COMPUTER CODE ANISN MULTIPLYING MEDIA AND SHIELDING CALCULATION II. CODE DESCRIPTION (INPUT/OUTPUT)

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1. INTRODUCTION

ANISN code was originally developed by Oak Ridge National Laboratory, by Engle /1/ in 1965, and it was an improvement of the early DTF.II code /2/. It was designed to solve the one-dimension transport equation for neutron or gamma-rays in slab, sphere, or cylinder geometry with general anisotropic scattering. The source may be fixed, fission, or a subcritical combination of two. Criticality search may be performed on any one of several parameters. Cross sections may be weighted using the space and energy dependent flux generated by solving the transport equation. The solution technique is an advanced discrete ordinates, and it was described in part I.

There are several versions of ANISN; and most of them are distributed by NUCLEAR ENERGY AGENCY DATA BANK (NEA), in Europa, and by RADIATION SHIELDING INFORMATION CENTER (RSIC) in the USA. Among Several Versions of ANISN, there are:

i) ANISN-ORNL(CCC-0254)
ii) ANISN-E (CCC-0082)
iii) ANISN-W (CCC-0255)
iv) ANISN-JR (CCC-0082).

Recently (March 1985), Parsons & Nigg adapted ANISN-W for personal micromputers (PC), CCC-255-C, and after a new version CCC-0514-ANISN/PC was released, and is currently distributed by NEA-Data Bank or RSIC. Since this version will be used during the "Workshop on Reactor Physics Calculation for Application in Nuclear Technology", in Appendix I, a description of the package (CCC-0514); as given by RSIC, is included, as well as, a "GENERAL DESCRIPTION OF ANISN/PC", given by the file "READ.ME". In addition to the ANISN/PC Code, the transmittal package includes an interactive input generator programa ("user friendly") called APE (ANISN Processor and Evaluator), which facilitate

the work of the user in giving input. Also, a 21 group photon cross section master library (FLUNGP.LIB) in ISOTX format, which can be edited by an executable file (LMOD.EXE), is included in the package.

Although, the general description of the input, output, subroutines etc are provided by the manuals of the several versions of ANISN /3,4/, here we wish to review briefly these topics, in order to condense these informations, and help the participants of the workshop to be more acquaintance with the code.

2. INPUT DATA DESCRIPTION

The input method used by ANISN is the FIDO system /5/, in which the data enter in units called "arrays", and in short they are divided into the following data sets:

i) Problem Title
ii) Problem Parameters (Integer and Floating Point)
iii) Cross Section Data
iv) Fixed, or shell, Source Data
v) Flux, or Fission Guess data
vi) Remainder of data.

There are three types of input format: fixed-field, or standard; free field input; and user-field, or non-standard. In the standard format, each 72 columns are divided into 6 fields (12 columns) and each field divided into 3 subfields. The first subfield (2 columns) is the data array identification, the second subfield (1 columns) defines operation type, or data type ($ - Integer; or * - real), and the third subfield (9 columns) is the data field. The format for the field is (I2,A1,F9.0).

The operation type (2nd subfield) is given by the following characters:

i) $ (integer) - indicates the beginning of an integer array, with a number in the first subfield identifying the array.

ii) * (real, or floating point) - indicates the beginning of a real array, with a number in the first subfield identifying the array.

iii) R (repeat) - indicates that the data contained in the "data field" are repeated R times, being the number of repetion indicate in the first subfield.

iv) I (interpolation) - indicates "linear interpolation" between the data in the associated third subfield. The first subfield defines the number of interpolation between the two data entries.

v) L (logarithmic interpolation) - indicates "logarithmic interpolation".

vi) T ("termination") - indicates termination of data for a particular subset. All entries following "T" are ignored, and the program proceeds to the next subset.

vii) S (skip) - indicates the number of entries to be skipped (1st subfield).

viii) F (filled) - indicates that the remainder of the array is to be filled with the data entered in the third subfield.

ix) + or - (exponentiation) - indicates that the data is multiplied by $10^{\pm N}$, where N is specified in the 1st subfield.

x) Z (zeros) - indicates the entry of N zeros, where N is specified in the first subfield.

xi) Q (sequence repeat) - indicates to repeat a sequence of numbers N times; N specified in the first subfield, and the lenght of the sequence indicated in the third subfield. As example, 1;2:3;2Q2 is equivalente to 1;2;3;1;2;1;2.

xii) N (interated sequence repeat) - has the same effect as "Q", except that the order of the sequence is reversed, as example: 1;2;3;2N2 is equivalent to 1;2;3;3;2;3;2.

xiii) M (negative inverted sequence repeat) - has the same effect as "N", except that the signs of the previous entries are reversed; as example 1;2;3 ; 2M2 is equivalent to 1;2;3;-3;-2;3;2.

xiv) E (End) - indicates the end of the array; this option skips to the end of an array.

In the standart format some aditional restriction must e observed. Thus, for instance, the third subfield of an rray definition (ex:15$, 8$;6* etc) must be skipped, and he input data must start in the next field. Enclosed (ANISN INPUT DATA SHEET), there are some examples of these perations.

In the free-format, option, there are few restriction in the format of the input data: i) the indicator of the type of the array must be entered twice (i.e, "$$", or "**"); ii) blanks separate fields; iii) number written with exponents must not have imbedded blanks, i.e, 1.0E+4 , 1.0E4, 1.0+4, but not 1.0 ß E4; iv) in the data field, only 9 digits, including the decimal, but not including the exponent field, can be used.

In the user-format, the user specifies the input format. The array identifier in this case is the character "U" or "V", and the format, in the rules of ordinary FORTRAN, must be given in the data field. In ANISN-W version, U is a non-standard format 6E12.5, and V is a 4(1X,E16.9 , 1X) format.

ANISN INPUT DATA SHEET

Name: J.R.Maiorino Problem: Examples of Operation Date: 1990 Page: 01

CARD	ARRAY	OP.	DATA FIELD	COMMENTS
	1 2	3	4 5 6 7 8 9 10 11 12	
	1 5	$		i) example of ($) operator
	13 14	15	16 17 18 19 20 21 22 23 24	
	1 6	*		ii) example of (*) operator
	25 26	27	28 29 30 31 32 33 34 35 36	iii) example of R
	1 0	R	1 . 0	operator.
	37 38	39	40 41 42 43 44 45 46 47 48	iv) example of
	4	I	0 . 0	interpolation;
	49 50	51	52 53 54 55 56 57 58 59 60	0.0/0.25;0.5;0.75/1.0
			1 . 0	
	61 62	63	64 65 66 67 68 69 70 71 72	v) example of F operator
		F	1 . 0	
	1 2	3	4 5 6 7 8 9 10 11 12	vi) example of exponentia
	5	+	3 . 0	tion ($3x10^5$).
	13 14	15	16 17 18 19 20 21 22 23 24	vii) example of zeros
	2	Z		(0.0;0.0)
	25 26	27	28 29 30 31 32 33 34 35 36	viii) example of free-
	1 5	$	$ 1 0 1 6	format
	37 38	39	40 41 42 43 44 45 46 47 48	ix) example of user-
	6	U	(6 E 1 2 . 5)	format.
	49 50	51	52 53 54 55 56 57 58 59 60	
	61 62	63	64 65 66 67 68 69 70 71 72	

R-Repeat I-Interpolate T-Terminate "+"or"-"-Exponentiation S-Skip $-integer *-real

EXAMPLES OF APE32 SCREENS

```
**********************************************************************

      INEL INTERACTIVE INPUT PROCESSOR AND EVALUATOR
          FOR THE ANISN-PC TRANSPORT CODE
              (VERSION 3.2, April, 1987)

      IDAHO NATIONAL ENGINEERING LABORATORY
            EG&G IDAHO, INC
            P.O. BOX 1625
          IDAHO FALLS, ID 83415

**********************************************************************

Beginning screen initialization for APE.  Does your machine recognize the
DOS screen clear escape sequence? (Y/N; Default=Yes)

**********************************************************************
                FILE PROCESSING MODULE FOR ANISN-PC
**********************************************************************

You are updating an old file.  In order for all arrays to be properly
processed, the old file should be in APE format.

Enter the file name for the old ANISN-PC input file: anisn1

The old file to be read is anisn1

Is this OK? (Y/N; Default=Yes) y

Enter the name for the new file to be generated: test

The name of the new file will be test

Is this OK? (Y/N; Default=Yes)
```

EXAMPLES OF APE32 SCREEN5

```
**********************************************************************
              MAIN MODULE FOR ANISN-PC INPUT FILE GENERATOR
**********************************************************************

This program will interactively generate an input file for the ANISN-PC Sn
transport code.  An entirely new file can be created or an existing file can
be reviewed and/or updated.  In either case the program leads interactively
through the file, prompting for information as it goes.  At some points,
numerical data are requested.  At others a simple 'YES' or 'NO' response is
all that is required.  In most cases when a 'YES/NO' response is requested
the word 'FILE' can also be entered.  This will cause a program exit and
the file being created will be saved as it stands.  This file can then be
finished at a later time by updating it as an old file.  In addition, when
vector contents are being displayed to the screen, the response 'REV' is
allowed.  This redisplays the data to the screen for review.  Only the first
letter of each of the commands described above needs to be entered.  Finally,
it may be noted that in most cases when numerical data are requested, default
values are displayed.  These may be selected by simply pressing 'ENTER'.

Do you want to create a new input file or review and update an old one?

Enter 'NEW' or 'OLD':
```

```
************************** ARRAY MENU ******************************

 15$$  The integer control array.
 16**  The floating point control array.
 14**  The input stream cross section array.
 3**   The flux guess array.
 1**   The fission spectrum (Chi) array.
 4**   The mesh line coordinate array.
 5**   The velocity array.
 6**   7**  The angular quadrature weight and cosine arrays.
 8$$   The zone number by mesh array.
 9$$   The material number by zone array.
 10$$  11$$  12**  The mix table arrays (Material, Component, Density)
 19$$  The P1 scatter order array.

Enter an array identifier to work on.  (Enter 'FILE' to exit)
```


When using ANISN-PC (CCC-0514), the user does not need to care with the input format, since this version has an interactive input generator (executable file, APE32.EXE) , which facilitate the user in his work of create new input files, or modifying old input files. Examples of the some screens displayed by APE32.EXE is enclosed to this notes, in order to illustrates the main features of this interactive input generator.

The input parameters starts with a title, containing 48 character (12A6), and a CPU time estimate (E8.5), which is optional. Following, the problem parameters are given by 15$, and 16* array. Cross Section Data are given by 13$, or 14*, arrays. Fixed, or shell, source data by 17*, or 18* arrays, and flux, or fission, guess data given in 2*, and 3* arrays. The remainder of data are given through arrays 1 to 28. A description of the input data; are enclosure with this note.

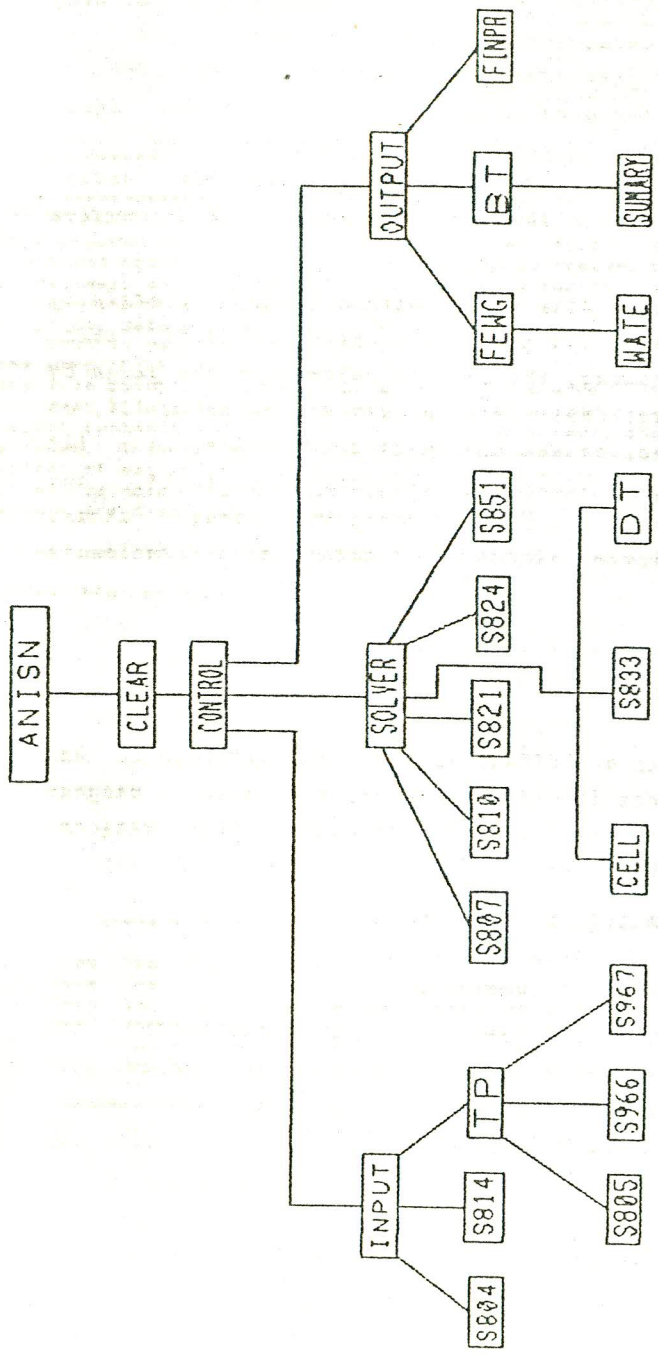
3. CODE STRUCTURE DESCRIPTION

ANISN code is a FORTRAN program , and although it has been modified since its first version, the basic program logic continues almost the same. Basically, ANISN performs the following operation:

- problem set up operation
- iterative calculations
- concluding calculations.

In figure 1, a flowchart structure of ANISN-PC, is reproduced to illustrate the main feature of the code. Also, a list of the main subroutines with their principal operation is illustrated in table 1.

The general information of the version ANISN-PC (CCC - 514 Micro) are included in the appendix. The source file (FOR) for ANISN-PC is divided in 4 files (ANISN1.FOR;



PROBLEM SETUP OPERATION ITERATIVE CALCULATIONS CONCLUDING CALCULATIONS

INF. MEDIA TRANSPORT DIFFUSION

FIGURE 1: FLOWCHART STRUCTURE OF ANISN-PC SUBROUTINES

(ANISN.2.FOR; ANISN3.FOR, and ANISN4.FOR). The first file contain driver and control routines, the second, input processing, the third contains solution routines, and the fourth, the output processing routines.

Table 1. List of ANISN-PC (CCC-0514) Code Subroutines And Their Principal Operation.

Subroutine name	Principal Operation
CONTRL	Overall Control of Program information flow. Open files and calls 3 main subroutines: 1. INPUT - Setup memory map in the master array and input data; 2. SOLVER - controls iteration loops; 3. OUTPUT - concluding remarks.
CLEAR	initialize the master array, and also print the heading.
ERRO	Prints error message and stops problem execution.
WOT	Print Routine.
WOT 8	Print Routine.
INPUT	Input Control prior iteration (in ANISN-W the equivalent routine is PLSNT).
FIDO	Generalized input routine.
TP	Reads Cross Section, and Source if IEVT=0, and Flux or Fission Guess, Also prepares tapes when IDAT1.NE.0.
S805	Performs adjoint reversal of cross section data.
S804	Check S_N constants and compute P_L constants.

(Table 1 - Continue)

S814	Compute Areas and Volumes for Initial Print and Source Normalization, sums fission spectrum, and if IEVT=0, computes total fixed source by Group and Normalizes Source.
S966	Read Neutron or Neutron Gamma Cross Section. In ANISN-PC it reads from the ISOTXS format "ANISNC4.LIB" file on unit 4.
S967	Read Gamma cross section from the ISOGXS format "ANISNC4. LIB" file on unit 4. Not available on ANISN-W.
MESH	Write Mesh intervals.
SOLVER	Controls the iteration link. Also checks the largest mesh cell in each zone in terms of mean free path. In ANISN-W an equivalent routine is GUTS.
S807	Mixes cross section (mixing table).
S810	Computes Geometry Dependent Arrays.
S821	Computes and Normalizes Fission Source. Also normalizes Fluxes when necessary (current also).
S824	Computes total source exclusive of In group Scatter for each interval.
DT	Diffusion Theory calculation (inner iteration). DT is used when no flux guess is intered or when specified by IDAT 2 and 24$.
CELL	Homogeneous one regions cell calculation.

(Table 1 - Continue)

S833	Transport Theory Calculation (inner iteration).
S851	Test outer iteration convergence, Compute new eigen values for Search.
OUTPUT	Controls the output link. In ANISN-W the equivalent subroutine is FINPR1.
FINPR	Final Output and Activities.
BT	Balance Tables.
SUMMARY	Summary Prints. Prints and Compute Summary Table.
FACTOR	Disadvantage Factor Calculation (only if ID> 1000).
FEWG	Preliminary Calculation for Cross Section weighting.
WATE	Cross Section Weighting Calculation (Flux Weighted).

4. DESCRIPTION OF OUTPUT

Output from an ANISN-PC problem can be obtained in screen, printed paper, or in a file. The information displayed by the code include the following:

i) title problem.

ii) a brief edit of 15$ and 16* array (problem definition), with a short explanation; see enclosure.

iii) a list of arrays read, with the number of entries, see enclosure.

iv) a list of the zone numbers by interval; radii, areas and volumes, fission density, and density factor if any; see enclosure.

v) a list of the zone; fission spectrum; velocities; right albedo (RT); left albedo (LFT); diffussion calculation marker (DIFF MARKER); material number (MAT'L/ZONE); order of scattering by zone (L OF P(L)) and the radius modifiers (RADIUS MOD); see enclosure.

vi) a list of cross section mixing table, including mixture, component, and number density; and a list of angular quadrature constants including direction cosine, weight, the reflected direction indices, and the product of cosines and weights (WT*COS). If ISCT>1, the Legendre coefficients used in the anisotropic scattering source is displayed, see enclosure.

vii) optionally (IPRT=0), the cross section for MT materials as given in the input, computed or modified via mixing table are displayed.

ix) next, an indication that the iterative calculation has been initiated is indicated by displaying the iteration monitor (OUTER, INNER iteration counter, balance (gain/losses), eingevalue (k); Source ration (lambda 1, λ_1), scattering ration (λ_2) and upscattering ratio . At the end of each outer iteration these counters are displayed, indicating the number of inner iteration for each outer, and the criticality balance indicators for an outer iteration are also displayed (note that with the exception of the multiplication factor, Keff, these numbers must be close to one). Imediatelly following the final iteration monitor, the zone numbers, radius, interval midpoints, area, volume and fission density (source neutrons/cm^3.sec.) are printed. See enclosure.

x) Optionaly (ID3≠0), activities calculated by ANISN are printed. First the activity number, material number, and position are displayed. The units used in the activities by zone are reactions per second. Finally, if ID4≠0, then interval activities (reactions.cm^{-3}.sec^{-1}) are displayed.

xi) The total fluxes (particles. cm^{-2}.sec^{-1}) by group and calculated at midpoint is printed. See enclosure.

xii) Optionally, (IEVT=0), the fixed source can be displayed, by group and at interval midpoint. The units of the source is particles per unit cm^3 and second, and in the case of shell source, particles per cm^3, second and unit weight. Also optionally (ID1=1), angular fluxes can be displayed by group, angle and midpoint interval in units of particle. cm^{-2}.seg^{-1}. To convert flux per steradian, one must divide by 4π.

xiii) Summary tables for each zone and by group, including sum for all groups in the last line, and also a summary for all system are displayed for the quatities: Fixed Sources; Fission Sources; In Scatter; Self Scatter; Out Scatter; Absorption; Net Leakage; Balance; Right Boundary Flux; Right

Boundary J^+; Right Boundary J; Right Leakage; Left Leakage; Fission Rate; Total Flux; Density. Enclosed, a summary Table for a sample problem is illustrated. In the summary tables, all reaction rates have units of reactions per second; balance is calculated as ratio of source to losses; the total flux is the sum over the appropriate intervals of the product of the scalar flux and the interval volume, and densityis the total flux divided by the group velocity.

xiv) optionally (IFG=1), cross section weighting data will be displayed, as given in 27$ and 28$ arrays. If cell calculation was performed, a Message is displayed.


```
*************************************************************
*                                                           *
*                                                           *
*  AAAAAAAA  NN       NN IIIIIIIIII  SSSSSSSS  NN       NN  *
* AAAAAAAAAA NNN      NN IIIIIIIIII SSSSSSSSSS NNN      NN  *
* AA      AA NNNN     NN     II     SS         NNNN     NN  *
* AA      AA NNNNN    NN     II     SS         NNNNN    NN  *
* AAAAAAAAAA NN NNN   NN     II      SSSSSSSS  NN NNN   NN  *
* AAAAAAAAAA NN  NNN NN     II       SSSSSSSS NN  NNN NN  *
* AA      AA NN   NNNNN     II             SS NN   NNNNN  *
* AA      AA NN    NNNN     II             SS NN    NNNN  *
* AA      AA NN     NNN IIIIIIIIII SSSSSSSSS NN     NNN  *
* AA      AA NN      NN IIIIIIIIII  SSSSSSSS  NN      NN  *
*                                                           *
*          INEL IBM-PC VERSION 3.0 (APR 1987)               *
*            IBM PRO. FORTRAN COMPILER 1.0                  *
*                                                           *
*                  D. KENT PARSONS                          *
*          IDAHO NATIONAL ENGINEERING LABORATORY            *
*                    EG&G IDAHO, INC                        *
*                    P.O. BOx 1625                          *
*                 IDAHO FALLS, ID 83415                     *
*                                                           *
-- More --
*************************************************************
```

```
ANISN 4 GROUP P1 REFLECTED CYLINDER ENGENVALUE TEST PROBLEM 1  (14**)

  15$ ARRAY     36 ENTRIES READ

  16* ARRAY     14 ENTRIES READ

   01

 ID    PROBLEM ID NO.                1     ITH   0/1 = REG./ADJ.                  0
 ISCT  ORDER OF SCATTERING           1     ISN   QUADRATURE ORDER                 4
 IGE   1/2/3 = PLA/CYL/SPH           2     IBL   0/1/2/3 = VAC/REFL/PER/ALBDO    1
 IBR   RT BC SAME AS LEFT BC,IBL     0     IZM   NO. OF ZONES                     2
 IM    NO. OF INTERVALS             25     IEVT  0/1/2/3/4/5/6=O/K/A/C/Z/R/H      1
 IGM   NO. OF GROUPS                 4     IHT   POS. OF SIGMA T                  3
 IHS   POS. OF SIGMA GG              5     IHM   TABLE LENGTH                     8
 MS    MIXING TABLE LENGTH           4     MOR   NO. MATLS. FROM CARDS           4
 MTP   NO. MATLS. FROM LIB TAPE      0     MT    NO. OF MATLS.                    8
 IDFM  0/1=NONE/DEN FACTORS(21*)     0     IPVT  0/1/2=NONE/K/ALPHA               0
 IQM   0/1=NONE/DIST. SOURCE         0     IPM   0/1/IM=NO/S(MM,IPP)/S(MM,IM)   0
-- More --
```

```
 IFF    INT OF SHELL SOURCE                0     IIM   INNER ITER. MAX.                  20

 ID1    0/1/2/3=NO/PRINT/PNCH/BOTH         0     ID2   -N/-1/0/1/2=ITX/IGX/-/ITX/PRV     0
 ID3    0/N=NO/ACTIV. BY ZONE              0     ID4   0/1=NO/ACTIV. BY INT              0
 ICM    OUTER ITER. MAX.                 100     IDAT1 0/1/2=NO/MIN/MAX TAPE             0
 IDAT2  0/1=NO/DIFF/INFN(24$)              0     IFG   0/1/2/3/4 NO/FG/R/W/RW            0
 IFLU   -1/0/1/2/3/4=DSA/LS/L/S/W/LW-1     1     IFN   -1/0/1/2=CCCC/2*/3*/PREV.        1
 IPRT   0/1 = PRINT XS/DO NOT              0     IXTR  0/1/2/3=FLUX SAVE-NO/R/W/R&W      0

 EV     EIGENVALUE GUESS          1.000E+00     EVM   EV MODIFIER, SEARCH       0.000E-01
 EPS    PRECISION DESIRED         1.000E-04     BF    BUCKLING FACTOR           0.000E-01
 DY     CYL OR PLA HEIGHT         0.000E-01     DZ    PLANE DEPTH               0.000E-01
 DFM1   HT. FOR VOID CORR.        0.000E-01     XNF   NORMALIZATION             1.000E+00
 PV     IPVT=1/2 - K/ALPHA        0.000E-01     RYF   SCAT, UPSCAT RELAX        5.000E-01
 XLAL   PT CONV EPS IF NE 0       2.000E-04     XLAH  1-LAMBDA MAX.,SEARCH      0.000E-01
 EQL    EV DEL EPS.,SEARCH        0.000E-01     XNPM  UNDERRELAXATION,SEARCH    0.000E-01

 80002 LOCATIONS ARE AVAILABLE FOR THIS PROBLEM

  2554 LOCATIONS WILL BE REQUIRED FOR FLUX CALCULATION

  1451 LOCATIONS WILL BE REQUIRED FOR COMPLETE SUMMARY TABLES

-- More --


  1690 LOCATIONS WILL BE REQUIRED FOR COMPLETE ACTIVITY TABLES

   832 BYTES WILL BE REQUIRED FOR THE PROFORT RUN-TIME BUFFER

   14* ARRAY    128 ENTRIES READ

    OT

    3* ARRAY    100 ENTRIES READ

    OT

    1* ARRAY      4 ENTRIES READ

    4* ARRAY     26 ENTRIES READ

    5* ARRAY      4 ENTRIES READ

    6* ARRAY      8 ENTRIES READ

    7* ARRAY      8 ENTRIES READ

    8$ ARRAY     25 ENTRIES READ
-- More --
```



```
    9$ ARRAY      2 ENTRIES READ

   10$ ARRAY      4 ENTRIES READ

   11$ ARRAY      4 ENTRIES READ

   12* ARRAY      4 ENTRIES READ

   19$ ARRAY      2 ENTRIES READ

    OT


 ANISN 4 GROUP P1 REFLECTED CYLINDER ENGENVALUE TEST PROBLEM 1  (14**)

 GEOMETRY EDIT

 INT   ZONE       RADIUS      AREA       VOLUME
   1     1    0.000E-01 0.000E-01 1.257E+01
   2     1    2.000E+00 1.257E+01 3.770E+01
   3     1    4.000E+00 2.513E+01 6.283E+01
-- More --

   4     1    6.000E+00 3.770E+01 8.796E+01
   5     1    8.000E+00 5.027E+01 1.131E+02
   6     1    1.000E+01 6.283E+01 1.382E+02
   7     1    1.200E+01 7.540E+01 1.634E+02
   8     1    1.400E+01 8.796E+01 1.885E+02
   9     1    1.600E+01 1.005E+02 2.136E+02
  10     1    1.800E+01 1.131E+02 2.388E+02
  11     1    2.000E+01 1.257E+02 2.639E+02
  12     1    2.200E+01 1.382E+02 2.890E+02
  13     1    2.400E+01 1.508E+02 3.142E+02
  14     1    2.600E+01 1.634E+02 3.393E+02
  15     1    2.800E+01 1.759E+02 3.644E+02
  16     2    3.000E+01 1.885E+02 3.896E+02
  17     2    3.200E+01 2.011E+02 4.147E+02
  18     2    3.400E+01 2.136E+02 4.398E+02
  19     2    3.600E+01 2.262E+02 4.650E+02
  20     2    3.800E+01 2.388E+02 4.901E+02
  21     2    4.000E+01 2.513E+02 5.152E+02
  22     2    4.200E+01 2.639E+02 5.404E+02
  23     2    4.400E+01 2.765E+02 5.655E+02
  24     2    4.600E+01 2.890E+02 5.906E+02
  25     2    4.800E+01 3.016E+02 6.158E+02
  26          5.000E+01 3.142E+02
-- More --
```

ANISN 4 GROUP P1 REFLECTED CYLINDER ENGENVALUE TEST PROBLEM 1 (14**)

GROUP DEPENDENT PARAMETERS EDIT

GRP	FISS SPEC	VELOCITY
1	7.376E-01	1.000E+00
2	2.622E-01	1.000E+00
3	2.000E-04	1.000E+00
4	0.000E-01	1.000E+00

ANISN 4 GROUP P1 REFLECTED CYLINDER ENGENVALUE TEST PROBLEM 1 (14**)

ZONE DEPENDENT PARAMETERS EDIT

ZONE	MATL/ZONE L OF P(L)	
1	5	1
2	7	1

-- More --

ZONE	WIDTH	OUTER RADIUS	NO. OF INT.
1	3.00000E+01	3.00000E+01	15
2	2.00000E+01	5.00000E+01	10

ANISN 4 GROUP P1 REFLECTED CYLINDER ENGENVALUE TEST PROBLEM 1 (14**)

CROSS SECTION MIXING TABLE

	MATL	COMP.	NO. DENSITY
1	5	1	1.000E+00
2	6	2	3.000E+00
3	7	3	1.000E+00
4	8	4	3.000E+00

ANISN 4 GROUP P1 REFLECTED CYLINDER ENGENVALUE TEST PROBLEM 1 (14**)

ANGULAR QUADRATURE CONSTANTS

-- More --

ANGLE	COSINE(MU)	WEIGHT	REFL DIR.	WT * COS
1	-4.950E-01	0.000E-01	3	0.000E-01
2	-3.500E-01	1.667E-01	3	-5.834E-02
3	3.500E-01	1.667E-01	2	5.834E-02
4	-9.367E-01	0.000E-01	8	0.000E-01
5	-8.689E-01	1.667E-01	8	-1.448E-01
6	-3.500E-01	1.667E-01	7	-5.834E-02
7	3.500E-01	1.667E-01	6	5.834E-02
8	8.689E-01	1.667E-01	5	1.448E-01

CROSS SECTION EDIT

LEGEND FOR CROSS SECTION TABLES

POS.	DESCRIPTION
1	SIGMA ABSORPTION FOR GROUP G
2	NU SIGMA FISSION FOR GROUP G

-- More --

3	SIGMA TOTAL FOR GROUP G
4	SIGMA UP-SCATTERING FROM G+ 1 TO G
5	SIGMA SCATTERING FROM G TO G
6	SIGMA DOWN-SCATTERING FROM G- 1 TO G
7	SIGMA DOWN-SCATTERING FROM G- 2 TO G
8	SIGMA DOWN-SCATTERING FROM G- 3 TO G
9	SIGMA UP-SCATTERING FROM GROUP G (CALCULATED BY THE CODE)

MATERIALS 1 THROUGH 4 ARE FROM CARDS
MATERIALS 5 THROUGH 8 ARE FROM THE MIXING TABLE

MAT. 1

POS.	GRP. 1	GRP. 2	GRP. 3	GRP. 4
1	6.98600E-04	7.59600E-04	1.55600E-02	1.75600E-01
2	9.73500E-04	1.15300E-03	1.75600E-02	2.38000E-01
3	2.22938E-01	5.18082E-01	7.09048E-01	1.46011E+00

-- More --

4	0.00000E-01	0.00000E-01	6.10100E-04	0.00000E-01
5	1.60940E-01	4.50880E-01	6.35970E-01	1.28390E+00
6	0.00000E-01	5.82400E-02	6.64420E-02	5.75180E-02
7	0.00000E-01	0.00000E-01	3.05900E-03	0.00000E-01
8	0.00000E-01	0.00000E-01	0.00000E-01	0.00000E-01
9	0.00000E-01	0.00000E-01	0.00000E-01	6.10100E-04

MAT. 2

POS.	GRP. 1	GRP. 2	GRP. 3	GRP. 4
1	0.00000E-01	0.00000E-01	0.00000E-01	0.00000E-01
2	THRU 3 SAME AS ABOVE			
4	0.00000E-01	0.00000E-01	4.42600E-04	0.00000E-01
5	7.42100E-02	2.01900E-01	3.68900E-01	3.08260E-01
6	0.00000E-01	2.17600E-02	2.85700E-02	1.63770E-02
7	0.00000E-01	0.00000E-01	0.00000E-01	0.00000E-01
8	0.00000E-01	0.00000E-01	0.00000E-01	0.00000E-01
9	0.00000E-01	0.00000E-01	0.00000E-01	4.42600E-04

MAT. 3

-- More --

POS.	GRP. 1	GRP. 2	GRP. 3	GRP. 4
1	-7.32200E-03	1.39900E-05	2.17990E-04	3.55020E-03
2	0.00000E-01	0.00000E-01	0.00000E-01	0.00000E-01
3	3.06105E-01	6.65321E-01	8.68195E-01	1.11655E+00
4	0.00000E-01	0.00000E-01	4.98000E-04	0.00000E-01
5	2.44130E-01	6.20770E-01	8.31580E-01	1.11250E+00
6	0.00000E-01	6.91190E-02	4.45370E-02	3.63970E-02
7	0.00000E-01	0.00000E-01	1.78300E-04	0.00000E-01
8	0.00000E-01	0.00000E-01	0.00000E-01	0.00000E-01
9	0.00000E-01	0.00000E-01	0.00000E-01	4.98000E-04

MAT. 4

POS.	GRP. 1	GRP. 2	GRP. 3	GRP. 4
1	0.00000E-01	0.00000E-01	0.00000E-01	0.00000E-01
2	THRU 3 SAME AS ABOVE			
4	0.00000E-01	0.00000E-01	2.00500E-04	0.00000E-01
5	8.97060E-02	1.27100E-01	1.92960E-01	1.15880E-01
6	0.00000E-01	7.03800E-03	7.77000E-03	3.16000E-09
7	0.00000E-01	0.00000E-01	0.00000E-01	0.00000E-01
8	0.00000E-01	0.00000E-01	0.00000E-01	0.00000E-01
9	0.00000E-01	0.00000E-01	0.00000E-01	2.00500E-04

-- More --

MAT. 5

POS.	GRP. 1	GRP. 2	GRP. 3	GRP. 4
1	6.98600E-04	7.59600E-04	1.55600E-02	1.75600E-01
2	9.73500E-04	1.15300E-03	1.75600E-02	2.38000E-01
3	2.22938E-01	5.18082E-01	7.09048E-01	1.46011E+00
4	0.00000E-01	0.00000E-01	6.10100E-04	0.00000E-01
5	1.60940E-01	4.50880E-01	6.35970E-01	1.28390E+00
6	0.00000E-01	5.82400E-02	6.64420E-02	5.75180E-02
7	0.00000E-01	0.00000E-01	3.05900E-03	0.00000E-01
8	0.00000E-01	0.00000E-01	0.00000E-01	0.00000E-01
9	0.00000E-01	0.00000E-01	0.00000E-01	6.10100E-04

MAT. 6

POS.	GRP. 1	GRP. 2	GRP. 3	GRP. 4
1	0.00000E-01	0.00000E-01	0.00000E-01	0.00000E-01
2	THRU 3 SAME AS ABOVE			
4	0.00000E-01	0.00000E-01	1.32780E-03	0.00000E-01
5	2.22630E-01	6.05700E-01	1.10670E+00	9.24780E-01

-- More --

6	0.00000E-01	6.52800E-02	8.57100E-02	4.91210E-02
7	0.00000E-01	0.00000E-01	0.00000E-01	0.00000E-01
8	0.00000E-01	0.00000E-01	0.00000E-01	0.00000E-01
9	0.00000E-01	0.00000E-01	0.00000E-01	1.32780E-03

MAT. 7

POS.	GRP. 1	GRP. 2	GRP. 3	GRP. 4
1	-7.32200E-03	1.39900E-05	2.17990E-04	3.55020E-03
2	0.00000E-01	0.00000E-01	0.00000E-01	0.00000E-01
3	3.06105E-01	6.65321E-01	8.68195E-01	1.11655E+00
4	0.00000E-01	0.00000E-01	4.98000E-04	0.00000E-01
5	2.44130E-01	6.20770E-01	8.31580E-01	1.11250E+00
6	0.00000E-01	6.91190E-02	4.45370E-02	3.63970E-02
7	0.00000E-01	0.00000E-01	1.78300E-04	0.00000E-01
8	0.00000E-01	0.00000E-01	0.00000E-01	0.00000E-01
9	0.00000E-01	0.00000E-01	0.00000E-01	4.98000E-04

MAT. 8

POS.	GRP. 1	GRP. 2	GRP. 3	GRP. 4

-- More --

```
  1   0.00000E-01 0.00000E-01 0.00000E-01 0.00000E-01
  2   THRU    3 SAME AS ABOVE
  4   0.00000E-01 0.00000E-01 6.01500E-04 0.00000E-01
  5   2.69118E-01 3.81300E-01 5.78880E-01 3.47640E-01
  6   0.00000E-01 2.11140E-02 2.33100E-02 9.48000E-03
  7   0.00000E-01 0.00000E-01 0.00000E-01 0.00000E-01
  8   0.00000E-01 0.00000E-01 0.00000E-01 0.00000E-01
  9   0.00000E-01 0.00000E-01 0.00000E-01 6.01500E-04

FOR ZONE  1, THE LARGEST MESH INTERVAL IS NUMBER   1 IN GROUP  4
AND IT IS  2.9202 MEAN FREE PATHS LARGE (BASED ON THE TOTAL XS)

FOR ZONE  2, THE LARGEST MESH INTERVAL IS NUMBER  16 IN GROUP  4
AND IT IS  2.2331 MEAN FREE PATHS LARGE (BASED ON THE TOTAL XS)


ITERATION EDIT

  OUTER INNER   BALANCE     EIGENVALUE   SRCE RATIO   SCAT RATIO  UPSCT RATIO
    1    21  9.99999E-01  1.16681E+00  1.16681E+00  0.00000E-01  1.91605E+00
-- More --

    2    34  9.99999E-01  1.16108E+00  9.95092E-01  1.00292E+00  1.02781E+00
    3    43  1.00000E+00  1.16081E+00  9.99766E-01  1.00015E+00  1.00098E+00
    4    52  1.00000E+00  1.16098E+00  1.00015E+00  9.99968E-01  9.99095E-01
    5    60  1.00000E+00  1.16112E+00  1.00012E+00  9.99969E-01  9.99306E-01
    6    68  1.00000E+00  1.16120E+00  1.00007E+00  9.99982E-01  9.99598E-01
    7    74  1.00000E+00  1.16125E+00  1.00004E+00  9.99988E-01  9.99784E-01
    8    79  1.00000E+00  1.16127E+00  1.00002E+00  9.99995E-01  9.99884E-01
              GROUP INNER   MFD      MAX. FLUX    MSF     MAX. SCALE  COARSE
                    ITERS   INT      DIFFERENCE   INT      FACTOR     MESH
                1     1     1    7.53560E-05     1    1.00012E+00     0
                2     1     2    2.95275E-05     1    1.00015E+00     0
                3     1     2    2.04189E-05     1    1.00013E+00     0
                4     1     1    1.99303E-05     1    1.00013E+00     0
    9    82  1.00000E+00  1.16128E+00  1.00001E+00  9.99997E-01  9.99939E-01

 ANISN 4 GROUP P1 REFLECTED CYLINDER ENGENVALUE TEST PROBLEM 1  (14**)

 INT   ZONE      RADIUS    INT MIDPT    AREA      VOLUME    FISS DENS
   1     1   0.000E-01  1.000E+00 0.000E-01  1.257E+01  4.693E-04
   2     1   2.000E+00  3.000E+00 1.257E+01  3.770E+01  4.673E-04
   3     1   4.000E+00  5.000E+00 2.513E+01  6.283E+01  4.633E-04
   4     1   6.000E+00  7.000E+00 3.770E+01  8.796E+01  4.574E-04
   5     1   8.000E+00  9.000E+00 5.027E+01  1.131E+02  4.497E-04
-- More --

    2    34  9.99999E-01  1.16108E+00  9.95092E-01  1.00292E+00  1.02781E+00
    3    43  1.00000E+00  1.16081E+00  9.99766E-01  1.00015E+00  1.00098E+00
    4    52  1.00000E+00  1.16098E+00  1.00015E+00  9.99968E-01  9.99095E-01
    5    60  1.00000E+00  1.16112E+00  1.00012E+00  9.99969E-01  9.99306E-01
    6    68  1.00000E+00  1.16120E+00  1.00007E+00  9.99982E-01  9.99598E-01
    7    74  1.00000E+00  1.16125E+00  1.00004E+00  9.99988E-01  9.99784E-01
    8    79  1.00000E+00  1.16127E+00  1.00002E+00  9.99995E-01  9.99884E-01
              GROUP INNER   MFD      MAX. FLUX    MSF     MAX. SCALE  COARSE
```



```
                    ITERS   INT      DIFFERENCE   INT      FACTOR     MESH
                1     1     1    7.53560E-05     1    1.00012E+00     0
                2     1     2    2.95275E-05     1    1.00015E+00     0
                3     1     2    2.04189E-05     1    1.00013E+00     0
                4     1     1    1.99303E-05     1    1.00013E+00     0
    9    82  1.00000E+00  1.16128E+00  1.00001E+00  9.99997E-01  9.99939E-01

 ANISN 4 GROUP P1 REFLECTED CYLINDER ENGENVALUE TEST PROBLEM 1  (14**)

 INT   ZONE      RADIUS    INT MIDPT    AREA      VOLUME    FISS DENS
   1     1   0.000E-01  1.000E+00 0.000E-01  1.257E+01  4.693E-04
   2     1   2.000E+00  3.000E+00 1.257E+01  3.770E+01  4.673E-04
   3     1   4.000E+00  5.000E+00 2.513E+01  6.283E+01  4.633E-04
   4     1   6.000E+00  7.000E+00 3.770E+01  8.796E+01  4.574E-04
   5     1   8.000E+00  9.000E+00 5.027E+01  1.131E+02  4.497E-04
-- More --

   6     1   1.000E+01  1.100E+01 6.283E+01  1.382E+02  4.402E-04
   7     1   1.200E+01  1.300E+01 7.540E+01  1.634E+02  4.291E-04
   8     1   1.400E+01  1.500E+01 8.796E+01  1.885E+02  4.163E-04
   9     1   1.600E+01  1.700E+01 1.005E+02  2.136E+02  4.025E-04
  10     1   1.800E+01  1.900E+01 1.131E+02  2.388E+02  3.868E-04
  11     1   2.000E+01  2.100E+01 1.257E+02  2.639E+02  3.716E-04
  12     1   2.200E+01  2.300E+01 1.382E+02  2.890E+02  3.539E-04
  13     1   2.400E+01  2.500E+01 1.508E+02  3.142E+02  3.452E-04
  14     1   2.600E+01  2.700E+01 1.634E+02  3.393E+02  3.533E-04
  15     1   2.800E+01  2.900E+01 1.759E+02  3.644E+02  5.518E-04
  16     2   3.000E+01  3.100E+01 1.885E+02  3.896E+02  0.000E-01
  17     2   3.200E+01  3.300E+01 2.011E+02  4.147E+02  0.000E-01
  18     2   3.400E+01  3.500E+01 2.136E+02  4.398E+02  0.000E-01
  19     2   3.600E+01  3.700E+01 2.262E+02  4.650E+02  0.000E-01
  20     2   3.800E+01  3.900E+01 2.388E+02  4.901E+02  0.000E-01
  21     2   4.000E+01  4.100E+01 2.513E+02  5.152E+02  0.000E-01
  22     2   4.200E+01  4.300E+01 2.639E+02  5.404E+02  0.000E-01
  23     2   4.400E+01  4.500E+01 2.765E+02  5.655E+02  0.000E-01
  24     2   4.600E+01  4.700E+01 2.890E+02  5.906E+02  0.000E-01
  25     2   4.800E+01  4.900E+01 3.016E+02  6.158E+02  0.000E-01
  26         5.000E+01             3.142E+02

 ANISN 4 GROUP P1 REFLECTED CYLINDER ENGENVALUE TEST PROBLEM 1  (14**)
-- More --
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TOTAL FLUX

INT.	GRP. 1	GRP. 2	GRP. 3	GRP. 4
1	4.47447E-03	5.26025E-03	4.83408E-03	1.57147E-03
2	4.45445E-03	5.23652E-03	4.81256E-03	1.56461E-03
3	4.41469E-03	5.19094E-03	4.77135E-03	1.55130E-03
4	4.35665E-03	5.12399E-03	4.71074E-03	1.53161E-03
5	4.28068E-03	5.03617E-03	4.63124E-03	1.50590E-03
6	4.18712E-03	4.92811E-03	4.53358E-03	1.47409E-03
7	4.07631E-03	4.80064E-03	4.41874E-03	1.43713E-03
8	3.94873E-03	4.65485E-03	4.28795E-03	1.39427E-03
9	3.80482E-03	4.49208E-03	4.14280E-03	1.34826E-03
10	3.64533E-03	4.31421E-03	3.98524E-03	1.29555E-03
11	3.47139E-03	4.12351E-03	3.81776E-03	1.24568E-03
12	3.28708E-03	3.92367E-03	3.64308E-03	1.18561E-03
13	3.10108E-03	3.71846E-03	3.46550E-03	1.16415E-03
14	2.92027E-03	3.51987E-03	3.28572E-03	1.21300E-03
15	2.53795E-03	3.27063E-03	3.12180E-03	2.06207E-03
16	1.75523E-03	2.72351E-03	2.84712E-03	3.86389E-03
17	1.03712E-03	2.01018E-03	2.39783E-03	5.22243E-03
18	6.70139E-04	1.44575E-03	1.91927E-03	5.66032E-03
19	4.42940E-04	1.02270E-03	1.48708E-03	5.53774E-03

-- More --

20	2.94603E-04	7.14379E-04	1.12082E-03	5.03191E-03
21	1.96123E-04	4.92868E-04	8.23597E-04	4.30639E-03
22	1.30215E-04	3.34507E-04	5.87137E-04	3.46203E-03
23	8.57099E-05	2.20308E-04	3.98941E-04	2.56134E-03
24	5.50314E-05	1.36124E-04	2.48041E-04	1.65864E-03
25	3.20798E-05	6.58349E-05	1.14955E-04	7.34917E-04

SUMMARY FOR ZONE 1 BY GROUP WITH SUM FOR ALL GRPS IN LINE 5 VOL= 2.82743E+03

GRP.	FIX SOURCE	FISS SOURCE	IN SCATTER	SLF SCATTER	OUT SCATTER	ABSORPTION
1	0.00000E-01	7.37600E-01	0.00000E-01	1.57676E+00	6.00563E-01	6.84431E-03
2	0.00000E-01	2.62200E-01	5.70588E-01	5.28392E+00	7.78647E-01	8.90185E-03
3	0.00000E-01	2.00000E-04	8.11040E-01	6.91623E+00	6.25513E-01	1.69216E-01
4	0.00000E-01	0.00000E-01	6.25513E-01	5.11006E+00	2.42829E-03	6.98907E-01
5	0.00000E-01	1.00000E+00	2.00714E+00	1.88870E+01	2.00715E+00	8.83869E-01

GRP.	LEAKAGE	BALANCE	RT BDY FLUX	RT BDY J+	RT BDY J	RT LEAKAGE
1	1.30192E-01	1.00000E+00	2.24429E-03	9.27282E-04	6.90692E-04	1.30192E-01
2	4.52383E-02	1.00000E+00	3.11632E-03	9.31080E-04	2.39997E-04	4.52383E-02
3	1.65095E-02	1.00000E+00	3.04889E-03	8.40442E-04	8.75854E-05	1.65095E-02
4	-7.58210E-02	9.99999E-01	2.88120E-03	5.55781E-04	-4.02243E-04	-7.58210E-02
5	1.16119E-01	1.00000E+00	1.12907E-02	3.25459E-03	6.16031E-04	1.16119E-01

-- More --

GRP.	LFT LEAKAGE	FISS RATE	TOTAL FLUX	DENSITY
1	0.00000E-01	5.53756E-03	9.79719E+00	9.79719E+00
2	0.00000E-01	1.35122E-02	1.17191E+01	1.17191E+01
3	0.00000E-01	1.90967E-01	1.08751E+01	1.08751E+01
4	0.00000E-01	9.47265E-01	3.98011E+00	3.98011E+00
5	0.00000E-01	1.16128E+00	3.63715E+01	3.63715E+01

SUMMARY FOR ZONE 2 BY GROUP WITH SUM FOR ALL GRPS IN LINE 5 VOL= 5.02655E+03

GRP.	FIX SOURCE	FISS SOURCE	IN SCATTER	SLF SCATTER	OUT SCATTER	ABSORPTION
1	0.00000E-01	0.00000E-01	0.00000E-01	4.95840E-01	1.40746E-01	-1.48713E-02
2	0.00000E-01	0.00000E-01	1.40384E-01	2.50559E+00	1.79763E-01	5.64673E-05
3	0.00000E-01	0.00000E-01	1.89174E-01	4.46792E+00	1.95554E-01	1.17122E-03
4	0.00000E-01	0.00000E-01	1.95554E-01	2.02156E+01	9.08314E-03	6.45119E-02
5	0.00000E-01	0.00000E-01	5.25113E-01	2.76850E+01	5.25146E-01	5.08683E-02

GRP.	LEAKAGE	BALANCE	RT BDY FLUX	RT BDY J+	RT BDY J	RT LEAKAGE
1	-1.25873E-01	9.99988E-01	2.17920E-05	1.37504E-05	1.37504E-05	4.31982E-03
2	-3.94345E-02	9.99993E-01	3.15691E-05	1.84741E-05	1.84741E-05	5.80382E-03
3	-7.54964E-03	9.99994E-01	4.89288E-05	2.85200E-05	2.85200E-05	8.95982E-03
4	1.21960E-01	9.99996E-01	2.53251E-04	1.46865E-04	1.46865E-04	4.61389E-02
5	-5.08968E-02	9.99992E-01	3.55541E-04	2.07609E-04	2.07609E-04	6.52224E-02

- More --

GRP.	LFT LEAKAGE	FISS RATE	TOTAL FLUX	DENSITY
1	1.30192E-01	0.00000E-01	2.03105E+00	2.03105E+00
2	4.52383E-02	0.00000E-01	4.03626E+00	4.03626E+00
3	1.65095E-02	0.00000E-01	5.37281E+00	5.37281E+00
4	-7.58210E-02	0.00000E-01	1.81713E+01	1.81713E+01
5	1.16119E-01	0.00000E-01	2.96115E+01	2.96115E+01

SUMMARY FOR SYSTEM VOLUME= 7.85398E+03

GRP.	FIX SOURCE	FISS SOURCE	IN SCATTER	SLF SCATTER	OUT SCATTER	ABSORPTION
1	0.00000E-01	7.37600E-01	0.00000E-01	2.07260E+00	7.41307E-01	-8.02702E-03
2	0.00000E-01	2.62200E-01	7.10972E-01	7.78951E+00	9.58411E-01	8.95831E-03
3	0.00000E-01	2.00000E-04	1.00021E+00	1.13842E+01	8.21067E-01	1.70388E-01
4	0.00000E-01	0.00000E-01	8.21068E-01	2.53257E+01	1.15114E-02	7.63419E-01
5	0.00000E-01	1.00000E+00	2.53225E+00	4.65719E+01	2.53230E+00	9.34737E-01

GRP.	LEAKAGE	BALANCE	RT BDY FLUX	RT BDY J+	RT BDY J	RT LEAKAGE
1	4.31982E-03	1.00000E+00	2.17920E-05	1.37504E-05	1.37504E-05	4.31982E-03
2	5.80382E-03	9.99999E-01	3.15691E-05	1.84741E-05	1.84741E-05	5.80382E-03
3	8.95982E-03	1.00000E+00	4.89288E-05	2.85200E-05	2.85200E-05	8.95982E-03
4	4.61389E-02	9.99999E-01	2.53251E-04	1.46865E-04	1.46865E-04	4.61389E-02
5	6.52224E-02	9.99999E-01	3.55541E-04	2.07609E-04	2.07609E-04	6.52224E-02

- More --

GRP.	LFT LEAKAGE	FISS RATE	TOTAL FLUX	DENSITY
1	1.30192E-01	0.00000E-01	2.03105E+00	2.03105E+00
2	4.52383E-02	0.00000E-01	4.03626E+00	4.03626E+00
3	1.65095E-02	0.00000E-01	5.37281E+00	5.37281E+00
4	-7.58210E-02	0.00000E-01	1.81713E+01	1.81713E+01
5	1.16119E-01	0.00000E-01	2.96115E+01	2.96115E+01

SUMMARY FOR SYSTEM VOLUME= 7.85398E+03

```
 GRP.  FIX  SOURCE FISS SOURCE IN  SCATTER SLF SCATTER OUT SCATTER  ABSORPTION
   1    0.00000E-01 7.37600E-01 0.00000E-01 2.07260E+00 7.41307E-01-8.02702E-03
   2    0.00000E-01 2.62200E-01 7.10972E-01 7.78951E+00 9.58411E-01 8.95831E-03
   3    0.00000E-01 2.00000E-04 1.00021E+00 1.13842E+01 8.21067E-01 1.70388E-01
   4    0.00000E-01 0.00000E-01 8.21068E-01 2.53257E+01 1.15114E-02 7.63419E-01
   5    0.00000E-01 1.00000E+00 2.53225E+00 4.65719E+01 2.53230E+00 9.34737E-01

 GRP.    LEAKAGE      BALANCE    RT BDY FLUX  RT BDY J+    RT BDY J   RT LEAKAGE
   1    4.31982E-03 1.00000E+00 2.17920E-05 1.37504E-05 1.37504E-05 4.31982E-03
   2    5.80382E-03 9.99999E-01 3.15691E-05 1.84741E-05 1.84741E-05 5.80382E-03
   3    6.95982E-03 1.00000E+00 4.89288E-05 2.85200E-05 2.85200E-05 8.95982E-03
   4    4.61389E-02 9.99999E-01 2.53251E-04 1.46865E-04 1.46865E-04 4.61389E-02
   5    6.52224E-02 9.99999E-01 3.55541E-04 2.07609E-04 2.07609E-04 6.52224E-02

-- More --

 GRP. LFT LEAKAGE  FISS RATE   TOTAL FLUX   DENSITY
   1    0.00000E-01 9.53756E-03 1.18282E+01 1.18282E+01
   2    0.00000E-01 1.35122E-02 1.57554E+01 1.57554E+01
   3    0.00000E-01 1.90967E-01 1.62479E+01 1.62479E+01
   4    0.00000E-01 9.47265E-01 2.21514E+01 2.21514E+01
   5    0.00000E-01 1.16128E+00 6.59830E+01 6.59830E+01

C:\APC >
```


REFERENCES

/1/ W.W.Engle, Jr., "A User's Manual for ANISN, A one dimensional Discrete Ordinates Transport Code with Anisotropic Scattering", Union Carbide Corp., Nuclear Division, K-25, Report K-1693, 1967.

/2/ W.W.Engle, M.A.Boling and B.W. Colston, "DTF-II, A One-Dimensional Multigroup Neutron Transport Program" , North American Aviation, Los Angeles, Report NAA-SR-10951, 1966.

/3/ "ANISN-ORNL - Multigroup One-Dimensional Discrete Ordinates Transport Code System with Anisotropic Scattering", RSIC Computer Code Colection, CCC-254, 1985.

/4/ Westinghouse Astronuclear Laboratory", ANISN-W-Multigroup One-Dimensional Discrete Ordinates Transport Code with Anisotropic Scattering", RSIC Computer Code Colection , CCC-255, 1975 (Also in PC-Version CCC-255-C).

/5/ W.A. Rhoades, "Description of FIDO Input System, Oak Ridge National Laboratory, ORNL-NPD, 1973.

/6/ T. Olsen, "Void Streaming in S_N Calculation", Nuclear Science and Engineering, 21, 271, 1965.

ARRAY	DATA (ENTRIES)	COMMENTS (Detailed Data Notes)
15 $	1. ID; problem identification 2. ITH; 0 - forward calculation 1 - adjoint calculation 3. ISCT; maximum order of scatter found in anyzone (0/1/2..; P0/P1/P2...) (19$ array specifies Pe order by zone). 4. ISN; order of angular quadrature (even integer only, 2/4/6..; S2-S4-S6) 5. IGE; geometry parameter (1-slab; 2-cylinder; 3-sphere). 6. IBL; left boundary condition (0-vaccum; 1-reflection; 2-periodic; 3-white/ Albedo) 7. IBR; right boundary condition (same-as IBL) 8. IZM; number of zones or regions (same material) - see 9 $ array. 9. IM, number of mesh intervals - see 8 $ array. 10. IEVT, Type of calculation (0-fixed source; 1- K calculation; 2-α calculation; 3- concentration search; 4 - zone tickness search; 5-outer radius search; 6-buckling search).	- 15 $ is an integer parameter array containing 36 entries. - if ID> (999 for ANISN/PC), disadvantage factor will be calculated by group for each material which appears in the calculation. - if a difusion theory solution is desired, set ISN=2 - in periodic b.c., angular flux leaving left boundary re-enters in the right boundary). - the white boundary condition causes the enter flux at the specified boundary to be isotropic. - the albedo for each group specifies the faction of the flux leaving to be returned, if not specified it is assumed 1. - white boundary condition is recomended for the outer boundary of cells. - shell source calculation is considered fixed source type of calculation. - the distributed source is entered by group and intervals as follows: group 1=interval 1 through IM; group 2=...etc. - If IPM=1, the shell source is entered by group and angle as follows:group 1, angle 1 throug angle M; group 2, etc.

ARRAY	DATA (ENTRIES)	COMMENTS (Detailed Data Notes)
	11. IGM; number of energy groups. 12. IHT; position of σtotal, or σtransport in cross section table. 13. IHS; position of σgg 14. IHM; lenght of cross section table 15. MS; cross section mixing table lenght (10$;11$;12*). 16. MCR; number of cross sections sets to be read from cards (14*) 17. MTP; number of cross sections sets to be read from tape (13$)(*). 18. MT; total number of cross section sets (elements + mixtures). 19. IDFM; 0 - density factor (21*) not used 1 - density factor used 20. IPVT; 0 - no effect 1 - enter κ_0 as PV(16*) 2 - enter α_0 as PV 21. IQM; 0 - no effect 1 - enter distributed source (17*)	- table of cross sections in ANISN (Po) Position / Cross Section 1 / Activity ⋮ / " IHT-2 / absorption IHT-1 / nux fission IHT / total IHT+1 / σg+Nus→g ⋮ / ⋮ up-scatter IHS-1 / σg+1→g IHS / σg→g downscatter IHS+1 / σg-1→g ⋮ IHM / σg-NDS→g where NUS and NDS are the number of groups of upscater and down scatter, respectivily. -if no activity cross sections appears, IHT=3, if no upscattering IHS=IHT+1. -The Pl cross sections tables must correspond to the Po-table, and must contain (2l+1)term. This factor may be included externally, or internally via mixing table. (*) ANISN/PC assumes the file name for this library to be ANISNC4.LIB, hence the need to copy the desired library data to this file.

ARRAY	DATA (ENTRIES)	COMMENTS (Detailed Data Notes)
	22. IPM; (0 - no effect; 1-enter shell source by group and angle, 18*; IM- enter shell source by interval, group and angle). 23. IPP; interval (number which contains shell source, if IPM=1, or 0 otherwise. 24. IIM; inner iteration maximum (IIM > 20). 25. ID1; (0 - no effect; 1-print angular flux; 2-punch scalar flux; 3-both 1 and 2). 26. ID2; (0 - no effect, all cross section from 14* file; 1-uses specially prepared group independent; 2-use cross sections and fixed source from previous problem). 27. ID3; (0 - no effect; N-Compute Nactivities by zone where N is any positive integer). 28. ID4; (0 - no effect; 1-Compute Nactivities by interval). 29. ICM; outer iteration maximum (> 50). 30. IDAT 1; (0 - all data in core; 1-cross section and fixed source storage on tape or file; 2-fluxes and currents on file also. 31. IDAT 2; (0 - no effect; N-first outer iteration will be executed according 24$ array).	- cross section mixing table is used to combine elements into macroscopic mixture and to specify the method of the concentration search. The following table illustrates the three types of operation performed by the mixing tabe 10$ 11$ 12* 1. M 0 X 2. M N X 3. M M 0.0 1. Multiply all cross sections in material M by X. 2. Multiply all cross sections in material N by X and add to corresponding cross sections in material M. 3. Multiply all cross sections in material M by EV the eigenvalue. - density factor is used to describe a void or a density variation by interval (21*). - if IPVT=1, ANISN will search for the parameter which results in a multiplication factor of PV. If IPVT=2, ANISN will search of 1.0 when α=PV. If IPVT=0, ANISN will search for a multiplication factor of 1.0 when α=0.0 - for ANISN/PC, ID1=2 punch a file containing the scalar flux by interval, file name ANISN C4.PUN; ID1=2 punch a file containing the scalar flux by interval, name ANISN C4. PUN, and ID1=-3, both 1 and -2.

ARRAY	DATA(ENTRIES)	COMMENTS (Detailed Data Notes)
	32. ITG; (0 - no effect; 1-flux weight P_0 and current weight P_1, do not save internaly; 2-use few group cross sections from previous problem; 3-same as (1) save internaly; 4-both 2 and 3). 33. IFLU; (0 - step model used when linear extrapolation yields negative flux; 1-use linear model only; 2-use step model only; 3-weighted difference model; 4-weighted model used as negative flux fixup for linear model). 34. IFN; (0- enter fission guess in 2* array; 1-enter flux guess in 3* array; -1-enter flux guess from a file ANISNC4.FLX; 2-use fluxes from previous stacked case). 35. IPRT; (0 - print cross section; 1-do not print cross section). 36. IXTR; (0 - enter zero (not yet been checked) or try 1-use fluxes from previous case; 2-save fluxes for next case; 3-both 1 and 2.	- for ANISN/PC ID2 can assume values - 1-Pure gamma problem:CCCC ISOGXS file; -N-Coupled neutron-gamma problem, N is the first gamma group. - All cross sections sets wheter elements or mixtures, are refered to by a continuos set of material numbers. In particular, the materials supplied in 14* become materials 1 through MCR, the material read from a tape or file become MCR+1 through MCR+MTP, and any number greater than MCR+MTP but less than or equal for MT refers to a mixture. - when the order of scatter for any zone (19$) is greater than zero, ANISN expects the P-1 cross section to be material M+1, the P-2 cross section to be M+2, etc, where M is the P_0 material number specified in 9$ array. - If IDAT2=0, implies a diffusion theory solution. - for ANISN-PC, IFLU has also an option -1; Linear Model with inner iteration DSA (Default value).

ARRAY	DATA (ENTRIES)	COMMENTS (Detailed Data Notes)
16*	1. EV; first guess of eigenvalue 2. EVM: eigenvalue modifier 3. EPS: precision desired for lambda and upscattering convergence (EPS<1.E-4) 4. BF; buckling factor(1.420892) 5. DY; cylinder or plane height for buckling correction (may include extrapolated distance) 6. DZ; plane depth for buckling correction. 7. DFM1; transverse dimension for void streaming correction. 8. XNF; normalization factor (suggested XNF=1.0). 9. PV; 0.0, κ_0, or α_0 according to IPVT=0,1 or 2. 10. RVF; λ_2 relaxation factor (suggested value=0.5). 11. XLAL; pointwise flux convergence criteria. If XLAL=0, then integral convergence tests are used with EPS as the criteria (suggested value=2*EPS).	- 16* array in a floating point array containing 14 entries. - the following table indicates suggested initial value of EV and EVM: IEVT: 0 EV: 0.0 EVM: 0.0 1 0.0 0.0 2 0.0 0.0 3 1.0 -0.1 4 0.0 -0.1 5 outer radius -(10% of outer radius) 6 1.0 -0.1 - When IEVT=0, there is no eigenvalue; when IEVT=1, the multiplication factor is the eigenvalue; when IEVT=2; α is the eigenvalue; when IEVT=3, the eigenvalue is defined by its use in the mixing table; when IEVT=4, the eigenvalue is a follows, $\Delta RI = \Delta RI\ (1.0+EV \times RMZ)$, where RMZ is the radius modifier (20*); when IEVT=5, the eigenvalue is the outer radius, and when IEVT=6, $EV=DY/DY^0=DZ/DZ^0$, where DY^0, DZ^0 are input. - When IEVT>0, the total fission source is normalized to XNF; when IEVT=0, the total fixed source is normalized to XNF, if XNF=0.0, there is no normalization.

ARRAY	DATA (ENTRIES)	COMMENTS (Detailed Data Notes)
	12. XLAH; upper limit of $/1.0-\lambda_1/$ used in linear search. 13. EQL; eigenvalue change epsilon for search calculation, zero otherwise. 14. XNPM; new paramer modifier; zero otherwise T; the 16* must finish with a Terminate card.	- ANISN computer a correction factor (DB^2) for finite transverse dimension, $B^2=(\frac{\pi}{DV+\frac{BF}{\Sigma tr}})^2+(\frac{\pi}{DZ+BF/\Sigma tr})^2$ Thus, the value of BF determines the extrapolation distance to be added to the input value DV and DZ. If DV and DZ are actual dimensions the value of BF may be 1.4208, otherwise enter 0.0. - The void streaming correction, DFM1, removes the transverse component of each angular flux in the void region using a technique provided by reference /6/. - When the absolute value of the difference between two sucessive lambdas (λ_1) is less than EQ1, the eigenvalue, EV, is changed. The first EV change is the result of adding or subtracting the eigenvalue modifier, EVM. The second EV change is the result of a linear extrapolation. To prevent large changes early in the calculation, the absolute value of the difference between 1.0 and λ_1 is not allowed to exceed XLAH. To prevent oscilation when using the linear search, the extrapolation is limited by XNPM. The third EV change is the result of the quadratic search; and is used until $/1-\lambda_1/$ < EQL XLAH is normally 0.05, and XNPM is 0.75. EQL should be larges of 0.001 and 3xEPS.
13$	Library ID number. Note: in ANISN/PC the input file is ANISNC4.LIB, which can be generated by a utility program LMOD by selecting materials from a Master library FLUNGP.LIB (21- Group photon cross section Master library in CCCC ISOTXS format).	
14*	Enter cross sections (MCRxIGMxIHM entries). Note: This array finish with a terminate card (T).	
17*	Distributed Source (IGMxIM entries if IQM=1). Note: the above data is followed by a T.	
18*	Shell Source (IGMxIPMxMM entries if IPM>0). Note: the above data is followed by a T.	

ARRAY	DATA (ENTRIES)	COMMENTS (Detailed Data Notes)
2*	Fission density /IM/; if IFN=0	- 2* and 3* are input guess data. If fissile material is present in the calculation, the flux guess (IFN=1) must be non-zero. - For fixed source, one can use 0.0 as first guess. - The 1* array is the fission spectrum X_g data. This data is the fraction of neutrons born in each group and the SUM over all groups should be 1.0. - The 4* array are the mesh line coordinates defining the mesh intervals. - The angular quadratures weights and cosines can be given as input, or use three types of standard quadrature (ANISN-PC): 1: Level Symmetric-LP_n (Default) 2: Gauss-Pn 3: Double Gauss-DP_n - Input in the 8$ array defines zones by mesh interval. - Input in the 9$ array defines material number by zone.
3*	Flux guess /IGMxIM/; if IFN=1	
	Note: 2 and 3 array must be followed by a T.	
1*	Fission spectrum; /IGM/ entries.	
4*	Radii by interval boundary; /IM+1/ entries.	
5*	Velocities; /IGM/ entries.	
6*	Angular quadrature weights; /MM/ entries.	
7*	Angular quadrature cosines; /MM/ entries.	
	Note: MM=ISN+1 for plane or sphere geometries MM=(ISNx(ISN+4))/4 for cylinder geom.	
8$	Zone number by interval; /IM/ entries.	
9$	Material numbers by zone; /IZM/ entries.	
10$	Mixture Number in Mixing Table; /MS/.	
11$	Component Number in Mixing Table; /MS/.	
12$	Number densities in Mixing Table; /MS/.	

ARRAY	DATA (ENTRIES)	COMMENTS (Detailed Data Notes)
19$	Order of scatter by zone; /IZM/; (ISCT> 0).	- Activities may be computed by zone and interval (ID3 and ID4). The zone activity is the total reaction rate and interval activity is per unity volume. The following table illustrates the uses of 22$, and 23$ arrays:
20*	Radius Modifier by zone; /IZM/; (IEVT=4).	
21*	Density Factors by Internal; /IM/; (IDFM=1).	
22$	Material Numbers for Activities; /ID3/.	
23$	Cross Section Table Position for Activities, /ID3/.	
24$	Calculation Type Markers by group; /IGM/; (IDAT2=1). 0- use the S_N theory for this group 1- use the diffusion theory for this group 2. use the infinite homogeneous media calculation for this group.	
25*	Albedo by group-right boundary; /IGM/; (IBR=3).	
26*	Albedo by group-left boundary; /IGM/; (IBL=3).	
27$	Few Group Parameters; (IFG > 0); 5 entries 1- ICON; (0 - no effect; 1- micro cross section desired; 2- macro cross section desired (minus implies cell weighting); 3- both 1 and 2). 2- IHTF; position of total or transport cross section in weighted cross section.	

	22$	23$
1.	1	3
2.	-5	1
3.	7	-1
4.	-3	-1

1. Compute activity for material 1, cross section position in the interval and/or zones in which material 1 appears.
2. Compute activity for material 5, cross section position 1 in all interval and/or zones.
3. Compute activity for material 7, position 1 in appropriate intervals and/or zones and multiply interval activities by 1.0; $2\pi r$; or $4\pi r^2$ (slab; cylinder or sphere).
4. Compute activity for material 3, position 1 in all intervals and/or zones and multiply interval by geometry factor.

ARRAY	DATA (ENTRIES)	COMMENTS (Detailed Data Notes)
	3- IHSF; position of $\Sigma_{g\to g}$ in weighted Σ (minus implies upscatter removal). 4- IHMF; table length of the weighted cross sections. 5- IPUN; (0 - no effect; 1- punch, or created a file).	- When microscopic weighted cross sections are requested(ICON=1). a set of cross sections is produced for each component of each material in each zone. When macroscopic cross sections are requested (ICON=2), a set of cross sections is produced for each material in each zone. The cross sections are weighted by the flux or current in the zone in which the material appears Since the mixing table is used to determine the components of a material, MS should not be zero when ICON=1. If the cross section structure specified for the weighted cross sections 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. If complete removal of the upscatter is desired, IHSF should be minus. /IHSF/ should be the position of the self scatter cross section before the upscatter is removed. IHMF should be the final table lenght. After the upscatter is removed, IHSF will be IHTF+1. The upscatter is removed by subtracting the reaction rate due to $\sigma_{j\to i}$ from the reaction rate due to $\sigma_{i\to j}$ where $j>i$. Thus the net transfer rate between groups j and i is preserved.
28$	Few group number for each multigroup; /IGM/.	
	Note: After 28$, use a Terminate (T) operator, also after 28$, use optionally double T (TT); which indicates that a case input is terminated, and ANISN will search for a new title card and an associated data to follow.	

GENERAL DESCRIPTION OF ANISN-PC (CCC-514-MICRO)

(Six dual sided, double density diskettes required)

RSIC# CCC-514 MICRO
CODE PKG NAME: ANISN-PC
COMPUTER: IBM PC
PACKAGED: 7/24/87
MOST RECENT UPDATE: 11/11/87

		DESCRIPTION	FILE SIZE (BYTES)
1.	ANISN.EXE	The ANISN/PC Executable File (Driver + 3 Overlays). This file was compiled and linked under PC/DOS 3.10 using the Ryan McFarland IBM Professional FORTRAN compiler Version 1.0 and the PLINK86+ Version 1.48 overlay linker. (11/87)	647856
2.	ANISN.SP1	Input for Sample Problem 1	4012
3.	ANISN.SP2	Input for Sample Problem 2	2456
4.	ANISN.SP3	Input for Sample Problem 3	3244
5.	ANISN1.OUT	Output for Sample Problem 1	21493
6.	ANISN2.OUT	Output for Sample Problem 2	21688
7.	ANISN3.OUT	Output for Sample Problem 3	36651
8.	ISOTXS.SP2	CCCC Library file for Sample Problem 2	1980
9.	ISOTXS.SP3	CCCC Library file for Sample Problem 3	14118
10.	APE32.EXE	Executable file for the APE ANISN/PC interactive input generator. This file was compiled and linked under PC/DOS 3.10 using the Ryan McFarland IBM Professional FORTRAN compiler Version 1.0 and the PC/DOS Version 3.10 linker.	505818
11.	LMOD.EXE	Executable file for the LMOD ISOTXS library editing utility program. This file was compiled and linked under PC/DOS 3.10 using the Ryan-McFarland Professional FORTRAN compiler Version 1.0 and the PC/DOS Version 3.10 linker.	45871
12.	FLUNGP.LIB	A 21-Group photon cross section master library in CCCC ASCII ISOTXS format.	342969
13.	ANISN1.FOR	FORTRAN source files for ANISN/PC. The first	12576
	ANISN2.FOR	file contains driver and control routines, the	73596
	ANISN3.FOR	second contains input processing routines, the	73081
	ANISN4.FOR	third contains solution routines and the fourth	50568
		contains the output processing routines. (ANISN4.FOR updated 11/87)	

RSIC# CCC-514 MICRO
CODE PKG NAME: ANISN-PC
COMPUTER: IBM PC
PACKAGED: 7/24/87

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14.	APE1.FOR	FORTRAN source files for APE32, interactive input generator for ANISN/PC.	52627
	APE2.FOR		42966
	APE3.FOR		48596
	APE4.FOR		53420
15.	LMOD.FOR	The FORTRAN source file for the LMOD ISOTXS interactive cross section library editor.	8075

NOTES: ANISN-PC was executed by RSIC on the IBM PC under DOS 3.1. It requires a 10MB fixed disk, 640K Random Access Memory and the 8087 math coprocessor. Because several files are open during ANISN execution, CONFIG.SYS must specify enough files to avoid DOS error 3012 (FILES=20).

Installation instructions: There are six dual-sided, double density (360 K) 5-1/4 inch diskettes in MS/DOS Backup/Restore format. To access these diskettes, create a directory on the PC fixed disk having the name \APC, and copy all files using the RESTORE command. If the fixed disk has the drive designator C: and the diskette drive has the designator A:, this command would take the form:

RESTORE A: C:

After the \APC directory is restored, it will contain several files including one named READ.ME. This file contains a technical description and operating instructions for the code package.

Ward Engle has suggested that the version CCC-0514 ANISN/PC should be the most adequate one and should contain the advanced acceleration techniques.

Follows the NEA-DB description of version CCC-0514

1. NAME OR DESIGNATION OF PROGRAM - ANISN/PC.

2. COMPUTER FOR WHICH PROGRAM IS DESIGNED AND OTHER MACHINE VERSION PACKAGES AVAILABLE -

Program-name	Package-ID	Orig. Computer	Test Computer
ANISN/PC	CCC-0514/02	IBM PC	IBM PC

3. DESCRIPTION OF PROGRAM OR FUNCTION - ANISN/PC solves the one-dimensional Boltzman equation for neutrons or gamma rays in slab, sphere, or cylinder geometry. Criticality search may be performed on any one of several parameters. Cross sections may be weighted using the energy dependent flux generated in solving the transport equation.

4. METHOD OF SOLUTION - The solution technique is an advanced discrete ordinates method which represents a generalization of the method originated by G.C. Wick and greatly developed and extended to curvo-linear geometry by B. G. Carlson at Los Alamos Scientific Laboratory.
   ANISN was designed to solve deep-penetration problems in which angle-dependent spectra are calculated in detail. The principal feature that makes it suitable for such problems is the use of a programming technique with optional data-storage configurations which allows execution of small, intermediate, and extremely large problems. It also includes a technique for handling general anisotropic scattering. For ANISN/PC the standard souce iteration method, accelerated by up to two single scale factors, is used for outer iterations. Inner iterations are accelerated either by a stabilized variable-mesh rebalancing scheme or by a linear diffusion synthetic scheme. A noniterative matrix inversion technique based on a reflection principle is used for diffusion theory inner iterations.

5. RESTRICTIONS ON THE COMPLEXITY OF THE PROBLEM - Problem size is limited only by machine size.

6. TYPICAL RUNNING TIME - Run times range from a few minutes to several hours hours, depending on the problem. In general, a 1.5 to 2 orders of magnitude increase in run time is seen between ANISN/PC on an IBM PC XT and ANISN-W on a CDC CYBER 176.
   CCC-0514/02: NEA-DB ran the four test cases included in this package on an IBM PC/AT in 6 minutes.

7. UNUSUAL FEATURES OF THE PROGRAM -

8. RELATED AND AUXILIARY PROGRAMS - ANISN/PC follows a series of developmental efforts over a period of years (see CCC-0254). It is a modification of ANISN-W (CCC-0255), the Westinghouse version which was based on the Oak Ridge National Laboratory work.

9. STATUS -
   CCC-0514/02 : Arrived at NEADB February 1989
   Tested at NEADB

10. REFERENCES

- W.W. Engle, Jr.:
"A User's Manual for ANISN: A One-Dimensional Discrete Ordinates Transport Code with Anisotropic Scattering"
K-1693 (1967)

- R.G. Soltesz and R.K. Disney:
"Nuclear Rocket Shielding Methods, Modification, Updating, and Input Data Preparation, Vol. 4, One-Dimensional Discrete Ordinates Transport Technique"
WANL-PR-(LL)-034 (August 1970)

- R.G. Soltesz et al.:
"ANISN-W"
WANL-TME-2778 (February 1971)

- R.G. Soltesz:
"Revised WANL ANISN Program User's Manual"
WANL-TM1-1967 (Supplement 1969)
CCC-0514/02 :

- Contents of the README File.

- Kent Pearson:
ANISN/PC Manual
EGG-2500 (April 1987)

11. MACHINE REQUIREMENTS - The minimum hardware requirements for ANISN/PC are: an IBM PC or compatible, the 8087 math processor chip, a 10MB fixed disk, 640K Random Access Memory.

12. PROGRAMMING LANGUAGE USED.
CCC-0514/02 : FORTRAN-77

13. OPERATING SYSTEM UNDER WHICH PROGRAM IS EXECUTED - The Ryan McFarland IBM Professional Fortran compiler Version 1.0 was used to compile the programs under PC/DOS 3.1. The PLINK86-Plus Version 1.48 overlay linker was used to create an executable ANISN file of approximately 640K bytes. The PC/DOS Version 3.1 linker was used to link the APE32 and LMOD programs. The executable files are included in the package.
CCC-0514/02: Operating System: MSDOS v 3.21;
Compiler: IBM Professional FORTRAN Version 1.52.RM;
Linker: PLINK86 for RM/FORTRAN;
PC/DOS Version 3.21 linker.

14. OTHER PROGRAMMING OR OPERATING INFORMATION OR RESTRICTIONS -

15. NAME AND ESTABLISHMENT OF AUTHORS -

EGSG Idaho, Inc.
Idaho Falls, Idaho, USA.

16. MATERIAL AVAILABLE -
CCC-0514/02 :

Original instruction file	208 records
BAT-file for running sample case 2	3 records
ANISN/PC executable module	
APE ANISN/PC executable module	
LMOD ISOTXS library editor program	
ANISN/PC input data for sample case 1	62 records
ANISN/PC input data for sample case 2	41 records
ANISN/PC input data for sample case 3	51 records
ANISN/PC output for sample case 1	489 records
ANISN/PC output for sample case 2	485 records
ANISN/PC output for sample case 3	667 records
21-grp photon x-sec lib in ISOTXS format	
CCCC library file for sample case 2	34 records
CCCC library file for sample case 3	197 records
ANISN/PC driver and control routs (FORTRAN)	388 records
ANISN/PC input processing routs (FORTRAN)	2363 records
ANISN/PC solution routines (FORTRAN)	2534 records
ANISN/PC output processing routs. (FORTRAN)	1619 records
BAT- file for compiling and linking ANISN/PC	8 records
APE32 1st source file (FORTRAN)	1506 records
APE32 2nd source file (FORTRAN)	1415 records
APE32 3rd source file (FORTRAN)	1514 records
APE32 4th source file (FORTRAN)	1789 records
LMOD library editor source (FORTRAN)	285 records

17. CATEGORY - C J
KEYWORDS -
Boltzmann equation, absorption, anisotropic scattering, criticality searches, neutron transport equation, photon transport, shielding.

GENERAL DESCRIPTION OF ANISN/PC

ANISN/PC is an improved version of the well-known ANISN one-dimensional discrete-ordinates neutral particle transport code that has been adapted for use on the IBM personal computer (or on compatible machines). The basic numerical methods and calculational options remain as in previous versions of ANISN. The major changes and improvements incorporated into ANISN/PC include:

1) A more descriptive output format that is 80 columns wide to permit easier reading on a monitor screen.

2) Use of the ASCII version of standard CCCC interface file formats for cross sections, flux files, etc. A description of the CCCC file formats is included in the manual transmitted with the code package.

3) An emphasis on the use of standard FORTRAN-77 coding in order to enhance portability of the source code in the future.

4) An option for inner iteration convergence acceleration based on the Diffusion Synthetic Acceleration (DSA) method.

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The minimum hardware requirements for the current version of ANISN/PC are: 1) An IBM PC or compatible, 2) 640K Random Access Memory, 3) the 8087 math coprocessor chip, and 4) a 10MB fixed disk. The code has been compiled using overlays in order to maximize the memory available for data storage. The MS/DOS or PC/DOS operating system is assumed for ANISN/PC.

In addition to the ANISN/PC code, the transmittal package includes an interactive input generator program called APE (Anisn Processor and Evaluator). This program will interactively generate an input file for ANISN/PC. An entirely new file can be created or an existing file can be reviewed and/or updated. In either case the program leads interactively through the file, prompting for information as it goes and checking for errors and inconsistencies. The three sample problem input files included with this transmittal package are in APE/ANISN compatable format and they can be read with tha APE program and examined and/or modified.

Finally, a utility program, LMOD is included for selecting materials from a master ASCII CCCC ISOTXS file and placing them on an ANISN CCCC input file (ANISNC4.LIB). A master photon library is included for convenience. This file contains 21-group photon cross sections for a number of shielding materials of interest. The data originated with the FLUNG cross section library distributed by the Radiation Shielding Information Center (RSIC) at Oak Ridge.

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DESCRIPTION OF THE CODE TRANSMITTAL PACKAGE

The /APC directory contains the following files:

1.	ANISN.EXE	The ANISN/PC Executable File (Driver + 3 Overlays). This file was compiled and linked under PC/DOS 3.10 using the Ryan McFarland IBM Professional FORTRAN compiler Version 1.0 and the PLINK86+ Version 1.48 overlay linker.
2.	ANISN.SP1	Input for Sample Problem 1
3.	ANISN.SP2	Input for Sample Problem 2
4.	ANISN.SP3	Input for Sample Problem 3
5.	ANISN1.OUT	Output for Sample Problem 1
6.	ANISN2.OUT	Output for Sample Problem 2

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7.	ANISN3.OUT	Output for Sample Problem 3
8.	ISOTXS.SP2	CCCC Library file for Sample Problem 2
9.	ISOTXS.SP3	CCCC Library file for Sample Problem 3
10.	APE32.EXE	Executable File for The APE ANISN/PC Interactive Input Generator. This file was compiled and linked under PC/DOS 3.10 using the Ryan McFarland IBM Professional FORTRAN compiler Version 1.0 and the PC/DOS Version 3.10 linker.
11.	LMOD.EXE	Executable file for the LMOD ISOTXS library editing utility program. This file was compiled and linked under PC/DOS 3.10 using the Ryan-McFarland Professional FORTRAN compiler Version 1.0 and the PC/DOS Version 3.10 linker.
12.	FLUNGP.LIB	A 21-Group photon cross section master library in CCCC ASCII ISOTXS format for use with ANISN/PC. Several shielding materials of interest are included. This file comes from the FLUNG library

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distributed by RSIC. It may be interactively edited using LMOD since one would ordinarily be using only a subset of the materials on this file in a given ANISN/PC calculation. (It may be noted that the file ISOTXS.SP3 is such a subset, containing only Lead (Pb) for use with Sample Problem 3.)

13. ANISN1.FOR, ANISN2.FOR, ANISN3.FOR, ANISN4.FOR — The FORTRAN source files for ANISN/PC. The first file contains driver and control routines, the second contains input processing routines, the third contains solution routines and the fourth contains the output processing routines. All subroutines are heavily commented for ease in adding options, making changes, etc.

14. APE1.FOR, APE2.FOR, APE3.FOR, APE4.FOR — The FORTRAN source files for APE32, the interactive input generator for ANISN/PC.

15. LMOD.FOR — The FORTRAN source file for the LMOD ISOTXS interactive cross section library editor.

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EXECUTION INSTRUCTIONS FOR ANISN/PC, APE32, and LMOD

To execute an ANISN/PC calculation, enter the following commands:

```
COPY CCCC.LIB ANISNC4.LIB
ANISN <INFILE >OUTFILE /R IBUF
```

Where:

CCCC.LIB = The file name for the CCCC library being used for the problem. If no CCCC library is being used then this step is not necessary. If a CCCC library is being used it should be noted that ANISN/PC assumes the file name for this library to be ANISNC4.LIB, hence the need to copy the desired library data to this file.

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ANISN <ANISN.SP2 /R B32

will generate the necessary cross section library in ISOTXS format and then execute the second sample problem and send the output to the screen. The output can also be sent to the printer at the same time by entering the command Ctrl-PrtSc before entering the ANISN/PC execute command. It may be noted that the input file for ANISN/PC is in standard free-form FIDO format, which is described in the accompanying code manual. The APE file format is a restricted subset of the free-form FIDO input.

To execute the APE interactive input processor simply enter the command 'APE32' and follow the instructions appearing on the screen.

To execute the LMOD interactive CCCC library processor enter the command 'LMOD' and follow the instructions appearing on the screen.

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DESCRIPTION OF THE SAMPLE PROBLEMS

Sample Problem 1: A 4-Group 2-Region P1 eigenvalue calculation in cylindrical geometry. The inner region is fueled with a mixture of

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uranium, aluminum, and water while the outer region represents a beryllium reflector. All cross sections are entered through the input stream in the standard ANISN 14** vector format (See the input manual supplied with the code package for more information on this)

Sample Problem 2: This is exactly the same as Sample Problem 1 except that the cross sections are now input using a CCCC standard interface file in ASCII format (File Name=ISOTXS.SP2). This is currently the standard format for inputting cross sections to ANISN/PC from an external file. The old GIP/ANISN format for external files is not available. It is important to note that the higher Pn components do NOT have to be multiplied by 2L+1 when the cross sections are brought in from a CCCC interface file. This can be seen by looking at the difference between the mixing tables used in Sample Problems 1 and 2.

Sample Problem 3: This is a 21-Group P3 fixed source calculation that models a sphere of Lead with a photon source in the center. Cross sections were taken from the file FLUNGP.LIB using the LMOD program.

C:\APE >

ANISN INPUT DATA SHEET

Name: _____ Problem: _____ Date: _____ Page: ___

CARD	ARRAY	OP.	DATA FIELD	COMMENTS
	1 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	
	1 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	

R-Repeat I-Interpolate T-Terminate '+'or'-'-Exponentiation S-Skip $-Integer *-real

ANISN INPUT DATA SHEET

Name: _____ Problem: _____ Date: _____ Page: ___

CARD	ARRAY	OP.	DATA FIELD	COMMENTS
	1 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	
	1 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	

R-Repeat I-Interpolate T-Terminate '+'or'-'-Exponentiation S-Skip $-Integer *-real