	1.43276E+00	0.	4.52947E+00	0.	7.89183E+01	0.	6.00841E-01	0.
4	0.	0.	2.58093E-30	-1.83703E-29	0.	0.	1.54856E-31	-1.10222E-30
5	0.	0.	5.46433E-29	-3.30666E-28	0.	0.	3.27860E-30	-1.98399E-29
6	0.	0.	6.64270E-27	-3.02827E-26	0.	0.	3.98562E-28	-1.81696E-27
7	0.	0.	7.43498E-25	-2.85238E-24	0.	0.	4.46099E-26	-1.71143E-25
8	0.	0.	2.17865E-22	-6.98544E-22	0.	0.	1.30719E-23	-4.19126E-23
9	0.	0.	1.22526E-20	-3.67296E-20	0.	0.	7.35157E-22	-2.20377E-21
10	0.	0.	1.19211E-17	-3.01869E-17	0.	0.	7.15265E-19	-1.81121E-18
11	0.	0.	1.71215E-10	-2.89375E-10	0.	0.	1.02729E-11	-1.73625E-11
12	0.	0.	4.51188E-05	-2.07133E-05	0.	0.	2.70713E-06	-1.24280E-06
13	0.	0.	3.72445E-02	3.49163E-02	0.	0.	2.23467E-03	2.09498E-03
14	1.40000E+00	0.	1.74869E+00	2.21831E+00	1.10000E+01	0.	1.55201E-01	1.33099E-01
15	0.	0.	1.90388E+00	-8.68152E-02	0.	0.	1.14233E-01	-5.20891E-03
16	0.	0.	9.11447E-01	-1.16764E+00	0.	0.	5.46868E-02	-7.00581E-02
17	0.	0.	1.99360E-01	-4.35010E-01	0.	0.	1.19616E-02	-2.61006E-02
18	0.	0.	1.71124E-03	-5.67105E-03	0.	0.	1.02674E-04	-3.40263E-04
19	0.	0.	0.	0.	0.	0.	0.	0.
POS.	20 THRU	POS.	34	SAME AS ABOVE				
35	0.	0.	2.39131E-02	2.66782E-02	0.	0.	1.43479E-03	1.60069E-03

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 36

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	3.53772E-02	0.	5.28422E-04	2.31050E-01	9.90114E+01	0.	4.06281E-01	1.38630E-02
2	0.	0.	0.	0.	2.02411E+02	0.	8.29885E-01	0.
3	1.43538E+00	0.	4.47309E+00	0.	1.10011E+02	0.	7.24915E-01	0.
4	0.	0.	1.19263E-27	-8.26378E-27	0.	0.	7.15576E-29	-4.95827E-28
5	0.	0.	3.07520E-26	-1.73954E-25	0.	0.	1.84512E-27	-1.04373E-26
6	0.	0.	5.29904E-25	-2.58341E-24	0.	0.	3.17943E-26	-1.55005E-25
7	0.	0.	4.51705E-23	-1.71293E-22	0.	0.	2.71023E-24	-1.02776E-23
8	0.	0.	2.22604E-20	-6.46301E-20	0.	0.	1.33562E-21	-3.87780E-21
9	0.	0.	1.15722E-17	-3.23288E-17	0.	0.	6.94335E-19	-1.93973E-18
10	0.	0.	8.62226E-16	-2.34055E-15	0.	0.	5.17336E-17	-1.40433E-16
11	0.	0.	3.73261E-13	-4.62293E-13	0.	0.	2.23956E-14	-2.77376E-14
12	0.	0.	2.09185E-07	-2.31188E-07	0.	0.	1.25511E-08	-1.38713E-08
13	0.	0.	2.71947E-02	1.54230E-02	0.	0.	1.63168E-03	9.25381E-04
14	1.40000E+00	0.	1.52956E+00	2.06035E+00	1.10000E+01	0.	1.42054E-01	1.23621E-01
15	0.	0.	1.50346E+00	9.97229E-02	0.	0.	9.02074E-02	5.98337E-03
16	0.	0.	6.84778E-01	-8.51153E-01	0.	0.	4.10867E-02	-5.10692E-02
17	0.	0.	1.81448E-01	-3.50342E-01	0.	0.	1.08889E-02	-2.10205E-02
18	0.	0.	1.89682E-02	-4.91315E-02	0.	0.	1.13809E-03	-2.94789E-03
19	0.	0.	3.82712E-05	-1.38953E-04	0.	0.	2.29627E-06	-8.33721E-06
20	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 21 THRU POS. 34		SAME AS ABOVE					
35	0.	0.	3.72491E-02	3.49131E-02	0.	0.	2.23495E-03	2.09479E-03

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 37

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	3.99805E-02	0.	5.95770E-04	2.32328E-01	6.20517E+01	0.	2.54808E-01	1.39397E-02
2	0.	0.	0.	0.	1.35982E+02	0.	5.57527E-01	0.
3	1.43998E+00	0.	4.66878E+00	0.	7.30517E+01	0.	5.85179E-01	0.
4	0.	0.	9.70710E-16	-2.60579E-15	0.	0.	5.82426E-17	-1.56347E-16
5	0.	0.	1.76190E-14	-4.42273E-14	0.	0.	1.05714E-15	-2.65964E-15
6	0.	0.	2.97568E-13	-1.58727E-13	0.	0.	1.78541E-14	-9.52363E-15
7	0.	0.	1.03037E-12	-2.70212E-13	0.	0.	6.18220E-14	-1.62127E-14
8	0.	0.	2.74806E-12	-1.85771E-12	0.	0.	1.64884E-13	-1.11462E-13
9	0.	0.	8.76453E-12	-1.54238E-11	0.	0.	5.25872E-13	-9.25430E-13
10	0.	0.	1.36670E-10	-2.78644E-10	0.	0.	8.20019E-12	-1.67186E-11
11	0.	0.	2.05102E-09	-3.55665E-09	0.	0.	1.23061E-10	-2.13399E-10
12	0.	0.	1.51231E-07	-1.87409E-07	0.	0.	9.07386E-09	-1.12446E-08
13	0.	0.	2.93493E-02	1.32396E-03	0.	0.	1.76096E-03	7.94374E-05
14	1.40000E+00	0.	2.90597E+00	1.99672E+00	1.10000E+01	0.	2.24638E-01	1.19803E-01
15	0.	0.	2.52401E+00	-7.64665E-01	0.	0.	1.51441E-01	-4.58799E-02
16	0.	0.	1.17721E+00	-1.39552E+00	0.	0.	7.06326E-02	-8.37312E-02
17	0.	0.	2.94332E-01	-5.57638E-01	0.	0.	1.76599E-02	-3.34583E-02
18	0.	0.	3.93235E-02	-8.86782E-02	0.	0.	2.35941E-03	-5.32069E-03
19	0.	0.	2.15524E-03	-6.09666E-03	0.	0.	1.29314E-04	-3.65799E-04
20	0.	0.	1.12730E-06	-4.37668E-06	0.	0.	6.76381E-08	-2.62601E-07
21	0.	0.	0.	0.	0.	0.	0.	0.
POS.	22 THRU POS.	34	SAME AS ABOVE					
35	0.	0.	2.72399E-02	1.54023E-02	0.	0.	1.63439E-03	9.24137E-04

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 38

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	4.95893E-02	0.	7.42951E-04	2.27261E-01	8.79110E+01	0.	3.60844E-01	1.36357E-02
2	0.	0.	0.	0.	1.90764E+02	0.	7.82132E-01	0.
3	1.44959E+00	0.	4.64915E+00	0.	9.89110E+01	0.	6.90028E-01	0.
4	0.	0.	1.51945E-08	-1.18906E-08	0.	0.	9.11671E-10	-7.13438E-10
5	0.	0.	3.12394E-08	-3.02155E-08	0.	0.	1.87436E-09	-1.81293E-09
6	0.	0.	8.88025E-08	-8.39124E-08	0.	0.	5.32815E-09	-5.03475E-09
7	0.	0.	2.18328E-07	-2.35659E-07	0.	0.	1.30997E-08	-1.41395E-08
8	0.	0.	5.42381E-07	-6.41452E-07	0.	0.	3.25429E-08	-3.84871E-08
9	0.	0.	2.51995E-06	-3.16628E-06	0.	0.	1.51197E-07	-1.89977E-07
10	0.	0.	1.92551E-05	-2.38636E-05	0.	0.	1.15531E-06	-1.43181E-06
11	0.	0.	3.25640E-04	-2.80443E-04	0.	0.	1.95384E-05	-1.68266E-05
12	0.	0.	2.65812E-03	-2.03243E-03	0.	0.	1.59487E-04	-1.21946E-04
13	0.	0.	1.14777E-01	-3.85277E-02	0.	0.	6.88660E-03	-2.31166E-03
14	1.40000E+00	0.	3.61376E+00	1.53922E+00	1.10000E+01	0.	2.67105E-01	9.23529E-02
15	0.	0.	1.65474E+00	-1.19234E+00	0.	0.	9.92841E-02	-7.15406E-02
16	0.	0.	3.78200E-01	-6.31420E-01	0.	0.	2.26920E-02	-3.78852E-02
17	0.	0.	7.56622E-02	-1.63570E-01	0.	0.	4.53973E-03	-9.81420E-03
18	0.	0.	5.93561E-03	-1.48877E-02	0.	0.	3.56137E-04	-8.93264E-04
19	0.	0.	2.00902E-04	-5.34438E-04	0.	0.	1.20541E-05	-3.20663E-05
20	0.	0.	2.61372E-06	-8.53080E-06	0.	0.	1.56823E-07	-5.11848E-07
21	0.	0.	0.	0.	0.	0.	0.	0.
22	POS. 22 THRU POS. 34	SAME AS ABOVE						
35	0.	0.	2.93495E-02	1.32372E-03	0.	0.	1.76097E-03	7.94235E-05

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 39

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8	
1	6.11332E-02	0.	9.18212E-04	2.28442E-01	1.85945E+02	0.	7.62772E-01	1.37065E-02	
2	0.	0.	0.	0.	3.74625E+02	0.	1.53596E+00	0.	
3	1.46113E+00	0.	4.65578E+00	0.	1.96945E+02	0.	1.09234E+00	0.	
4	0.	0.	8.80860E-07	-7.32993E-07	0.	0.	5.28516E-08	-4.39796E-08	
5	0.	0.	1.27098E-06	-1.22496E-06	0.	0.	7.62589E-08	-7.34977E-08	
6	0.	0.	2.49602E-06	-2.79085E-06	0.	0.	1.49761E-07	-1.67451E-07	
7	0.	0.	6.47792E-06	-8.04292E-06	0.	0.	3.88675E-07	-4.82575E-07	
8	0.	0.	1.89501E-05	-2.37350E-05	0.	0.	1.13701E-06	-1.42410E-06	
9	0.	0.	7.61356E-05	-7.41064E-05	0.	0.	4.56814E-06	-4.44638E-06	
10	0.	0.	3.91808E-04	-3.35623E-04	0.	0.	2.35085E-05	-2.01374E-05	
11	0.	0.	2.24730E-03	-1.86344E-03	0.	0.	1.34838E-04	-1.11807E-04	
12	0.	0.	2.46392E-02	-1.71327E-02	0.	0.	1.47835E-03	-1.02796E-03	
13	0.	0.	2.54644E-01	-1.20327E-01	0.	0.	1.52787E-02	-7.21965E-03	
14	1.40000E+00	0.	3.20337E+00	1.71524E+00	1.10000E+01	0.	2.42482E-01	1.02914E-01	
15	0.	0.	7.02525E-01	-5.17455E-01	0.	0.	4.21515E-02	-3.10473E-02	
16	0.	0.	6.40245E-02	-9.80707E-02	0.	0.	3.84147E-03	-5.88424E-03	
17	0.	0.	3.46507E-03	-5.81046E-03	0.	0.	2.07904E-04	-3.48628E-04	
18	0.	0.	4.98286E-05	-1.41991E-04	0.	0.	2.98972E-06	-8.51944E-06	
19	0.	0.	6.10412E-07	-1.98043E-06	0.	0.	3.66247E-08	-1.18826E-07	
20	0.	0.	2.36572E-09	-8.60541E-09	0.	0.	1.41943E-10	-5.16324E-10	
21	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 22 THRU POS. 34		SAME AS ABOVE						
35	0.	0.	1.14777E-01	-3.85278E-02	0.	0.	6.88661E-03	-2.31167E-03	

TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 40

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	6.85945E-02	0.	1.02327E-03	2.24991E-01	2.36532E+02	0.	9.70194E-01	1.34995E-02
2	0.	0.	0.	0.	4.61678E+02	0.	1.89288E+00	0.
3	1.46859E+00	0.	4.66514E+00	0.	2.47532E+02	0.	1.30032E+00	0.
4	0.	0.	3.40443E-06	-2.26953E-06	0.	0.	2.04286E-07	-1.36172E-07
5	0.	0.	3.85377E-06	-3.97744E-06	0.	0.	2.31226E-07	-2.38646E-07
6	0.	0.	6.10749E-06	-6.94809E-06	0.	0.	3.66449E-07	-4.16886E-07
7	0.	0.	1.56007E-05	-1.76121E-05	0.	0.	9.36041E-07	-1.05673E-06
8	0.	0.	6.98710E-05	-6.04649E-05	0.	0.	4.19226E-06	-3.62789E-06
9	0.	0.	2.14041E-04	-1.70002E-04	0.	0.	1.28425E-05	-1.02001E-05
10	0.	0.	4.57149E-04	-3.86895E-04	0.	0.	2.74289E-05	-2.32137E-05
11	0.	0.	1.81051E-03	-1.49100E-03	0.	0.	1.08691E-04	-8.94603E-05
12	0.	0.	1.04766E-02	-8.31330E-03	0.	0.	6.28599E-04	-4.98798E-04
13	0.	0.	1.58184E-01	-8.43774E-02	0.	0.	9.49105E-03	-5.06265E-03
14	1.40000E+00	0.	2.89643E+00	1.85768E+00	1.10000E+01	0.	2.24066E-01	1.11461E-01
15	0.	0.	5.38081E-01	-3.18117E-01	0.	0.	3.22848E-02	-1.90870E-02
16	0.	0.	1.39345E-01	-1.39815E-01	0.	0.	8.36068E-03	-8.38891E-03
17	0.	0.	7.90430E-03	-1.36672E-02	0.	0.	4.74258E-04	-8.20034E-04
18	0.	0.	6.95569E-05	-1.96991E-04	0.	0.	4.17341E-06	-1.18194E-05
19	0.	0.	5.46771E-07	-1.76202E-06	0.	0.	3.28063E-08	-1.05721E-07
20	0.	0.	3.01814E-09	-1.16566E-08	0.	0.	1.81088E-10	-6.99398E-10
21	0.	0.	4.56757E-12	-2.11379E-11	0.	0.	2.74054E-13	-1.26828E-12
22	0.	0.	0.	0.	0.	0.	0.	0.
23	POS. 23 THRU POS. 34	SAME AS ABOVE	2.57303E-01	-1.22360E-01	0.	0.	1.54382E-02	-7.34159E-03

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 41

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	7.57354E-02	0.	1.13268E-03	2.18508E-01	2.14724E+02	0.	8.80819E-01	1.31105E-02
2	0.	0.	0.	0.	4.23098E+02	0.	1.73470E+00	0.
3	1.47574E+00	0.	4.67123E+00	0.	2.25724E+02	0.	1.21130E+00	0.
4	0.	0.	9.36946E-05	-3.94191E-05	0.	0.	5.62167E-06	-2.36514E-06
5	0.	0.	1.22745E-04	-6.68458E-05	0.	0.	7.36472E-06	-4.01075E-06
6	0.	0.	1.97667E-04	-1.22270E-04	0.	0.	1.18600E-05	-7.33623E-06
7	0.	0.	2.87304E-04	-1.95556E-04	0.	0.	1.72382E-05	-1.17333E-05
8	0.	0.	4.87923E-04	-3.71276E-04	0.	0.	2.92754E-05	-2.22766E-05
9	0.	0.	1.09001E-03	-8.89017E-04	0.	0.	6.54004E-05	-5.33410E-05
10	0.	0.	2.61389E-03	-2.17000E-03	0.	0.	1.56833E-04	-1.30200E-04
11	0.	0.	6.09465E-03	-5.12234E-03	0.	0.	3.65679E-04	-3.07340E-04
12	0.	0.	2.76119E-02	-2.17769E-02	0.	0.	1.65672E-03	-1.30661E-03
13	0.	0.	2.28899E-01	-1.45426E-01	0.	0.	1.37340E-02	-8.72556E-03
14	1.40000E+00	0.	3.42844E+00	1.55546E+00	1.10000E+01	0.	2.55986E-01	9.33274E-02
15	0.	0.	8.97760E-01	-5.47935E-01	0.	0.	5.38666E-02	-3.28761E-02
16	0.	0.	4.60238E-01	-3.54462E-01	0.	0.	2.76143E-02	-2.12677E-02
17	0.	0.	1.10514E-01	-1.29143E-01	0.	0.	6.63085E-03	-7.74860E-03
18	0.	0.	5.01740E-03	-8.08703E-03	0.	0.	3.01044E-04	-4.85222E-04
19	0.	0.	6.04950E-06	-1.80336E-05	0.	0.	3.62970E-07	-1.08202E-06
20	0.	0.	6.26519E-08	-2.20519E-07	0.	0.	3.75911E-09	-1.32311E-08
21	0.	0.	2.30513E-10	-1.00223E-09	0.	0.	1.38308E-11	-6.01340E-11
22	0.	0.	2.19231E-13	-1.17547E-12	0.	0.	1.31538E-14	-7.05285E-14
23	0.	0.	0.	0.	0.	0.	0.	0.
POS.	24 THRU POS.	34	SAME AS ABOVE					
35	0.	0.	1.83149E-01	-1.01791E-01	0.	0.	1.09889E-02	-6.10744E-03

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 42

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	8.51710E-02	0.	1.27815E-03	2.05482E-01	2.14590E+02	0.	8.80315E-01	1.23289E-02
2	0.	0.	0.	0.	4.36082E+02	0.	1.78794E+00	0.
3	1.48517E+00	0.	4.66567E+00	0.	2.25590E+02	0.	1.21046E+00	0.
4	0.	0.	9.03819E-04	-2.06420E-04	0.	0.	5.42292E-05	-1.23852E-05
5	0.	0.	6.33161E-04	-2.47539E-04	0.	0.	3.79897E-05	-1.48523E-05
6	0.	0.	6.22336E-04	-3.36332E-04	0.	0.	3.73402E-05	-2.01799E-05
7	0.	0.	7.79200E-04	-5.18351E-04	0.	0.	4.67520E-05	-3.11010E-05
8	0.	0.	1.11780E-03	-8.17886E-04	0.	0.	6.70580E-05	-4.90732E-05
9	0.	0.	2.19049E-03	-1.70439E-03	0.	0.	1.31429E-04	-1.02264E-04
10	0.	0.	4.83169E-03	-4.02333E-03	0.	0.	2.89902E-04	-2.41400E-04
11	0.	0.	1.16738E-02	-9.98073E-03	0.	0.	7.00429E-04	-5.98844E-04
12	0.	0.	3.31599E-02	-2.71941E-02	0.	0.	1.98959E-03	-1.63165E-03
13	0.	0.	1.93228E-01	-1.34052E-01	0.	0.	1.15937E-02	-8.04310E-03
14	1.40000E+00	0.	3.51621E+00	1.46988E+00	1.10000E+01	0.	2.61253E-01	8.81927E-02
15	0.	0.	5.42190E-01	-3.76411E-01	0.	0.	3.25314E-02	-2.25847E-02
16	0.	0.	2.79675E-01	-2.25542E-01	0.	0.	1.67805E-02	-1.35325E-02
17	0.	0.	1.82751E-01	-1.59042E-01	0.	0.	1.09650E-02	-9.54250E-03
18	0.	0.	2.92664E-02	-4.11959E-02	0.	0.	1.75598E-03	-2.47175E-03
19	0.	0.	1.71065E-03	-1.88292E-03	0.	0.	1.02639E-04	-1.12975E-04
20	0.	0.	9.11996E-08	-2.89525E-07	0.	0.	5.47198E-09	-1.73715E-08
21	0.	0.	9.76655E-10	-4.10825E-09	0.	0.	5.85993E-11	-2.46495E-10
22	0.	0.	1.91906E-12	-1.05102E-11	0.	0.	1.15144E-13	-6.30612E-13
23	0.	0.	8.71806E-16	-6.14471E-15	0.	0.	5.23084E-17	-3.68682E-16
24	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 25 THRU POS. 34		SAME AS ABOVE					
35	0.	0.	2.41643E-01	-1.55627E-01	0.	0.	1.44986E-02	-9.33760E-03

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 43

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	9.63245E-02	0.	1.45103E-03	1.67692E-01	2.39692E+02	0.	9.83274E-01	1.00615E+02
2	0.	0.	0.	0.	4.94965E+02	0.	2.02936E+00	0.
3	1.49632E+00	0.	4.70380E+00	0.	2.50692E+02	0.	1.31569E+00	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	3.25868E-03	-1.02009E-03	0.	0.	1.95521E-04	-6.12053E-05
6	0.	0.	2.71700E-03	-1.18692E-03	0.	0.	1.63020E-04	-7.12149E-05
7	0.	0.	3.09541E-03	-1.77071E-03	0.	0.	1.85725E-04	-1.06243E-04
8	0.	0.	3.92263E-03	-2.71091E-03	0.	0.	2.35358E-04	-1.62655E-04
9	0.	0.	5.24752E-03	-4.05009E-03	0.	0.	3.14851E-04	-2.43005E-04
10	0.	0.	1.01988E-02	-8.48353E-03	0.	0.	6.11930E-04	-5.09012E-04
11	0.	0.	2.90847E-02	-2.43547E-02	0.	0.	1.74508E-03	-1.46128E-03
12	0.	0.	7.82465E-02	-6.48015E-02	0.	0.	4.69479E-03	-3.88809E-03
13	0.	0.	2.68709E-01	-2.03395E-01	0.	0.	1.61225E-02	-1.22037E-02
14	1.40000E+00	0.	3.83943E+00	1.17428E+00	1.10000E+01	0.	2.80546E-01	7.04567E-02
15	0.	0.	5.40068E-01	-3.99214E-01	0.	0.	3.24041E-02	-2.39529E-02
16	0.	0.	2.64829E-01	-2.17668E-01	0.	0.	1.58898E-02	-1.30601E-02
17	0.	0.	1.76911E-01	-1.51312E-01	0.	0.	1.06146E-02	-9.07874E-03
18	0.	0.	1.01155E-01	-9.80172E-02	0.	0.	6.06929E-03	-5.88103E-03
19	0.	0.	1.42457E-02	-1.99438E-02	0.	0.	8.54744E-04	-1.19663E-03
20	0.	0.	1.10721E-03	-7.69176E-04	0.	0.	6.64323E-05	-4.61506E-05
21	0.	0.	1.77991E-09	-7.25225E-09	0.	0.	1.06795E-10	-4.35135E-10
22	0.	0.	3.13121E-11	-1.58615E-10	0.	0.	1.87872E-12	-9.51690E-12
23	0.	0.	3.77923E-14	-2.57989E-13	0.	0.	2.26754E-15	-1.54793E-14
24	0.	0.	9.68671E-18	-8.69370E-17	0.	0.	5.81203E-19	-5.21622E-18
25	0.	0.	0.	0.	0.	0.	0.	0.
POS.	26 THRU POS.	34	SAME AS ABOVE					
35	0.	0.	2.23045E-01	-1.57658E-01	0.	0.	1.33827E-02	-9.45951E-03

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 44

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	1.07834E-01	0.	1.63237E-03	1.45101E-01	2.75068E+02	0.	1.12836E+00	8.70608E-03
2	0.	0.	0.	0.	5.69799E+02	0.	2.33618E+00	0.
3	1.50783E+00	0.	4.72814E+00	0.	2.86068E+02	0.	1.46223E+00	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	4.91872E-03	-1.59104E-03	0.	0.	2.95123E-04	-9.18626E-05
7	0.	0.	3.87805E-03	-1.77326E-03	0.	0.	2.32683E-04	-1.06396E-04
8	0.	0.	3.64524E-03	-2.29141E-03	0.	0.	2.18714E-04	-1.37485E-04
9	0.	0.	5.27225E-03	-3.94116E-03	0.	0.	3.16335E-04	-2.36470E-04
10	0.	0.	8.12403E-03	-6.59228E-03	0.	0.	4.87442E-04	-3.95537E-04
11	0.	0.	1.96265E-02	-1.62612E-02	0.	0.	1.17759E-03	-9.75674E-04
12	0.	0.	4.94159E-02	-4.20746E-02	0.	0.	2.96496E-03	-2.52448E-03
13	0.	0.	1.93229E-01	-1.50271E-01	0.	0.	1.15937E-02	-9.01623E-03
14	1.40000E+00	0.	3.80848E+00	1.16347E+00	1.10000E+01	0.	2.78789E-01	6.98083E-02
15	0.	0.	2.84301E-01	-2.22096E-01	0.	0.	1.70581E-02	-1.33257E-02
16	0.	0.	1.35093E-01	-1.13066E-01	0.	0.	8.10556E-03	-6.78397E-03
17	0.	0.	8.48510E-02	-7.17746E-02	0.	0.	5.09106E-03	-4.30648E-03
18	0.	0.	6.52145E-02	-5.43108E-02	0.	0.	3.91287E-03	-3.25865E-03
19	0.	0.	2.44924E-02	-2.73741E-02	0.	0.	1.46954E-03	-1.64245E-03
20	0.	0.	3.91349E-03	-5.16864E-03	0.	0.	2.34810E-04	-3.10119E-04
21	0.	0.	3.29746E-04	-1.63529E-04	0.	0.	1.97848E-05	-9.81175E-06
22	0.	0.	3.25125E-11	-1.65002E-10	0.	0.	1.95075E-12	-9.90013E-12
23	0.	0.	4.03622E-13	-2.62999E-12	0.	0.	2.42173E-14	-1.57799E-13
24	0.	0.	2.85330E-16	-2.58541E-15	0.	0.	1.71198E-17	-1.55124E-16
25	0.	0.	3.86288E-20	-4.67584E-19	0.	0.	2.31773E-21	-2.80550E-20
26	0.	0.	0.	0.	0.	0.	0.	0.
POS.	27 THRU POS.	34	SAME AS ABOVE					
35	0.	0.	3.08497E-01	-2.36173E-01	0.	0.	1.85098E-02	-1.41704E-02

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 45

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	1.20314E-01	0.	1.80588E-03	1.62767E-01	3.13002E+02	0.	1.28394E+00	9.76605E-03
2	0.	0.	0.	0.	6.48315E+02	0.	2.65809E+00	0.
3	1.52031E+00	0.	4.72343E+00	0.	3.24002E+02	0.	1.61751E+00	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS.	5 THRU POS.	6 SAME AS ABOVE					
7	0.	0.	8.34669E-03	-2.62185E-03	0.	0.	5.00801E-04	-1.57311E-04
8	0.	0.	7.27997E-03	-3.49049E-03	0.	0.	4.36798E-04	-2.09430E-04
9	0.	0.	8.44639E-03	-5.54568E-03	0.	0.	5.06784E-04	-3.32741E-04
10	0.	0.	1.37344E-02	-1.04786E-02	0.	0.	8.24063E-04	-6.28714E-04
11	0.	0.	2.20826E-02	-1.80048E-02	0.	0.	1.32495E-03	-1.08029E-03
12	0.	0.	4.40920E-02	-3.77718E-02	0.	0.	2.64552E-03	-2.26631E-03
13	0.	0.	1.71109E-01	-1.39153E-01	0.	0.	1.02665E-02	-8.34916E-03
14	1.40000E+00	0.	3.97686E+00	1.09327E+00	1.10000E+01	0.	2.88892E-01	6.55961E-02
15	0.	0.	3.23310E-01	-2.55456E-01	0.	0.	1.93986E-02	-1.53274E-02
16	0.	0.	1.56113E-01	-1.30984E-01	0.	0.	9.36680E-03	-7.85903E-03
17	0.	0.	8.77245E-02	-7.55076E-02	0.	0.	5.26347E-03	-4.53046E-03
18	0.	0.	6.31800E-02	-5.35367E-02	0.	0.	3.79080E-03	-3.21220E-03
19	0.	0.	5.04010E-02	-4.09764E-02	0.	0.	3.02406E-03	-2.45858E-03
20	0.	0.	1.27941E-02	-1.63060E-02	0.	0.	7.67645E-04	-9.78362E-04
21	0.	0.	2.55873E-03	-3.14914E-03	0.	0.	1.53524E-04	-1.88949E-04
22	0.	0.	1.30635E-04	-1.09308E-04	0.	0.	7.83811E-06	-6.55845E-06
23	0.	0.	3.24727E-12	-1.92913E-11	0.	0.	1.94836E-13	-1.15748E-12
24	0.	0.	3.28967E-14	-2.54292E-13	0.	0.	1.97380E-15	-1.52575E-14
25	0.	0.	1.71486E-17	-1.86021E-16	0.	0.	1.02892E-18	-1.11613E-17
26	0.	0.	1.62260E-21	-2.35319E-20	0.	0.	9.73561E-23	-1.41191E-21
27	0.	0.	0.	0.	0.	0.	0.	0.
	POS.	28 THRU POS.	34 SAME AS ABOVE					
35	0.	0.	2.85996E-01	-2.27417E-01	0.	0.	1.71598E-02	-1.36450E-02

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 46

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	1.36090E-01	0.	2.04882E-03	8.54584E-03	3.67740E+02	0.	1.50843E+00	5.12751E-04
2	0.	0.	0.	0.	7.61769E+02	0.	3.12325E+00	0.
3	1.53609E+00	0.	4.88346E+00	0.	3.78740E+02	0.	1.85159E+00	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS.		7 SAME AS ABOVE					
8	0.	0.	1.97819E-02	-6.87943E-03	0.	0.	1.18691E-03	-4.12766E-04
9	0.	0.	1.80288E-02	-8.99797E-03	0.	0.	1.08173E-03	-5.39878E-04
10	0.	0.	2.11597E-02	-1.42067E-02	0.	0.	1.26958E-03	-8.52405E-04
11	0.	0.	2.80825E-02	-2.26314E-02	0.	0.	1.68495E-03	-1.35789E-03
12	0.	0.	4.65190E-02	-3.97901E-02	0.	0.	2.79114E-03	-2.38741E-03
13	0.	0.	1.44879E-01	-1.21311E-01	0.	0.	8.69272E-03	-7.27867E-03
14	1.40000E+00	0.	4.31553E+00	4.93014E-01	1.10000E+01	0.	3.09212E-01	2.95808E-02
15	0.	0.	2.70986E-01	-2.23917E-01	0.	0.	1.62592E-02	-1.34350E-02
16	0.	0.	1.42659E-01	-1.22677E-01	0.	0.	8.55955E-03	-7.36060E-03
17	0.	0.	9.65894E-02	-8.25265E-02	0.	0.	5.79536E-03	-4.95159E-03
18	0.	0.	6.33657E-02	-5.26875E-02	0.	0.	3.80194E-03	-3.16125E-03
19	0.	0.	4.72971E-02	-3.83207E-02	0.	0.	2.83783E-03	-2.29924E-03
20	0.	0.	2.53801E-02	-2.36911E-02	0.	0.	1.52280E-03	-1.42147E-03
21	0.	0.	7.94829E-03	-9.62383E-03	0.	0.	4.76897E-04	-5.77430E-04
22	0.	0.	1.65599E-03	-1.72266E-03	0.	0.	9.93592E-05	-1.03360E-04
23	0.	0.	1.42352E-05	-3.79651E-05	0.	0.	8.54111E-07	-2.27791E-06
24	0.	0.	2.09531E-13	-1.53030E-12	0.	0.	1.25718E-14	-9.18178E-14
25	0.	0.	1.68168E-15	-1.61663E-14	0.	0.	1.00901E-16	-9.69976E-16
26	0.	0.	6.17918E-19	-8.38600E-18	0.	0.	3.70751E-20	-5.03160E-19
27	0.	0.	3.86352E-23	-6.99669E-22	0.	0.	2.31811E-24	-4.19801E-23
28	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 29 THRU POS.		34 SAME AS ABOVE					
35	0.	0.	2.55608E-01	-2.10563E-01	0.	0.	1.53365E-02	-1.26338E-02

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 47

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	1.59819E-01	0.	2.42604E-03	-2.22689E-03	4.55840E+02	0.	1.86974E+00	-1.33614E-04
2	0.	0.	0.	0.	9.44279E+02	0.	3.87154E+00	0.
3	1.55982E+00	0.	4.84587E+00	0.	4.66840E+02	0.	2.21062E+00	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS.		8 SAME AS ABOVE					
9	0.	0.	3.79479E-02	-1.58623E-02	0.	0.	2.27688E-03	-9.51740E-04
10	0.	0.	3.07905E-02	-1.81276E-02	0.	0.	1.84743E-03	-1.08766E-03
11	0.	0.	3.92509E-02	-2.88572E-02	0.	0.	2.35505E-03	-1.73143E-03
12	0.	0.	7.98139E-02	-6.51091E-02	0.	0.	4.78883E-03	-3.90655E-03
13	0.	0.	1.45271E-01	-1.22992E-01	0.	0.	8.71623E-03	-7.37950E-03
14	1.40000E+00	0.	4.45032E+00	3.18751E-01	1.10000E+01	0.	3.17299E-01	1.91251E-02
15	0.	0.	2.10545E-01	-1.79214E-01	0.	0.	1.26327E-02	-1.07528E-02
16	0.	0.	1.10094E-01	-9.53764E-02	0.	0.	6.60563E-03	-5.72259E-03
17	0.	0.	8.80626E-02	-7.37863E-02	0.	0.	5.28376E-03	-4.42718E-03
18	0.	0.	5.49730E-02	-4.59152E-02	0.	0.	3.29838E-03	-2.75491E-03
19	0.	0.	4.32819E-02	-3.40844E-02	0.	0.	2.59691E-03	-2.04507E-03
20	0.	0.	3.28646E-02	-2.48733E-02	0.	0.	1.97187E-03	-1.49240E-03
21	0.	0.	9.30851E-03	-1.08990E-02	0.	0.	5.58510E-04	-6.53939E-04
22	0.	0.	5.02362E-03	-5.30010E-03	0.	0.	3.01417E-04	-3.18006E-04
23	0.	0.	7.96999E-04	-8.60777E-04	0.	0.	4.78199E-05	-5.16466E-05
24	0.	0.	9.73331E-07	-2.82367E-06	0.	0.	5.83999E-08	-1.69420E-07
25	0.	0.	7.62242E-15	-7.29574E-14	0.	0.	4.57345E-16	-4.37744E-15
26	0.	0.	4.69520E-17	-5.95880E-16	0.	0.	2.81712E-18	-3.57528E-17
27	0.	0.	1.16006E-20	-2.07985E-19	0.	0.	6.96034E-22	-1.24791E-20
28	0.	0.	4.52554E-25	-1.07599E-23	0.	0.	2.71532E-26	-6.45593E-25
29	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 30 THRU POS.		34 SAME AS ABOVE					
35	0.	0.	2.21493E-01	-1.85924E-01	0.	0.	1.32896E-02	-1.11554E-02

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 48

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	1.88574E-01	0.	2.89223E-03	3.94409E-03	5.62508E+02	0.	2.30720E+00	2.36645E-04
2	0.	0.	0.	0.	1.16523E+03	0.	4.77754E+00	0.
3	1.58857E+00	0.	4.84123E+00	0.	5.73508E+02	0.	2.64778E+00	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	POS. 5 THRU POS. 9		SAME AS ABOVE					
10	0.	0.	2.71587E-02	-1.32547E-02	0.	0.	1.62952E-03	-7.95280E-04
11	0.	0.	2.70275E-02	-1.79684E-02	0.	0.	1.62165E-03	-1.07810E-03
12	0.	0.	4.62527E-02	-3.57235E-02	0.	0.	2.77516E-03	-2.14341E-03
13	0.	0.	6.96594E-02	-5.75697E-02	0.	0.	4.17956E-03	-3.45418E-03
14	1.40000E+00	0.	4.48141E+00	3.06004E-01	1.10000E+01	0.	3.19165E-01	1.83602E-02
15	0.	0.	8.97588E-02	-7.63062E-02	0.	0.	5.38553E-03	-4.57837E-03
16	0.	0.	4.39795E-02	-3.78705E-02	0.	0.	2.63877E-03	-2.27223E-03
17	0.	0.	3.61703E-02	-2.95087E-02	0.	0.	2.17022E-03	-1.77052E-03
18	0.	0.	2.38692E-02	-1.93670E-02	0.	0.	1.43215E-03	-1.16202E-03
19	0.	0.	1.88457E-02	-1.43996E-02	0.	0.	1.13074E-03	-8.63974E-04
20	0.	0.	1.42123E-02	-1.04856E-02	0.	0.	8.52740E-04	-6.29134E-04
21	0.	0.	1.09284E-02	-7.77457E-03	0.	0.	6.55702E-04	-4.66474E-04
22	0.	0.	2.49468E-03	-2.83001E-03	0.	0.	1.49681E-04	-1.69801E-04
23	0.	0.	1.70050E-03	-1.51970E-03	0.	0.	1.02030E-04	-9.11819E-05
24	0.	0.	2.42480E-04	-1.82867E-04	0.	0.	1.45488E-05	-1.09720E-05
25	0.	0.	3.82206E-18	-1.15411E-17	0.	0.	2.29323E-19	-6.92466E-19
26	0.	0.	1.04106E-16	-1.42127E-15	0.	0.	6.24698E-18	-8.52764E-17
27	0.	0.	4.73753E-19	-8.61912E-18	0.	0.	2.84252E-20	-5.17147E-19
28	0.	0.	7.41046E-23	-1.90145E-21	0.	0.	4.44627E-24	-1.14087E-22
29	0.	0.	1.66775E-27	-5.63169E-26	0.	0.	1.00065E-28	-3.37902E-27
30	0.	0.	0.	0.	0.	0.	0.	0.
31	POS. 31 THRU POS. 34		SAME AS ABOVE					
35	0.	0.	2.28656E-01	-1.92451E-01	0.	0.	1.37194E-02	-1.15470E-02

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 49

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	2.20100E-01	0.	3.41953E-03	-3.56928E-01	6.84213E+02	0.	2.80633E+00	-2.14157E-02
2	0.	0.	0.	0.	1.41748E+03	0.	5.81168E+00	0.
3	1.62010E+00	0.	5.08886E+00	0.	6.95213E+02	0.	3.16174E+00	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 10	SAME AS ABOVE						
11	0.	0.	4.53810E-02	-2.43313E-02	0.	0.	2.72286E-03	-1.45988E-03
12	0.	0.	4.70885E-02	-3.34186E-02	0.	0.	2.82531E-03	-2.00512E-03
13	0.	0.	5.53799E-02	-4.56991E-02	0.	0.	3.32279E-03	-2.74195E-03
14	1.40000E+00	0.	4.81548E+00	-8.54049E-01	1.10000E+01	0.	3.39209E-01	-5.12429E-02
15	0.	0.	7.34039E-02	-6.06087E-02	0.	0.	4.40423E-03	-3.63652E-03
16	0.	0.	5.02757E-02	-4.15525E-02	0.	0.	3.01654E-03	-2.49315E-03
17	0.	0.	2.87823E-02	-2.31201E-02	0.	0.	1.72694E-03	-1.38721E-03
18	0.	0.	2.31340E-02	-1.77780E-02	0.	0.	1.38804E-03	-1.06668E-03
19	0.	0.	1.60776E-02	-1.20816E-02	0.	0.	9.64658E-04	-7.24898E-04
20	0.	0.	1.45994E-02	-1.00431E-02	0.	0.	8.75967E-04	-6.02584E-04
21	0.	0.	1.07224E-02	-7.10942E-03	0.	0.	6.43346E-04	-4.26555E-04
22	0.	0.	7.22476E-03	-4.84128E-03	0.	0.	4.33486E-04	-2.90477E-04
23	0.	0.	1.68544E-03	-1.71331E-03	0.	0.	1.01127E-04	-1.02799E-04
24	0.	0.	1.25883E-03	-9.59565E-04	0.	0.	7.55297E-05	-5.75739E-05
25	0.	0.	1.34678E-04	-8.42031E-05	0.	0.	8.08070E-06	-5.05219E-06
26	0.	0.	0.	0.	0.	0.	0.	0.
27	0.	0.	7.36376E-18	-1.30571E-16	0.	0.	4.41826E-19	-7.83425E-18
28	0.	0.	2.76345E-20	-6.51652E-19	0.	0.	1.65807E-21	-3.90991E-20
29	0.	0.	3.24155E-24	-1.07105E-22	0.	0.	1.94493E-25	-6.42628E-24
30	0.	0.	5.17310E-29	-2.22952E-27	0.	0.	3.10386E-30	-1.33771E-28
31	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 32 THRU POS. 34	SAME AS ABOVE						
35	0.	0.	2.01467E-01	-1.63086E-01	0.	0.	1.20880E-02	-9.78517E-03



TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 50

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	2.93559E-01	0.	4.47556E-03	-3.94856E-01	9.22161E+02	0.	3.78225E+00	-2.36914E-02
2	0.	0.	0.	0.	1.91026E+03	0.	7.83207E+00	0.
3	1.69356E+00	0.	4.56780E+00	0.	9.33161E+02	0.	4.10693E+00	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
POS. 5 THRU POS. 11	SAME AS ABOVE							
12	0.	0.	5.14268E-02	-3.23939E-02	0.	0.	3.08561E-03	-1.94363E-03
13	0.	0.	4.32253E-02	-3.46165E-02	0.	0.	2.59352E-03	-2.07699E-03
14	1.40000E+00	0.	4.36828E+00	-1.03779E+00	1.10000E+01	0.	3.12377E-01	-6.22674E-02
15	0.	0.	5.25385E-02	-4.33278E-02	0.	0.	3.15231E-03	-2.59967E-03
16	0.	0.	4.50117E-02	-3.52256E-02	0.	0.	2.70070E-03	-2.11353E-03
17	0.	0.	2.38457E-02	-1.77136E-02	0.	0.	1.43074E-03	-1.06282E-03
18	0.	0.	2.04414E-02	-1.37496E-02	0.	0.	1.22648E-03	-8.24975E-04
19	0.	0.	1.37941E-02	-9.07906E-03	0.	0.	8.27646E-04	-5.44743E-04
20	0.	0.	1.08456E-02	-6.79009E-03	0.	0.	6.50734E-04	-4.07405E-04
21	0.	0.	1.06938E-02	-6.14580E-03	0.	0.	6.41626E-04	-3.68748E-04
22	0.	0.	8.55075E-03	-4.51368E-03	0.	0.	5.13045E-04	-2.70821E-04
23	0.	0.	4.04215E-03	-2.45650E-03	0.	0.	2.42529E-04	-1.47390E-04
24	0.	0.	1.14395E-03	-9.32456E-04	0.	0.	6.86372E-05	-5.59474E-05
25	0.	0.	9.12920E-04	-5.40104E-04	0.	0.	5.47752E-05	-3.24062E-05
26	0.	0.	7.63590E-05	-3.30957E-05	0.	0.	4.58154E-06	-1.98574E-06
27	0.	0.	0.	0.	0.	0.	0.	0.
28	0.	0.	2.95005E-19	-7.31617E-18	0.	0.	1.77003E-20	-4.38970E-19
29	0.	0.	8.92268E-22	-2.92237E-20	0.	0.	5.35361E-23	-1.75342E-21
30	0.	0.	7.60295E-26	-3.44683E-24	0.	0.	4.56177E-27	-2.06810E-25
31	0.	0.	8.29858E-31	-4.83985E-29	0.	0.	4.97915E-32	-2.90391E-30
32	0.	0.	0.	0.	0.	0.	0.	0.
POS. 33 THRU POS. 34	SAME AS ABOVE							
35	0.	0.	1.77979E-01	-1.34500E-01	0.	0.	1.06787E-02	-8.06999E-03

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 51

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	4.20619E-01	0.	6.43611E-03	-3.74659E-01	1.35805E+03	0.	5.56996E+00	-2.24795E-02
2	0.	0.	0.	0.	2.81300E+03	0.	1.15333E+01	0.
3	1.82062E+00	0.	4.35369E+00	0.	1.36905E+03	0.	5.88108E+00	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 12	SAME AS ABOVE						
13	0.	0.	9.69283E-03	-7.51416E-03	0.	0.	5.81570E-04	-4.50850E-04
14	1.40000E+00	0.	4.16129E+00	-1.00021E+00	1.10000E+01	0.	2.99957E-01	-6.00123E-02
15	0.	0.	1.03993E-02	-8.26922E-03	0.	0.	6.23957E-04	-4.96153E-04
16	0.	0.	1.05622E-02	-7.50909E-03	0.	0.	6.33734E-04	-4.50545E-04
17	0.	0.	6.39567E-03	-4.25975E-03	0.	0.	3.83740E-04	-2.55585E-04
18	0.	0.	4.62134E-03	-2.70035E-03	0.	0.	2.77280E-04	-1.62021E-04
19	0.	0.	4.07935E-03	-2.04683E-03	0.	0.	2.44761E-04	-1.22810E-04
20	0.	0.	2.83172E-03	-1.36243E-03	0.	0.	1.69903E-04	-8.17458E-05
21	0.	0.	2.80380E-03	-1.26968E-03	0.	0.	1.68228E-04	-7.61809E-05
22	0.	0.	2.28395E-03	-9.94420E-04	0.	0.	1.37037E-04	-5.96652E-05
23	0.	0.	2.08713E-03	-7.93682E-04	0.	0.	1.25228E-04	-4.76209E-05
24	0.	0.	7.02662E-04	-3.46045E-04	0.	0.	4.21597E-05	-2.07627E-05
25	0.	0.	2.48010E-04	-1.44402E-04	0.	0.	1.48806E-05	-8.66415E-06
26	0.	0.	2.12192E-04	-8.59790E-05	0.	0.	1.27315E-05	-5.15874E-06
27	0.	0.	1.47982E-05	-6.59677E-07	0.	0.	8.87891E-07	-3.95806E-08
28	0.	0.	0.	0.	0.	0.	0.	0.
29	0.	0.	1.56653E-21	-6.98846E-20	0.	0.	9.39918E-23	-4.19308E-21
30	0.	0.	3.46664E-24	-2.02937E-22	0.	0.	2.07999E-25	-1.21762E-23
31	0.	0.	1.84980E-28	-1.48121E-26	0.	0.	1.10988E-29	-8.88728E-28
32	0.	0.	1.14686E-33	-1.16490E-31	0.	0.	6.88115E-35	-6.98938E-33
33	0.	0.	0.	0.	0.	0.	0.	0.
34	0.	0.	0.	0.	0.	0.	0.	0.
35	0.	0.	1.80762E-01	-1.19867E-01	0.	0.	1.08457E-02	-7.19201E-03

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TABLE 5-4 (Continued)

CROSS SECTIONS FOR GROUP 52

POS.	MAT. 1	MAT. 2	MAT. 3	MAT. 4	MAT. 5	MAT. 6	MAT. 7	MAT. 8
1	6.05551E-01	0.	9.80514E-03	-6.40828E-01	2.05283E+03	0.	8.41945E+00	-3.84497E-02
2	0.	0.	0.	0.	4.25161E+03	0.	1.74316E+01	0.
3	2.00565E+00	0.	3.82814E+00	0.	2.06383E+03	0.	8.69883E+00	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5 THRU POS. 13	SAME AS ABOVE						
14	1.40000E+00	0.	3.60952E+00	-1.81687E+00	1.10000E+01	0.	2.66851E-01	-1.09012E-01
15	0.	0.	5.20580E-03	-3.90382E-03	0.	0.	3.12348E-04	-2.34229E-04
16	0.	0.	6.66386E-03	-4.00943E-03	0.	0.	3.99831E-04	-2.40566E-04
17	0.	0.	5.39514E-03	-2.81175E-03	0.	0.	3.23708E-04	-1.68705E-04
18	0.	0.	3.46095E-03	-1.62679E-03	0.	0.	2.07667E-04	-9.76075E-05
19	0.	0.	3.13181E-03	-1.23560E-03	0.	0.	1.87908E-04	-7.41361E-05
20	0.	0.	2.43975E-03	-8.12773E-04	0.	0.	1.46385E-04	-4.87664E-05
21	0.	0.	1.75503E-03	-5.28579E-04	0.	0.	1.05302E-04	-3.17147E-05
22	0.	0.	1.90436E-03	-5.66562E-04	0.	0.	1.14261E-04	-3.39937E-05
23	0.	0.	1.47972E-03	-4.39223E-04	0.	0.	8.87833E-05	-2.63534E-05
24	0.	0.	1.43565E-03	-3.43494E-04	0.	0.	8.61391E-05	-2.06096E-05
25	0.	0.	4.03085E-04	-1.38875E-04	0.	0.	2.41851E-05	-8.33250E-06
26	0.	0.	1.62391E-04	-6.08014E-05	0.	0.	9.74344E-06	-3.64809E-06
27	0.	0.	1.43515E-04	-3.64644E-05	0.	0.	8.61089E-06	-2.18786E-06
28	0.	0.	1.04822E-05	-6.69816E-08	0.	0.	6.28931E-07	-4.01890E-09
29	0.	0.	0.	0.	0.	0.	0.	0.
30	0.	0.	8.89349E-23	-6.27944E-21	0.	0.	5.33609E-24	-3.76767E-22
31	0.	0.	1.64997E-25	-1.50937E-23	0.	0.	9.89979E-27	-9.05624E-25
32	0.	0.	6.78523E-30	-8.34837E-28	0.	0.	4.07114E-31	-5.00902E-29
33	0.	0.	3.08049E-35	-4.72920E-33	0.	0.	1.84830E-36	-2.83752E-34
34	0.	0.	0.	0.	0.	0.	0.	0.
35	0.	0.	2.08817E-01	-1.05615E-01	0.	0.	1.25290E-02	-6.33691E-03

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TABLE 5-4 (Continued)

PO.52GROUPS, AL.C.U235									
52	34	1	1						
POS.	GRP. 1	GRP. 2	GRP. 3	GRP. 4	GRP. 5	GRP. 6	GRP. 7	GRP. 8	
1	1.20424E-02	8.20503E-03	6.08559E-03	5.96618E-03	6.13793E-03	6.44652E-03	6.27864E-03	6.05517E-03	
2	2.82344E-02	2.24757E-02	1.53139E-02	1.50100E-02	1.47374E-02	1.47001E-02	1.37556E-02	1.28646E-02	
3	1.08541E-01	1.04533E-01	1.13195E-01	1.57223E-01	1.64904E-01	1.43865E-01	1.56727E-01	1.97375E-01	
4	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 5 THRU POS. 13			SAME AS ABOVE					
14	4.86902E-02	4.73964E-02	5.58687E-02	8.06892E-02	7.50420E-02	6.46228E-02	1.04698E-01	1.35039E-01	
15	0.	1.94829E-02	2.11779E-02	3.38459E-02	5.02095E-02	6.54859E-02	6.49507E-02	4.08643E-02	
16	0.	0.	2.42202E-03	3.26098E-03	1.24618E-03	1.08009E-02	1.00225E-02	1.94638E-03	
17	0.	0.	0.	7.66554E-03	3.43348E-04	5.87471E-04	1.99316E-03	2.38201E-03	
18	0.	0.	0.	0.	9.37041E-03	5.41060E-03	2.14585E-03	2.57936E-03	
19	0.	0.	0.	0.	0.	5.13484E-03	1.06749E-02	5.56518E-03	
20	0.	0.	0.	0.	0.	0.	1.20485E-03	5.21556E-03	
21	0.	0.	0.	0.	0.	0.	0.	1.20404E-03	
22	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 23 THRU POS. 34			SAME AS ABOVE					
POS.	GRP. 9	GRP. 10	GRP. 11	GRP. 12	GRP. 13	GRP. 14	GRP. 15	GRP. 16	
1	6.02628E-03	7.41018E-03	9.88053E-03	1.58834E-02	2.30703E-02	3.07019E-02	5.21912E-02	9.69182E-02	
2	1.21643E-02	1.41035E-02	1.77507E-02	2.76928E-02	4.18219E-02	5.12495E-02	8.58022E-02	1.63769E-01	
3	2.43562E-01	3.02300E-01	3.43701E-01	3.51797E-01	3.51370E-01	3.60635E-01	3.82777E-01	4.27773E-01	
4	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 5 THRU POS. 13			SAME AS ABOVE					
14	1.90239E-01	2.63028E-01	2.89627E-01	2.92930E-01	2.84609E-01	2.86576E-01	2.97080E-01	2.99193E-01	
15	5.40335E-02	4.65389E-02	3.16347E-02	4.41822E-02	4.29815E-02	4.36911E-02	4.33970E-02	3.35054E-02	
16	3.13164E-03	1.81556E-03	5.59522E-04	1.81034E-04	1.04786E-05	1.99063E-06	0.	0.	
17	3.23146E-03	1.62358E-03	3.49644E-04	1.27372E-04	3.52801E-05	5.57908E-07	3.34877E-07	0.	
18	3.50108E-03	2.32452E-03	1.60129E-04	5.68115E-05	4.66451E-05	7.17838E-06	8.74845E-08	3.40354E-08	
19	3.02865E-03	2.05150E-03	2.89321E-04	2.56446E-05	1.62087E-05	1.72521E-05	2.90981E-06	1.17031E-08	
20	5.48538E-03	1.73049E-03	2.38008E-04	4.54370E-05	3.69388E-06	5.97054E-06	7.02093E-06	2.64916E-07	
21	1.98173E-03	2.14869E-03	1.91742E-04	3.67352E-05	6.49711E-06	5.11543E-07	2.40053E-06	6.23654E-07	
22	1.01563E-03	7.90037E-04	1.86934E-04	2.91444E-05	5.21930E-06	8.97281E-07	7.41842E-08	2.25691E-07	
23	0.	2.92517E-04	6.53519E-05	2.41230E-05	4.11706E-06	7.19017E-07	1.29909E-07	6.08633E-09	
24	0.	0.	1.36448E-05	9.68264E-06	3.53579E-06	5.66075E-07	1.04065E-07	1.17060E-08	
25	0.	0.	0.	2.00039E-06	1.35498E-06	5.70367E-07	9.18282E-08	9.31463E-09	
26	0.	0.	0.	0.	2.78829E-07	1.85662E-07	1.08054E-06	7.34839E-09	
27	0.	0.	0.	0.	0.	3.81464E-08	2.67490E-08	5.52377E-09	
28	0.	0.	0.	0.	0.	0.	5.48364E-09	2.45315E-09	
29	0.	0.	0.	0.	0.	0.	0.	5.13816E-10	
30	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 31 THRU POS. 34			SAME AS ABOVE					
POS.	GRP. 17	GRP. 18	GRP. 19	GRP. 20	GRP. 21	GRP. 22	GRP. 23	GRP. 24	
1	1.35710E-01	1.12747E-01	3.06143E-01	2.09294E-01	3.27284E-01	2.54621E-01	3.51637E-01	2.01727E-01	
2	2.05018E-01	1.93956E-01	5.18947E-01	3.28547E-01	4.72898E-01	4.23981E-01	5.09338E-01	3.14067E-01	

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TABLE 5-4 (Continued)

3	4.66579E-01	4.43615E-01	6.63864E-01	5.43155E-01	6.78317E-01	5.88234E-01	6.91525E-01	5.33084E-01
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5	THRU POS. 13	SAME AS ABOVE					
14	2.72724E-01	1.59730E-01	1.86295E-01	1.62783E-01	1.78985E-01	1.62743E-01	1.68623E-01	1.60268E-01
15	3.16619E-02	5.48873E-02	1.60339E-01	1.61088E-01	1.61130E-01	1.61516E-01	1.60516E-01	1.61023E-01
16	0.	0.	3.25738E-03	1.07988E-02	1.03374E-02	9.94740E-03	1.05318E-02	1.03548E-02
17	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.
19	3.32006E-09	0.	0.	0.	0.	0.	0.	0.
20	1.70049E-09	4.91843E-10	0.	0.	0.	0.	0.	0.
21	0.	3.04269E-10	3.44894E-10	0.	0.	0.	0.	0.
22	0.	0.	2.29494E-10	2.45419E-10	0.	0.	0.	0.
23	0.	0.	0.	1.74209E-10	1.77039E-10	0.	0.	0.
24	5.60576E-10	0.	0.	0.	1.32931E-10	1.29320E-10	0.	0.
25	0.	0.	0.	0.	0.	1.01867E-10	9.55233E-11	0.
26	0.	0.	0.	0.	0.	0.	7.83087E-11	7.12344E-11
27	0.	0.	0.	0.	0.	0.	0.	6.03932E-11
28	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 29	THRU POS. 34	SAME AS ABOVE					
	POS. 25	GRP. 26	GRP. 27	GRP. 28	GRP. 29	GRP. 30	GRP. 31	GRP. 32
1	3.85084E-01	4.62736E-01	1.26941E-01	2.53531E-01	9.88951E-02	1.86883E-01	6.93401E-02	1.12690E-01
2	3.79215E-01	8.30712E-01	1.30626E-01	2.55123E-01	5.13469E-02	3.03645E-01	1.35688E-01	1.43600E-01
3	7.25625E-01	8.02293E-01	4.58140E-01	5.86240E-01	4.34680E-01	5.21026E-01	4.06765E-01	4.51757E-01
4	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 5	THRU POS. 13	SAME AS ABOVE					
14	1.69512E-01	1.68391E-01	1.60256E-01	1.61377E-01	1.64986E-01	1.63033E-01	1.65933E-01	1.70471E-01
15	1.60475E-01	1.60589E-01	1.60784E-01	1.60902E-01	1.60653E-01	1.60488E-01	1.61068E-01	1.60237E-01
16	1.02420E-02	1.06134E-02	1.04400E-02	1.03824E-02	1.00416E-02	1.06782E-02	1.03116E-02	1.00416E-02
17	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 18	THRU POS. 26	SAME AS ABOVE					
27	5.35658E-11	0.	0.	0.	0.	0.	0.	0.
28	4.66513E-11	4.05572E-11	0.	0.	0.	0.	0.	0.
29	0.	3.61059E-11	3.08767E-11	0.	0.	0.	0.	0.
30	0.	0.	2.79861E-11	2.36186E-11	0.	0.	0.	0.
31	0.	0.	0.	5.64059E-09	1.81309E-11	0.	0.	0.
32	0.	0.	0.	0.	0.	1.39689E-11	0.	0.
33	0.	0.	0.	0.	0.	0.	7.20433E-10	0.
34	0.	0.	0.	0.	0.	0.	0.	0.
	POS. 33	GRP. 34	GRP. 35	GRP. 36	GRP. 37	GRP. 38	GRP. 39	GRP. 40
1	7.29362E-02	8.80409E-02	2.78823E-01	4.06281E-01	2.54808E-01	3.60844E-01	7.62772E-01	9.70194E-01
2	1.41810E-01	1.71217E-01	4.98483E-01	8.29885E-01	5.57527E-01	7.82132E-01	1.53596E+00	1.89288E+00
3	4.14228E-01	4.13297E-01	6.00841E-01	7.24915E-01	5.85179E-01	6.90028E-01	1.09234E+00	1.30032E+00
4	7.07728E-43	6.78112E-37	1.54856E-31	7.15576E-29	5.82426E-17	9.11671E-10	5.28516E-08	2.04266E-07
5	2.33831E-40	1.41591E-34	3.27860E-30	1.84512E-27	1.05714E-15	1.87436E-09	7.62589E-08	2.31226E-07
6	2.82993E-37	2.57374E-32	3.98562E-28	3.17943E-26	1.78541E-14	5.32815E-09	1.49761E-07	3.66449E-07

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TABLE 5-4 (Continued)

7	3.80271E-35	1.42198E-29	4.46099E-26	2.71023E-24	6.18220E-14	1.30997E-08	3.88675E-07	9.36041E-07
8	2.39311E-31	1.18271E-27	1.30719E-23	1.33562E-21	1.64884E-13	3.25429E-08	1.13701E-06	4.19226E-06
9	2.72276E-22	2.64611E-24	7.35157E-22	6.94335E-19	5.25872E-13	1.51197E-07	4.56814E-06	1.28425E-05
10	1.19430E-15	2.63300E-16	7.15265E-19	5.17336E-17	8.20019E-12	1.15531E-06	2.35085E-05	2.74289E-05
11	2.84292E-12	2.27238E-10	1.02729E-11	2.23956E-14	1.23061E-10	1.95384E-05	1.34838E-04	1.08631E-04
12	2.78442E-08	2.79157E-07	2.70713E-06	1.25511E-08	9.07386E-09	1.59487E-04	1.47835E-03	6.28599E-04
13	3.67442E-04	1.43476E-03	2.23467E-03	1.63168E-03	1.76096E-03	6.88660E-03	1.52787E-02	9.49105E-03
14	1.56690E-01	1.51553E-01	1.55201E-01	1.42054E-01	2.24638E-01	2.67105E-01	2.42482E-01	2.24066E-01
15	1.04268E-01	1.16657E-01	1.14233E-01	9.02074E-02	1.51441E-01	9.92841E-02	4.21515E-02	3.22848E-02
16	9.50834E-03	5.10984E-02	5.46868E-02	4.10867E-02	7.06326E-02	2.26920E-02	3.84147E-03	8.36068E-03
17	0.	1.64203E-03	1.19616E-02	1.08869E-02	1.76599E-02	4.53973E-03	2.07904E-04	4.74258E-04
18	0.	0.	1.02674E-04	1.13809E-03	2.35941E-03	3.56137E-04	2.98972E-06	4.17341E-06
19	0.	0.	0.	2.29627E-06	1.29314E-04	1.20541E-05	3.66247E-08	3.28063E-08
20	0.	0.	0.	0.	6.76381E-08	1.56823E-07	1.41943E-10	1.81088E-10
21	0.	0.	0.	0.	0.	0.	0.	2.74054E-13
22	0.	0.	0.	0.	0.	0.	0.	0.

POS. 23 THRU POS. 34 SAME AS ABOVE

POS.	GRP. 41	GRP. 42	GRP. 43	GRP. 44	GRP. 45	GRP. 46	GRP. 47	GRP. 48
1	8.80819E-01	8.80315E-01	9.83274E-01	1.12836E+00	1.28394E+00	1.50843E+00	1.86974E+00	2.30720E+00
2	1.73470E+00	1.78794E+00	2.02936E+00	2.33618E+00	2.65809E+00	3.12325E+00	3.87154E+00	4.77754E+00
3	1.21130E+00	1.21046E+00	1.31569E+00	1.46223E+00	1.61751E+00	1.83159E+00	2.21062E+00	2.64778E+00
4	5.62167E-06	5.42292E-05	0.	0.	0.	0.	0.	0.
5	7.36472E-06	3.79897E-05	1.95521E-04	0.	0.	0.	0.	0.
6	1.18600E-05	3.73402E-05	1.63020E-04	2.95123E-04	0.	0.	0.	0.
7	1.72382E-05	4.67520E-05	1.85725E-04	2.32683E-04	5.00801E-04	0.	0.	0.
8	2.92754E-05	6.70680E-05	2.35358E-04	2.18714E-04	4.36798E-04	1.18691E-03	0.	0.
9	6.54004E-05	1.31429E-04	3.14851E-04	3.16335E-04	5.06784E-04	1.08173E-03	2.27688E-03	0.
10	1.56833E-04	2.89902E-04	6.11930E-04	4.87442E-04	8.24063E-04	1.26958E-03	1.84743E-03	1.62952E-03
11	3.65679E-04	7.00429E-04	1.74508E-03	1.17759E-03	1.32495E-03	1.68495E-03	2.35505E-03	1.62165E-03
12	1.65672E-03	1.98959E-03	4.69479E-03	2.96496E-03	2.64552E-03	2.79114E-03	4.78883E-03	2.77516E-03
13	1.37340E-02	1.15937E-02	1.61225E-02	1.15937E-02	1.02665E-02	8.69272E-03	8.71623E-03	4.17956E-03
14	2.55986E-01	2.61253E-01	2.80646E-01	2.78789E-01	2.88892E-01	3.09212E-01	3.17299E-01	3.19165E-01
15	5.38656E-02	3.25314E-02	3.24041E-02	1.70581E-02	1.93986E-02	1.62592E-02	1.26327E-02	5.38553E-03
16	2.76143E-02	1.67805E-02	1.58898E-02	8.10556E-03	9.36680E-03	8.55955E-03	6.60563E-03	2.63877E-03
17	6.63085E-03	1.09650E-02	1.06146E-02	5.09106E-03	5.26347E-03	5.79536E-03	5.28376E-03	2.17022E-03
18	3.01044E-04	1.75598E-03	6.06929E-03	3.91287E-03	3.79080E-03	3.80194E-03	3.29838E-03	1.43215E-03
19	3.62970E-07	1.02639E-04	8.54744E-04	1.46954E-03	3.02406E-03	2.83783E-03	2.59691E-03	1.13074E-03
20	3.75911E-09	5.47198E-09	6.64323E-05	2.34810E-04	7.67645E-04	1.52280E-03	1.97187E-03	8.52740E-04
21	1.38308E-11	5.85993E-11	1.06795E-10	1.97848E-05	1.53524E-04	4.76897E-04	5.58510E-04	6.55702E-04
22	1.31538E-14	1.15144E-13	1.87872E-12	1.95075E-12	7.83811E-06	9.93592E-05	3.01417E-04	1.49681E-04
23	0.	5.23084E-17	2.26754E-15	2.42173E-14	1.94836E-13	8.54111E-07	4.78199E-05	1.02030E-04
24	0.	0.	5.81203E-19	1.71198E-17	1.97380E-15	1.25718E-14	5.83999E-08	1.45488E-05
25	0.	0.	0.	2.31773E-21	1.02892E-18	1.00901E-16	4.57345E-16	2.29323E-19
26	0.	0.	0.	0.	9.73561E-23	3.70751E-20	2.81712E-18	6.24638E-18
27	0.	0.	0.	0.	0.	2.31811E-24	6.96034E-22	2.84252E-20
28	0.	0.	0.	0.	0.	0.	2.71532E-26	4.44627E-24

TABLE 5-4 (Continued)

POS.	GRP. 49	GRP. 50	GRP. 51	GRP. 52
29	0.	0.	0.	0.
30	0.	0.	0.	0.
POS.	31 THRU POS.	32	SAME AS ABOVE	0.
POS.	5 THRU POS.	10	SAME AS ABOVE	0.
1	2.80633E+00	3.78225E+00	5.56996E+00	8.41945E+00
2	5.81168E+00	7.83207E+00	1.15333E+01	1.74316E+01
3	3.16174E+00	4.10633E+00	5.88108E+00	8.69883E+00
4	0.	0.	0.	0.
11	2.72286E-03	0.	0.	0.
12	2.82531E-03	3.08561E-03	0.	0.
13	3.32279E-03	2.59352E-03	5.81570E-04	0.
14	3.39209E-01	3.12377E-01	2.99957E-01	2.66851E-01
15	4.40423E-03	3.15231E-03	6.23957E-04	3.12348E-04
16	3.01654E-03	2.70070E-03	6.33734E-04	3.99831E-04
17	1.72694E-03	1.43074E-03	3.83740E-04	3.23708E-04
18	1.38804E-03	1.22648E-03	2.77280E-04	2.07657E-04
19	9.64658E-04	8.27646E-04	2.44761E-04	1.87908E-04
20	8.75967E-04	6.50734E-04	1.69903E-04	1.46385E-04
21	6.43346E-04	6.41626E-04	1.68228E-04	1.05302E-04
22	4.33486E-04	5.13045E-04	1.37037E-04	1.14261E-04
23	1.01127E-04	2.42529E-04	1.25228E-04	8.87833E-05
24	7.55297E-05	6.86372E-05	4.21597E-05	8.61391E-05
25	8.08070E-06	5.47752E-05	1.48806E-05	2.41851E-05
26	0.	4.58154E-06	1.27315E-05	9.74344E-06
27	4.41826E-19	0.	8.87891E-07	8.61089E-06
28	1.65807E-21	1.77003E-20	0.	6.28931E-07
29	1.94493E-25	5.35361E-23	9.39918E-23	0.
30	3.10386E-30	4.56177E-27	2.07999E-25	5.33609E-24
31	0.	4.97915E-32	1.10988E-29	9.89979E-27
32	0.	0.	6.88115E-35	4.07114E-31
33	0.	0.	0.	1.84830E-36
34	0.	0.	0.	0.

1.00065E+28  
0.

TABLE 5-4 (Continued)

		52	34	2	2	P1,52GRDUPS, AL+C,U235			
POS.	GRP. 1	GRP. 2	GRP. 3	GRP. 4	GRP. 5	GRP. 6	GRP. 7	GRP. 8	
1	3.85066E-02	2.94064E-02	3.64414E-02	3.44220E-02	2.13381E-02	1.58618E-02	2.29307E-02	2.95535E-02	
2	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 3 THRU POS. 13 SAME AS ABOVE								
14	1.27558E-01	1.17819E-01	1.45859E-01	2.05437E-01	1.84484E-01	1.35640E-01	1.00457E-01	1.27325E-01	
15	0.	-6.05849E-03	-2.18210E-02	-3.41791E-02	-7.56308E-02	-9.84494E-02	-8.80541E-02	-3.16649E-02	
16	0.	0.	-5.97984E-03	-7.77900E-03	-2.35560E-03	-2.65398E-02	-2.20200E-02	0.	
17	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 18 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 9	GRP. 10	GRP. 11	GRP. 12	GRP. 13	GRP. 14	GRP. 15	GRP. 16	
1	3.05883E-02	2.46505E-02	2.03241E-02	1.60932E-02	1.62960E-02	1.59012E-02	1.59334E-02	1.59502E-02	
2	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 3 THRU POS. 13 SAME AS ABOVE								
14	1.25410E-01	9.79041E-02	9.82841E-02	8.41384E-02	8.44799E-02	8.06801E-02	6.52665E-02	1.02568E-01	
15	-3.86645E-02	-3.36451E-02	-2.39526E-02	-3.73117E-02	-3.58589E-02	-3.55919E-02	-3.29764E-02	-1.74655E-02	
16	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 17 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 17	GRP. 18	GRP. 19	GRP. 20	GRP. 21	GRP. 22	GRP. 23	GRP. 24	
1	1.89509E-02	1.59518E-02	1.60269E-02	1.59599E-02	1.60077E-02	1.59572E-02	1.59780E-02	1.59511E-02	
2	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 3 THRU POS. 13 SAME AS ABOVE								
14	1.01036E-01	1.83127E-01	1.82907E-01	1.82968E-01	1.84382E-01	1.82539E-01	1.83190E-01	1.83098E-01	
15	-5.47175E-02	-4.49160E-02	-1.08514E-01	-1.09098E-01	-1.10231E-01	-1.10197E-01	-1.08899E-01	-1.09736E-01	
16	0.	0.	-8.26697E-03	-2.67576E-02	-2.57292E-02	-2.48568E-02	-2.61618E-02	-2.57688E-02	
17	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 18 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 25	GRP. 26	GRP. 27	GRP. 28	GRP. 29	GRP. 30	GRP. 31	GRP. 32	
1	1.59784E-02	1.59753E-02	1.59518E-02	1.59555E-02	1.59637E-02	1.59591E-02	1.59700E-02	1.59743E-02	
2	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 3 THRU POS. 13 SAME AS ABOVE								
14	1.82503E-01	1.82985E-01	1.82690E-01	1.83607E-01	1.82182E-01	1.83033E-01	1.83602E-01	1.79563E-01	
15	-1.08900E-01	-1.08612E-01	-1.09228E-01	-1.09766E-01	-1.09249E-01	-1.08619E-01	-1.10090E-01	-1.08015E-01	
16	-2.55198E-02	-2.63442E-02	-2.59566E-02	-2.58312E-02	-2.50686E-02	-2.64924E-02	-2.56722E-02	-2.50656E-02	
17	0.	0.	0.	0.	0.	0.	0.	0.	
	POS. 18 THRU POS. 34 SAME AS ABOVE								
POS.	GRP. 33	GRP. 34	GRP. 35	GRP. 36	GRP. 37	GRP. 38	GRP. 39	GRP. 40	
1	2.84601E-02	1.62818E-02	1.57096E-02	1.38630E-02	1.39397E-02	1.36357E-02	1.37065E-02	1.34995E-02	
2	0.	0.	0.	0.	0.	0.	0.	0.	
3	0.	0.	0.	0.	0.	0.	0.	0.	
4	-6.19026E-02	-5.66002E-03	-1.10222E-03	-4.95827E-02	-1.56347E-01	-7.13439E-01	-4.39796E-08	-1.36172E-07	
5	-1.62323E-09	-8.61669E-04	-1.98399E-09	-1.04373E-06	-2.65364E-05	-1.81293E-09	-7.34977E-08	-2.38646E-07	

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TABLE 5-4 (Continued)

6	-1.48684E-36	-1.27200E-31	-1.81696E-27	-1.55005E-25	-9.52363E-15	-5.03475E-09	-1.67451E-07	-4.16886E-07
7	-1.75369E-34	-5.56709E-29	-1.71143E-25	-1.02776E-23	-1.62127E-14	-1.41395E-08	-4.82575E-07	-1.05673E-06
8	-8.23203E-31	-4.19836E-27	-4.19126E-23	-3.87780E-21	-1.11462E-13	-3.84871E-08	-1.42410E-06	-3.62789E-06
9	-6.30254E-22	-7.54216E-24	-2.20377E-21	-1.93973E-18	-9.25430E-13	-1.89977E-07	-4.44638E-06	-1.02001E-05
10	-2.55179E-15	-5.34413E-16	-1.81121E-18	-1.40433E-16	-1.67186E-11	-1.43181E-06	-2.01374E-05	-2.32137E-05
11	-4.88933E-12	-3.38850E-10	-1.73625E-11	-2.77376E-14	-2.13399E-10	-1.68266E-05	-1.11807E-04	-8.94603E-05
12	-2.09133E-08	-1.90795E-07	-1.24280E-06	-1.38713E-08	-1.12446E-08	-1.21946E-04	-1.02796E-03	-4.98798E-04
13	3.23297E-04	1.60071E-03	2.09498E-03	9.25381E-04	7.94374E-05	-2.31166E-03	-7.21965E-03	-5.06265E-03
14	1.79586E-01	1.39152E-01	1.33099E-01	1.23621E-01	1.19803E-01	9.23529E-02	1.02914E-01	1.11461E-01
15	-2.72134E-02	2.22599E-03	-5.20891E-03	5.98337E-03	-4.58799E-02	-7.15406E-02	-3.10473E-02	-1.90870E-02
16	-2.26009E-02	-7.50118E-02	-7.00581E-02	-5.10692E-02	-8.37312E-02	-3.78852E-02	-5.88424E-03	-8.38891E-03
17	0.	-4.81702E-03	-2.61006E-02	-2.10205E-02	-3.34583E-02	-9.81420E-03	-3.48628E-04	-8.20034E-04
18	0.	0.	-3.40263E-04	-2.94789E-03	-5.32069E-03	-8.93264E-04	-8.51944E-06	-1.18194E-05
19	0.	0.	0.	-8.33721E-06	-3.65799E-04	-3.20663E-05	-1.18826E-07	-1.05721E-07
20	0.	0.	0.	0.	-2.62601E-07	-5.11848E-07	-5.16324E-10	-6.99398E-10
21	0.	0.	0.	0.	0.	0.	0.	-1.26828E-12
22	0.	0.	0.	0.	0.	0.	0.	0.
	POS.	23 THRU POS.	34	SAME AS ABOVE				

POS.	GRP. 41	GRP. 42	GRP. 43	GRP. 44	GRP. 45	GRP. 46	GRP. 47	GRP. 48
1	1.31105E-02	1.23289E-02	1.00615E-02	8.70608E-03	9.76609E-03	5.12751E-04	-1.33614E-04	2.36645E-04
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	-2.36514E-06	-1.23852E-05	0.	0.	0.	0.	0.	0.
5	-4.01075E-06	-1.48523E-05	-6.12053E-05	0.	0.	0.	0.	0.
6	-7.33623E-06	-2.01799E-05	-7.12149E-05	-9.18626E-05	0.	0.	0.	0.
7	-1.17333E-05	-3.11010E-05	-1.06243E-04	-1.06396E-04	-1.57311E-04	0.	0.	0.
8	-2.22766E-05	-4.90732E-05	-1.62655E-04	-1.37485E-04	-2.09430E-04	-4.12766E-04	0.	0.
9	-5.33410E-05	-1.02264E-04	-2.43005E-04	-2.36470E-04	-3.32741E-04	-5.39878E-04	-9.51740E-04	0.
10	-1.30200E-04	-2.41400E-04	-5.09012E-04	-3.95537E-04	-6.28714E-04	-8.52405E-04	-1.08766E-03	-7.95280E-04
11	-3.07340E-04	-5.98844E-04	-1.46128E-03	-9.78674E-04	-1.08029E-03	-1.35789E-03	-1.73143E-03	-1.07810E-03
12	-1.30661E-03	-1.63165E-03	-3.88809E-03	-2.52448E-03	-2.26631E-03	-2.38741E-03	-3.90655E-03	-2.14341E-03
13	-8.72556E-03	-8.04310E-03	-1.22037E-02	-9.01623E-03	-8.34916E-03	-7.27867E-03	-7.37950E-03	-3.45418E-03
14	9.33274E-02	8.81927E-02	7.04567E-02	6.98083E-02	6.55961E-02	2.95808E-02	1.91251E-02	1.83602E-02
15	-3.28761E-02	-2.25847E-02	-2.39529E-02	-1.33257E-02	-1.53274E-02	-1.34350E-02	-1.07528E-02	-4.57837E-03
16	-2.12677E-02	-1.35325E-02	-1.30601E-02	-6.78397E-03	-7.85903E-03	-7.36060E-03	-5.72259E-03	-2.27223E-03
17	-7.74860E-03	-9.54250E-03	-9.07874E-03	-4.30648E-03	-4.53046E-03	-4.95159E-03	-4.42718E-03	-1.77052E-03
18	-4.85222E-04	-2.47175E-03	-5.88103E-03	-3.25865E-03	-3.21220E-03	-3.16125E-03	-2.75491E-03	-1.16202E-03
19	-1.08202E-04	-1.12975E-04	-1.19663E-03	-1.64245E-03	-2.45858E-03	-2.29924E-03	-2.04507E-03	-8.63974E-04
20	-1.32311E-08	-1.73715E-08	-4.61506E-05	-3.10119E-04	-9.78362E-04	-1.42147E-03	-1.49240E-03	-6.29134E-04
21	-6.01340E-11	-2.46495E-10	-4.35135E-10	-9.81175E-06	-1.88949E-04	-5.77430E-04	-6.53939E-04	-4.66474E-04
22	-7.05285E-14	-6.30612E-13	-9.51690E-12	-9.90013E-12	-6.55845E-06	-1.03360E-04	-3.18006E-04	-1.69801E-04
23	0.	-3.68682E-16	-1.54793E-14	-1.57799E-13	-1.15748E-12	-2.27791E-06	-5.16466E-05	-9.11819E-05
24	0.	0.	-5.21622E-18	-1.55124E-16	-1.52575E-14	-9.18178E-14	-1.69420E-07	-1.09720E-05
25	0.	0.	0.	-2.80550E-20	-1.11613E-17	-9.69976E-16	-4.37744E-15	-6.92466E-19
26	0.	0.	0.	0.	-1.41191E-17	-5.03160E-19	-3.57528E-17	-8.52764E-17
27	0.	0.	0.	0.	0.	-4.19801E-23	-1.24791E-20	-5.17147E-19

TABLE 5-4 (Continued)

28	0.	0.	0.	0.	0.	0.	0.	-6.45593E-25	-1.14087E-22
29	0.	0.	0.	0.	0.	0.	0.	0.	-3.37902E-27
30	0.	0.	0.	0.	0.	0.	0.	0.	0.
	POS.	31 THRU POS.	34	SAME AS ABOVE					
POS.	GRP. 49	GRP. 50	GRP. 51	GRP. 52					
1	-2.14157E-02	-2.36914E-02	-2.24795E-02	-3.84497E-02					
2	0.	0.	0.	0.					
	POS.	3 THRU POS.	10	SAME AS ABOVE					
11	-1.45988E-03	0.	0.	0.					
12	-2.00512E-03	-1.94363E-03	0.	0.					
13	-2.74195E-03	-2.07699E-03	-4.50850E-04	0.					
14	-5.12429E-02	-6.22674E-02	-6.00123E-02	-1.09012E-01					
15	-3.63652E-03	-2.59967E-03	-4.96153E-04	-2.34229E-04					
16	-2.49315E-03	-2.11353E-03	-4.50545E-04	-2.40566E-04					
17	-1.38721E-03	-1.06282E-03	-2.55585E-04	-1.68705E-04					
18	-1.06668E-03	-8.24975E-04	-1.62021E-04	-9.76075E-05					
19	-7.24898E-04	-5.44743E-04	-1.22810E-04	-7.41361E-05					
20	-6.02584E-04	-4.07405E-04	-8.17458E-05	-4.87664E-05					
21	-4.26565E-04	-3.68748E-04	-7.61809E-05	-3.17147E-05					
22	-2.90477E-04	-2.70821E-04	-5.96652E-05	-3.39937E-05					
23	-1.02799E-04	-1.47390E-04	-4.76209E-05	-2.63534E-05					
24	-5.75739E-05	-5.59474E-05	-2.07627E-05	-2.06096E-05					
25	-5.05219E-06	-3.24092E-05	-8.66415E-06	-8.33250E-06					
26	0.	-1.98574E-06	-5.15874E-06	-3.64809E-06					
27	-7.83425E-18	0.	-3.95806E-08	-2.18786E-06					
28	-3.90991E-20	-4.38970E-19	0.	-4.01890E-09					
29	-6.42628E-24	-1.75342E-21	-4.19308E-21	0.					
30	-1.33771E-28	-2.06810E-25	-1.21762E-23	-3.76767E-22					
31	0.	-2.90391E-30	-8.88728E-28	-9.05624E-25					
32	0.	0.	-6.98938E-33	-5.00902E-29					
33	0.	0.	0.	-2.83752E-34					
34	0.	0.	0.	0.					

The next section lists the cross section set identification number and title followed by the input cross section data (10\* array or from tape) for MTP sets. Each cross section set contains IGM energy groups and IHP table positions.

The next section of printout lists the cross section data for all elements (MTP) and mixtures (MTX) for energy group 1. The next page contains similar data for group 2. This pattern is repeated for IGM groups. Note that even though the elements and mixtures are printed, if IMIX > 0, only the mixtures (MTX) are placed on the group-independent tape.

If ITYPE = 1, the code attempts to write a group-dependent tape from the group-independent tape. If insufficient core storage is available, a message giving the core storage needed to generate a group-dependent tape is given; execution is then terminated. If sufficient core storage is available, the group-dependent data are printed out by material. Each material contains IHP x IGM values. This concludes the printout from a SATURN code calculation.

#### 5.5.2 Punched Output

Punched card output from the SATURN code is only obtained if ICARDS = 1 in Data Set 1, and a group-dependent tape is generated. Under these conditions, either MTP sets (if MTX = 0) or MTX sets of cross section data are punched out in a (6E 12.5) FORTRAN format. Each punched cross section set contains IHP table positions for each IGM group. Each set begins on a new card.

#### 5.5.3 Tape Output

Two binary tapes can be generated as output data by the SATURN code: a group-dependent and a group-independent cross section tape.

The group independent tape contains IGM records. Each record contains either MTP x (IHP + 1) values (if MTX = 0) or MTX x (IHP + 1) values. If the input cross section

data include upscatter,  $I = 1$ ; otherwise  $I = 0$ . This tape is called the "specially prepared" cross section tape and is suitable for use in the DOT-IIW and ANISN-W codes with the appropriate input parameters. Note that for the ANISN-W code, the total upscatter cross section is computed by the SATURN code and is placed in position IHP + 1; for the DOT-IIW code, the total upscatter cross section is placed in position IHT + 1 and the previous cross sections from IHT + 1 to IHP are placed in table positions IHT + 2 to IHP + 1. With this tape, ANISN-W and DOT-IIW calculations can be made with little dependence on the number of energy groups.

The group dependent tape contains either MTP (if MTX = 0) or MTX sets of cross section data with IHP  $\times$  IGM values of cross section data for the particular material. This tape is the conventional, cross section tape used as input data to the ANISN-W and DOT-IIW codes.

## 5.6 PROGRAM LOGIC

The general code logic used in the SATURN code is presented in this section. A description of each of the subroutines and their function in the overall code logic is described.

### 5.6.1 Subroutine Description

The SATURN code contains a total of 14 subroutines. In developing the code, a modular approach was used. That is, each subroutine performs a specific task within the total calculational procedure. As a result, the code is versatile, because of the ease of adding another module to the system. Table 5-5 describes the principal function performed by each subroutine in the SATURN code.

### 5.6.2 Calculational Procedure

The general code logic for the SATURN code is shown in Figure 5-2. As shown, the calculational procedure is straightforward.

The calculational procedure begins in the SATURN main program, where the core is zeroed out and the flexible dimension arrays are defined. The RING 1 subroutine is then used to read the cross section data, perform relabeling (if requested) and compute the total upscatter cross section. If adjoint theory calculations are to be performed, subroutine ADJN performs the necessary adjoint reversal of the cross section data. Subroutine PLSUM is used to compute a transport correction for  $P_g$  data for use with transverse leakage data. The RING 3 subroutine is used to prepare the group-independent tape. At this point, if mixtures are desired, subroutine MIX is used to combine the cross section data. If a group-dependent tape is requested, subroutine RING 2 is used to generate this tape from the group-independent tape generated in subroutine RING 3. Each output tape is rewound and contains an end-of-file mark. The problem is then terminated.

TABLE 5-5

## LIST OF SATURN CODE SUBROUTINES AND THEIR FUNCTIONS

<u>Subroutine Name</u>	<u>Principal Operation</u>
SATURN	Zero out core, compute flexible dimensions, and control overall program logic
RING 1	Read cross section data, perform relabeling task, and compute total upscatter cross section
RING 2	Prepare group-dependent cross section tape from group-independent tape
RING 3	Prepare group-independent cross section tape and control mixture operations
TRANS	Add in transverse leakage correction data
MIX	Perform cross section mixture operations
PLSUM	Compute a transport correction for P(L) data for use with transverse leakage data
ADJN	Perform adjoint reversal of cross section data
ERROT	Print out end-of-file error message and related information
FIDO	Generalized, input data read routine
WOT	Print out, 1-, 2-, or 3- dimensional arrays
DUMP	Special subroutine to assist in debug of code
WOT 8	Print out up to 8 columns of fixed and/or floating point data of variable length
OW	Print out special page at normal termination of a calculation

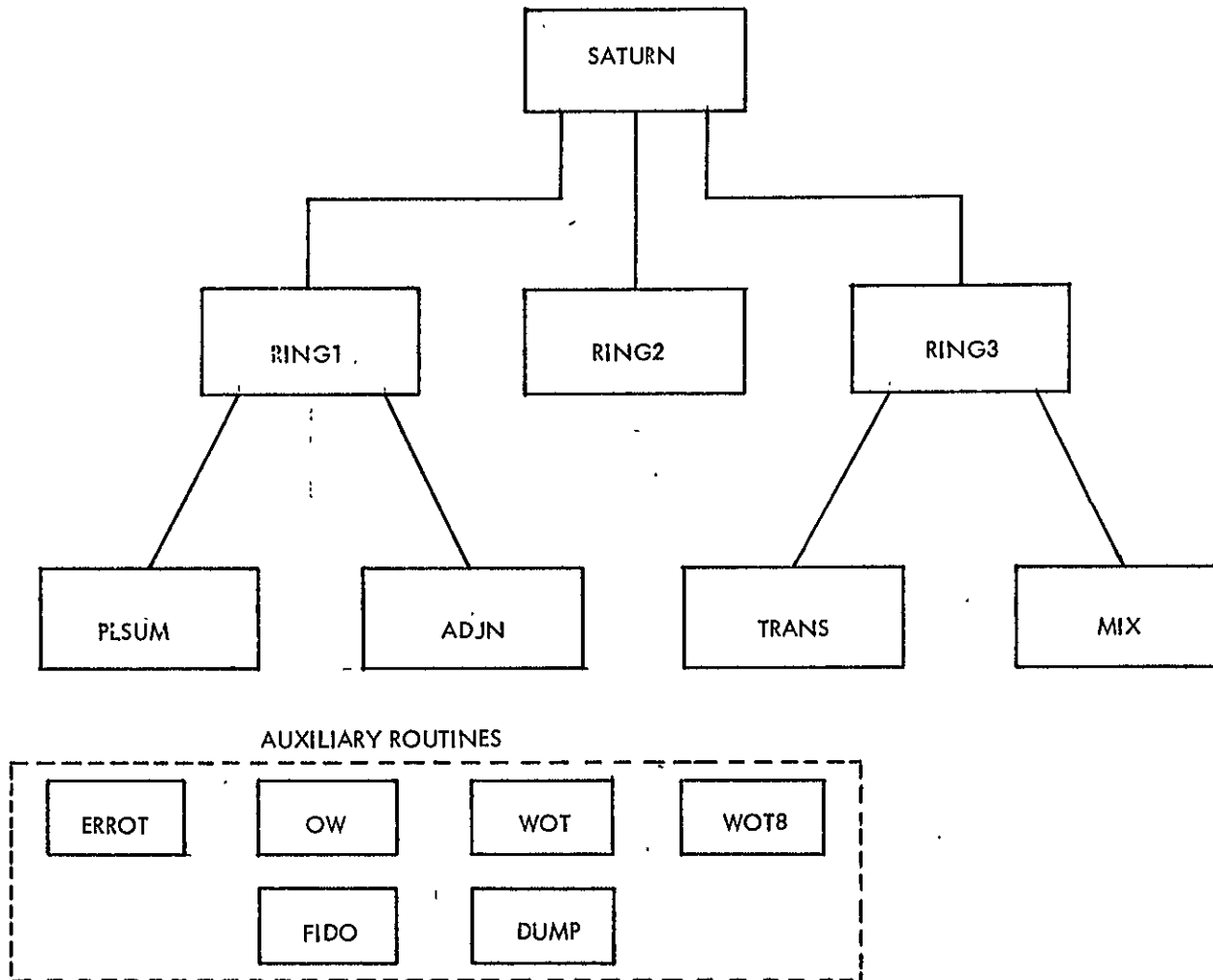


Figure 5-2. Code Logic for the SATURN Code

## 5.7 METHOD OF SOLUTION

Because the SATURN code is an auxiliary, data processing code, the method of solution in the code reduces to the program logic described in Section 5.6. A thorough discussion of the mixing table calculations and transverse leakage calculations is given in Sections 5.3.1 and 5.3.2, respectively. These two sections represent the only set of calculations in the code. All other operations are processing operations to prepare the data in the proper format for use in the ANISN-W and DOT-IIW codes.