**=======================================================================VIRGIN**

 **VIRGIN**

 **PROGRAM VIRGIN VIRGIN**

 **VERSION 76-1 (NOVEMBER 1976) VIRGIN**

 **VERSION 84-1 (JUNE 1984) \*DOUBLE PRECISION ENERGY VIRGIN**

 **VERSION 86-1 (JANUARY 1986)\*FORTRAN-77/H VERSION VIRGIN**

 **VERSION 88-1 (JULY 1988) \*OPTION...INTERNALLY DEFINE ALL I/O VIRGIN**

 **FILE NAMES (SEE, SUBROUTINE FILEIO VIRGIN**

 **FOR DETAILS). VIRGIN**

 **\*IMPROVED BASED ON USER COMMENTS. VIRGIN**

 **VERSION 89-1 (JANUARY 1989)\*PSYCHOANALYZED BY PROGRAM FREUD TO VIRGIN**

 **INSURE PROGRAM WILL NOT DO ANYTHING VIRGIN**

 **CRAZY. VIRGIN**

 **\*UPDATED TO USE NEW PROGRAM CONVERT VIRGIN**

 **KEYWORDS. VIRGIN**

 **\*ADDED LIVERMORE CIVIC COMPILER VIRGIN**

 **CONVENTIONS. VIRGIN**

 **VERSION 92-1 (JANUARY 1992)\*COMPLETE RE-WRITE VIRGIN**

 **\*OUTPUT IN PLOTTAB FORMAT VIRGIN**

 **\*UP TO 2000 THICKNESSES VIRGIN**

 **\*INCREASED INCORE PAGE SIZE TO 6000 VIRGIN**

 **CROSS SECTION POINTS VIRGIN**

 **\*ADDED PHOTON CALCULATIONS VIRGIN**

 **\*ADDED BLACKBODY SPECTRUM VIRGIN**

 **\*ADDED MULTIPLE LAYERS VIRGIN**

 **\*ADDED SPATIALLY DEPENDENT DENSITY VIRGIN**

 **\*ADDED FORTRAN SAVE OPTION VIRGIN**

 **\*COMPLETELY CONSISTENT I/O ROUTINES - VIRGIN**

 **TO MINIMIZE COMPUTER DEPENDENCE. VIRGIN**

 **VERSION 92-2 (MAY 1992) \*CORRECTED TO HANDLE MULTIGROUP CROSS VIRGIN**

 **SECTIONS AS INPUT IN ENDF/B FORMAT. VIRGIN**

 **VERSION 96-1 (JANUARY 1996) \*COMPLETE RE-WRITE VIRGIN**

 **\*IMPROVED COMPUTER INDEPENDENCE VIRGIN**

 **\*ALL DOUBLE PRECISION VIRGIN**

 **\*ON SCREEN OUTPUT VIRGIN**

 **\*UNIFORM TREATMENT OF ENDF/B I/O VIRGIN**

 **\*IMPROVED OUTPUT PRECISION VIRGIN**

 **\*DEFINED SCRATCH FILE NAMES VIRGIN**

 **VERSION 99-1 (MARCH 1999) \*CORRECTED CHARACTER TO FLOATING VIRGIN**

 **POINT READ FOR MORE DIGITS VIRGIN**

 **\*UPDATED TEST FOR ENDF/B FORMAT VIRGIN**

 **VERSION BASED ON RECENT FORMAT CHANGEVIRGIN**

 **\*GENERAL IMPROVEMENTS BASED ON VIRGIN**

 **USER FEEDBACK VIRGIN**

 **VERS. 2000-1 (FEBRUARY 2000)\*GENERAL IMPROVEMENTS BASED ON VIRGIN**

 **USER FEEDBACK VIRGIN**

 **VERS. 2002-1 (MAY 2002) \*OPTIONAL INPUT PARAMETERS VIRGIN**

 **VERS. 2004-1 (MARCH 2004) \*ADDED INCLUDE FOR COMMON VIRGIN**

 **\*UP TO 2000 THICKNESSES VIRGIN**

 **\*INCREASED INCORE PAGE SIZE TO 60,000 VIRGIN**

 **VERS. 2007-1 (JAN. 2007) \*CHECKED AGAINST ALL ENDF/B-VII. VIRGIN**

 **\*INCREASED INCORE PAGE SIZE TO VIRGIN**

 **240,000 FROM 60,000. VIRGIN**

 **VERS. 2007-2 (DEC. 2007) \*72 CHARACTER FILE NAME. VIRGIN**

 **VERS. 2010-1 (Apr. 2010) \*General update based on user feedbackVIRGIN**

 **\*INCREASED INCORE PAGE SIZE TO VIRGIN**

 **600,000 FROM 240,000. VIRGIN**

 **VERS. 2012-1 (Aug. 2012) \*Added CODENAME VIRGIN**

 **\*32 and 64 bit Compatible VIRGIN**

 **\*Added ERROR stop VIRGIN**

 **VERS. 2015-1 (Jan. 2015) \*Extended OUT9. VIRGIN**

 **\*Replaced ALL 3 way IF Statements. VIRGIN**

 **\*Generalized TART Group Structures. VIRGIN**

 **\*Generalized SAND-II Group Structures.VIRGIN**

 **\*Extended SAND-II to 60, 150, 200 MeV.VIRGIN**

 **VERS. 2015-2 (Apr. 2015) \*Changed ALL data to "D" instead of VIRGIN**

 **"E" to insure it is REAL\*8 and avoid VIRGIN**

 **Truncation ERRORS. VIRGIN**

 **VERS. 2017-1 (May 2017) \*Added UKAEA 1102 Group Structure. VIRGIN**

 **\*Increased points to 3,000,000 VIRGIN**

 **\*Increased groupd to 30,000 VIRGIN**

 **\*Updated based on user feedback VIRGIN**

 **\*Defintion of built-in group structureVIRGIN**

 **using SUBROUTINE GROPE is identical VIRGIN**

 **for GROUPIE and VIRGIN. VIRGIN**

 **\*All floating point parameters changedVIRGIN**

 **to character inout + IN9 conversion. VIRGIN**

 **VERS. 2018-1 (Jan. 2018) \*Decreased PAGE size from 3,000,000 VIRGIN**

 **to 1,500,000 VIRGIN**

 **\*On-line output for ALL ENDERROR VIRGIN**

 **VERS. 2019-1 (June 2019) \*Additional Interpolation Law Tests VIRGIN**

 **\*Checked Maximum Tabulated Energy to VIRGIN**

 **insure it is the same for all MTs - VIRGIN**

 **if not, print WARNING messages. VIRGIN**

 **VERS. 2020-1 (Feb. 2020) \*Identical to 2019-1. VIRGIN**

 **VERS. 2023-1 (Feb. 2023) \*Decreasee page size from 1,500,000 VIRGIN**

 **TO 120,000 VIRGIN**

 **VIRGIN**

 **2015-2 Acknowledgment VIRGIN**

 **===================== VIRGIN**

 **I thank Andrej Trkov (NDS, IAEA) for finding the problem with VIRGIN**

 **the "E" formatted DATA (this effected both VIRGIN and GROUPIE). VIRGIN**

 **I also thank Andrej for overseeing the entire PREPRO project VIRGIN**

 **at IAEA, Vienna; he is part of a truly International team who VIRGIN**

 **worked together to produce PREPRO-2015-2, and to make it VIRGIN**

 **available Internationally on-line for FREE to ALL users. VIRGIN**

 **VIRGIN**

 **OWNED, MAINTAINED AND DISTRIBUTED BY VIRGIN**

 **------------------------------------ VIRGIN**

 **THE NUCLEAR DATA SECTION VIRGIN**

 **INTERNATIONAL ATOMIC ENERGY AGENCY VIRGIN**

 **P.O. BOX 100 VIRGIN**

 **A-1400, VIENNA, AUSTRIA VIRGIN**

 **EUROPE VIRGIN**

 **VIRGIN**

 **ORIGINALLY WRITTEN BY VIRGIN**

 **------------------------------------ VIRGIN**

 **Dermott E. Cullen VIRGIN**

 **VIRGIN**

 **PRESENT CONTACT INFORMATION VIRGIN**

 **--------------------------- VIRGIN**

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 **VIRGIN**

 **PURPOSE VIRGIN**

 **------- VIRGIN**

 **THIS PROGRAM IS DESIGNED TO CALCULATE UNCOLLIDED (I.E. VIRGIN) VIRGIN**

 **FLUX AND REACTIONS DUE TO TRANSMISSION OF A MONODIRECTIONAL VIRGIN**

 **BEAM OF NEUTRONS THROUGH ANY THICKNESS OF MATERIAL. IN ORDER VIRGIN**

 **TO SIMULATE AN EXPERIMENTAL MEASUREMENT THE RESULTS ARE GIVEN VIRGIN**

 **AS INTEGRALS OVER ENERGY TALLY GROUPS (AS OPPOSED TO POINTWISE VIRGIN**

 **IN ENERGY). BY TAKING THE RATIO OF REACTIONS TO FLUX IN EACH VIRGIN**

 **GROUP AN EQUIVALENT SPATIALLY DEPENDENT GROUP AVERAGED CROSS VIRGIN**

 **SECTION IS CALCULATED BY THE PROGRAM. VIRGIN**

 **VIRGIN**

 **EVALUATED DATA VIRGIN**

 **-------------- VIRGIN**

 **THE EVALUATED DATA MUST BE IN THE ENDF/B FORMAT. HOWEVER IT VIRGIN**

 **MUST BE LINEAR-LINEAR INTERPOLABLE IN ENERGY-CROSS SECTION VIRGIN**

 **BETWEEN TABULATED POINTS. SINCE ONLY CROSS SECTIONS (FILE 3 OR 23)VIRGIN**

 **ARE USED, THIS PROGRAM WILL WORK ON ANY VERSION OF ENDF/B VIRGIN**

 **(I.E. ENDF/B-I, II, III, IV, V OR VI). VIRGIN**

 **VIRGIN**

 **RELATED COMPUTER CODES VIRGIN**

 **---------------------- VIRGIN**

 **IN ORDER TO CONVERT ENDF/B DATA TO THE FORM REQUIRED BY THIS CODE VIRGIN**

 **THE FOLLOWING COMPUTER CODES MAY BE USED, VIRGIN**

 **VIRGIN**

 **LINEAR - CONVERT FROM GENERAL ENDF/B INTERPOLATION TO LINEAR- VIRGIN**

 **LINEAR INTERPOLATION. VIRGIN**

 **RECENT - ADD THE RESONANCE CONTRIBUTION TO TABULATED BACKGROUND VIRGIN**

 **CROSS SECTIONS TO OBTAIN LINEAR-LINEAR INTERPOLABLE VIRGIN**

 **RESULTS. VIRGIN**

 **SIGMA1 - DOPPLER BROADEN CROSS SECTION TO OBTAIN LINEAR-LINEAR VIRGIN**

 **INTERPOLABLE RESULTS. VIRGIN**

 **MIXER - MIX INDIVIDUAL MATERIALS TOGETHER TO DEFINE COMPOSITE VIRGIN**

 **MIXTURES, E.G., COMBINE MATERIALS TO DEFINE STAINLESS VIRGIN**

 **STELL. VIRGIN**

 **VIRGIN**

 **IN ORDER TO PLOT THE OUTPUT RESULTS OF THIS CODE USE PROGRAM VIRGIN**

 **PLOTTAB. VIRGIN**

 **VIRGIN**

 **COPIES OF ANY OR ALL OF THESE CODES MAY BE OBTAINED FROM D.E. VIRGIN**

 **CULLEN AT THE ABOVE ADDRESS. VIRGIN**

 **VIRGIN**

 **OUTPUT FORMAT VIRGIN**

 **------------- VIRGIN**

 **FOR ALL VERSIONS OF THIS PROGRAM PRIOR TO VERSION 92-1 OUTPUT WAS VIRGIN**

 **IN TABULAR FORM. VIRGIN**

 **VIRGIN**

 **FOR VERSION 92-1 AND LATER VERSIONS OF THIS CODE ALL OUTPUT IS IN VIRGIN**

 **THE PROGRAM PLOTTAB FORMAT TO ALLOW RESULTS TO BE EASILY PLOTTED. VIRGIN**

 **FOR A COPY OF PROGRAM PLOTTAB CONTACT D.E. CULLEN AT THE ABOVE VIRGIN**

 **ADDRESS. VIRGIN**

 **VIRGIN**

 **TALLY GROUPS VIRGIN**

 **------------ VIRGIN**

 **THE TALLY GROUP STRUCTURE MAY BE ANY SET OF MONONTONICALLY VIRGIN**

 **INCREASING ENERGY BOUNDARIES. THERE MAY BE UP TO 2000 TALLY VIRGIN**

 **GROUPS. BY USING THE INPUT PARAMETERS THE USER MAY SPECIFY ANY VIRGIN**

 **ARBITRARY TALLY GROUP STRUCTURE OR SELECT ONE OF THE FOLLOWING VIRGIN**

 **BUILT-IN GROUP STRUCTURES. VIRGIN**

 **VIRGIN**

 **(0) TART 175 GROUPS VIRGIN**

 **(1) ORNL 50 GROUPS VIRGIN**

 **(2) ORNL 126 GROUPS VIRGIN**

 **(3) ORNL 171 GROUPS VIRGIN**

 **(4) SAND-II 620 GROUPS - 1.0D-4 eV UP TO 18 MEV VIRGIN**

 **(5) SAND-II 640 GROUPS - 1.0D-4 eV UP TO 20 MEV VIRGIN**

 **(6) WIMS 69 GROUPS VIRGIN**

 **(7) GAM-I 68 GROUPS VIRGIN**

 **(8) GAM-II 99 GROUPS VIRGIN**

 **(9) MUFT 54 GROUPS VIRGIN**

 **(10) ABBN 28 GROUPS VIRGIN**

 **(11) TART 616 GROUPS TO 20 MeV VIRGIN**

 **(12) TART 700 GROUPS To 1 GeV VIRGIN**

 **(13) SAND-II 665 GROUPS - 1.0D-5 eV UP TO 18 MEV VIRGIN**

 **(14) SAND-II 685 GROUPS - 1.0D-5 eV UP TO 20 MEV VIRGIN**

 **(15) TART 666 GROUPS TO 200 MeV VIRGIN**

 **(16) SAND-II 725 GROUPS - 1.0D-5 eV UP TO 60 MEV VIRGIN**

 **(17) SAND-II 755 GROUPS - 1.0D-5 eV UP TO 150 MEV VIRGIN**

 **(18) SAND-II 765 GROUPS - 1.0D-5 eV UP TO 200 MEV VIRGIN**

 **(19) UKAEA 1102 GROUPS - 1.0D-5 eV UP TO 1 GeV VIRGIN**

 **VIRGIN**

 **INCIDENT SPECTRUM VIRGIN**

 **----------------- VIRGIN**

 **THE INCIDENT SPECTRUM MAY BE ANY TABULATED FUNCTION THAT IS VIRGIN**

 **GIVEN BY A SET OF POINTS THAT IS MONOTONICALLY INCREASING IN VIRGIN**

 **ENERGY AND LINEAR-LINEAR INTERPOLABLE IN ENERGY-SPECTRUM VIRGIN**

 **BETWEEN TABULATED POINTS. THERE IS NO LIMIT TO THE NUMBER OF VIRGIN**

 **POINTS USED TO DESCRIBE THE SPECTRUM. THERE ARE FIVE BUILT-IN VIRGIN**

 **OPTIONS FOR THE SPECTRUM. VIRGIN**

 **VIRGIN**

 **(1) CONSTANT...ENERGY INDEPENDENT (INPUT 0) VIRGIN**

 **(2) 1/E (INPUT 1) VIRGIN**

 **(3) BLACKBODY - PHOTON SPECTRUM VIRGIN**

 **(4) BLACKBODY - ENERGY SPECTRUM (E TIMES THE PHOTON SPECTRUM) VIRGIN**

 **(5) TRANSMITTED SPECTRUM FROM PREVIOUS CASE VIRGIN**

 **VIRGIN**

 **NORMALIZATION OF SPECTRUM VIRGIN**

 **------------------------- VIRGIN**

 **ANY INCIDENT SPECTRUM, EITHER READ AS INPUT OR ONE OF THE VIRGIN**

 **BUILT-IN SPECTRA, WILL BE NORMALIZED TO UNITY WHEN INTEGRATED VIRGIN**

 **OVER THEIR ENTIRE ENERGY RANGE. VIRGIN**

 **VIRGIN**

 **TRANSMITTED SPECTRA WILL NOT BE RE-NORMALIZED, SINCE IT ALREADY VIRGIN**

 **INCLUDES THE NORMALIZATION OF THE INCIDENT SPECTRUM. VIRGIN**

 **VIRGIN**

 **NOTE, INCIDENT SPECTRA IS NORMALIZED TO UNITY OVER THEIR ENTIRE VIRGIN**

 **ENERGY RANGE - NOT OVER THE ENERGY RANGE OF THE GROUPS. IF THE VIRGIN**

 **ENERGY RANGE OF THE GROUPS IS LESS THAN THAT OF THE SPECTRUM VIRGIN**

 **ONLY THAT PORTION OF THE SPECTRUM WILL BE USED AND THIS WILL VIRGIN**

 **NOT BE RE-NORMALIZED TO UNITY. VIRGIN**

 **VIRGIN**

 **COMPOSITION OF A LAYER VIRGIN**

 **---------------------- VIRGIN**

 **YOU MAY RUN PROBLEMS INVOLVING VIRGIN**

 **1) A LAYER OF UNIFORM DENSITY - DENSITY FOR ATTENUATION IS THAT VIRGIN**

 **OF THE TOTAL. DENSITY FOR REACTIONS IS THAT OF THE REACTION. VIRGIN**

 **2) A LAYER OF UNIFORM DENSITY - DENSITY IS THE SUM OF THE TOTAL VIRGIN**

 **AND REACTION DENSITIES - THE SUM OF THE CROSS SECTIONS IS VIRGIN**

 **USED FOR ATTENUATION AND REACTIONS. VIRGIN**

 **3) A LAYER OF VARYING DENSITY BASED ON A UNIFORM TOTAL DENSITY VIRGIN**

 **PLUS A VARIATION BETWEEN 0 AND A MAXIMUM BASED ON THE VIRGIN**

 **REACTION DENSITY - 0 AT 0 THICKNESS AND MAXIMUM AT MAXIMUM VIRGIN**

 **THICKNESS. IN THIS CASE THE AVERAGE REACTION DENSITY IS EQUAL VIRGIN**

 **TO THE INPUT REACTION DENSITY. THE VARIATION IN REACTION VIRGIN**

 **DENSITY CAN BE LINEAR, SQUARE OR CUBIC. VIRGIN**

 **4) A LAYER OF VARYING DENSITY BASED ON A TOTAL DENSITY WHICH VIRGIN**

 **VARYING FROM MAXIMUM AT 0 THICKNESS TO 0 AT MAXIMUM THICKNESS VIRGIN**

 **PLUS A REACTION DENSITY WHICH VARIES FROM 0 AT 0 THICKNESS VIRGIN**

 **TO MAXIMUM AT MAXIMUM THICKNESS. IN THIS CASE THE AVERAGE VIRGIN**

 **DENSITY OF THE TOTAL AND REACTION WILL BOTH BE EQUAL TO THE VIRGIN**

 **INPUT TOTAL AND REACTION DENSITIES. THE VARIATION IN TOTAL VIRGIN**

 **AND REACTION DENSITY CAN BE LINEAR, SQUARE OR CUBIC. VIRGIN**

 **VIRGIN**

 **IN THE FIRST CASE THE TWO REQUESTED CROSS SECTIONS ARE CONSIDERED VIRGIN**

 **TO BE INDEPENDENT - THE TOTAL CROSS SECTION IS USED TO CALCULATE VIRGIN**

 **ATTENUATION AND THE REACTION CROSS SECTION IS USED TO CALCULATE VIRGIN**

 **REACTIONS, E.G., TRANSMISSION THROUGH NATURAL URANIUM (THE TOTAL VIRGIN**

 **CROSS SECTION SHOULD BE THAT OF NATURAL URANIUM) AND REACTIONS VIRGIN**

 **IN A U-235 DETECTOR (THE REACTION CROSS SECTION SHOULD BE THAT OF VIRGIN**

 **U-235). VIRGIN**

 **VIRGIN**

 **IN THE OTHER THREE CASES THE TWO REQUESTED CROSS SECTIONS ARE VIRGIN**

 **TREATED AS TWO CONSTITUENTS OF A MIXTURE OF TWO MATERIALS AND VIRGIN**

 **THE TWO CROSS SECTIONS ARE USED BOTH TO DEFINE A TOTAL CROSS VIRGIN**

 **SECTION FOR ATTENUATION AND A REACTION CROSS SECTION TO DEFINE VIRGIN**

 **REACTIONS. IN THESE CASES THE MIXTURE WILL VARY CONTINUOUSLY, VIRGIN**

 **E.G., IN CASE 4) HALF WAY THROUGH THE LAYER THE COMPOSITION WILL VIRGIN**

 **BE 1/2 THE MATERIAL DEFINED BY THE TOTAL AND 1/2 THE MATERIAL VIRGIN**

 **BASED ON THE REACTION. IN THESE CASES RATHER THAN THINKING OF VIRGIN**

 **THE TWO CROSS SECTIONS AS A TOTAL AND REACTION CROSS SECTION, VIRGIN**

 **IT IS BETTER TO THINK OF THEM AS THE TOTAL CROSS SECTIONS FOR VIRGIN**

 **MATERIALS A AND B AND THE CALCULATED REACTIONS WILL BE BASED VIRGIN**

 **ON THESE TWO TOTAL CROSS SECTIONS. VIRGIN**

 **VIRGIN**

 **MULTIPLE LAYERS VIRGIN**

 **--------------- VIRGIN**

 **THIS CODE MAY BE USED TO RUN EITHER A NUMBER OF INDEPENDENT VIRGIN**

 **PROBLEMS, EACH INVOLVING TRANSMISSION THROUGH A SINGLE LAYER OF VIRGIN**

 **MATERIAL, OR TRANSMISSION THROUGH A NUMBER OF LAYERS ONE AFTER VIRGIN**

 **THE OTHER. VIRGIN**

 **VIRGIN**

 **IN THE CASE OF MULTIPLE LAYERS, ONE LAYER AFTER ANOTHER, THE VIRGIN**

 **TRANSMITTED ENERGY DEPENDENT SPECTRUM IS USED AS THE INCIDENT VIRGIN**

 **SPECTRUM FOR THE NEXT LAYER. THERE IS NO LIMIT TO THE NUMBER VIRGIN**

 **OF LAYERS WHICH MAY BE USED - EACH LAYER IS TREATED AS A VIRGIN**

 **COMPLETELY INDEPENDENT PROBLEM WITH A DEFINED INCIDENT SOURCE, VIRGIN**

 **AND AS SUCH THE CYCLE OF TRANSMISSION THROUGH EACH LAYER AND VIRGIN**

 **USING THE TRANSMITTED SPECTRUM AS THE INCIDENT SPECTRUM FOR THE VIRGIN**

 **NEXT LAYER MAY BE REPEATED ANY NUMBER OF TIMES. VIRGIN**

 **VIRGIN**

 **REMEMBER - THE INCIDENT SPECTRUM IS ASSUMED TO BE LINEARLY VIRGIN**

 **INTERPOLABLE IN ENERGY AND SPECTRUM BETWEEN THE ENERGIES AT VIRGIN**

 **WHICH IT IS TABULATED. THE TRANSMITTED SPECTRUM WILL BE TABULATED VIRGIN**

 **AT THE UNION OF ALL ENERGIES OF THE INCIDENT SPECTRUM AND CROSS VIRGIN**

 **SECTIONS (TOTAL AND REACTION). IN ORDER TO INSURE THE ACCURACY VIRGIN**

 **OF THE RESULT WHEN PERFORMING MULTIPLE LAYER CALCULATION BE SURE VIRGIN**

 **TO SPECIFY THE INCIDENT SPECTRUM ON THE FIRST LAYER TO SUFFICIENT VIRGIN**

 **DETAIL (ENOUGH ENERGY POINTS CLOSELY SPACED TOGETHER) IN ORDER TO VIRGIN**

 **ALLOW THE TRANSMITTED SPECTRUM TO BE ACCURATELY REPRESENTED BY VIRGIN**

 **LINEAR INTERPOLATION BETWEEN SUCCESSIVE ENERGY POINTS - THERE IS VIRGIN**

 **NO LIMIT TO THE NUMBER OF POINTS ALLOWED IN THE INCIDENT SPECTRUM,VIRGIN**

 **SO IF YOU ARE IN DOUBT, SIMPLY USE MORE ENERGY POINTS TO SPECIFY VIRGIN**

 **THE INCIDENT SPECTRUM. VIRGIN**

 **VIRGIN**

 **RESULT OUTPUT UNITS VIRGIN**

 **------------------- VIRGIN**

 **FLUX = EXACTLY AS CALCULATED VIRGIN**

 **REACTIONS = 1/CM OR 1/GRAM VIRGIN**

 **AVERAGE = 1/CM - MACROSCOPIC UNITS VIRGIN**

 **CROSS VIRGIN**

 **SECTION VIRGIN**

 **VIRGIN**

 **THICKNESS AND DENSITY VIRGIN**

 **--------------------- VIRGIN**

 **THE UNCOLLIDED CALCULATION ONLY DEPENDS ON THE PRODUCT OF VIRGIN**

 **THICKNESS AND DENSITY (I.E. GRAMS PER CM SQUARED). THIS FACT VIRGIN**

 **MAY BE USED TO SIMPLIFY INPUT BY ALLOWING THE THICKNESS AND VIRGIN**

 **DENSITY TO BE GIVEN EITHER AS CM AND GRAMS/CC RESPECTIVELY VIRGIN**

 **OR ELSE TO GIVE THICKNESS IN GRAMS/(CM\*CM) AND INPUT A VIRGIN**

 **DENSITY OF 1.0 - OR IN ANY OTHER CONVENIENT UNITS AS LONG AS VIRGIN**

 **THE PRODUCT OF THICKNESS AND DENSITY IS IN THE CORRECT GRAMS VIRGIN**

 **PER CENTIMETER SQUARED. VIRGIN**

 **VIRGIN**

 **GRAMS/(CM\*CM) ARE RELATED TO ATOMS/BARN THROUGH THE RELATIONSHIP VIRGIN**

 **VIRGIN**

 **GRAMS/(CM\*CM)=(ATOMS/BARN)\*(GRAMS/MOLE)\*(MOLE/ATOM) VIRGIN**

 **VIRGIN**

 **OR... VIRGIN**

 **VIRGIN**

 **GRAMS/(CM\*CM)=(ATOMS/BARN)\*(ATOMIC WEIGHT)/0.602 VIRGIN**

 **VIRGIN**

 **CROSS SECTIONS AT A SPACE POINT AND OPTICAL THICKNESS VIRGIN**

 **----------------------------------------------------- VIRGIN**

 **THIS PROGRAM ALLOWS LAYERS OF EITHER UNIFORM DENSITY OR VIRGIN**

 **CONTINUOUSLY VARYING DENSITY. THE DENSITY CAN BE ONE OF THE VIRGIN**

 **FOLLOWING FORMS, VIRGIN**

 **1) C = UNIFORM DENSITY VIRGIN**

 **2) C\*2\*(X/T) = LINEAR VARIATION FROM 0 TO C VIRGIN**

 **3) C\*(2-2\*(X/T)) = LINEAR VARIATION FROM C TO 0 VIRGIN**

 **4) C\*3\*(X/T)\*\*2 = SQUARE VARIATION FROM 0 TO C VIRGIN**

 **5) C\*(3-3\*(X/T)\*\*2)/2 = SQUARE VARIATION FROM C TO 0 VIRGIN**

 **6) C\*4\*(X/T)\*\*3 = CUBIC VARIATION FROM 0 TO C VIRGIN**

 **7) C\*(4-4\*(X/T)\*\*3)/3 = CUBIC VARIATION FROM C TO 0 VIRGIN**

 **VIRGIN**

 **IN ORDER TO CALCULATE REACTIONS AT A POINT THE MICROSCOPIC VIRGIN**

 **REACTION CROSS SECTION NEED MERELY BE SCALED BY THESE DENSITIES. VIRGIN**

 **VIRGIN**

 **IN ORDER TO CALCULATE TRANSMISSION WE MUST DEFINE THE OPTICAL VIRGIN**

 **PATH LENGTH WHICH MAY BE DEFINED BY INTEGRATING EACH OF THE VIRGIN**

 **ABOVE DENSITY FORMS TO FIND, VIRGIN**

 **1) C\*X VIRGIN**

 **2) C\*X\*(X/T) VIRGIN**

 **3) C\*X\*(2-(X/T)) VIRGIN**

 **4) C\*X\*(X/T)\*\*2 VIRGIN**

 **5) C\*X\*(3-(X/T)\*\*2)/2 VIRGIN**

 **6) C\*X\*(X/T)\*\*3 VIRGIN**

 **7) C\*X\*(4-(X/T)\*\*3))/3 VIRGIN**

 **VIRGIN**

 **IN ORDER TO CALCULATE TRANSMISSION TO A POINT THE MICROSCOPIC VIRGIN**

 **TOTAL CROSS SECTION NEED MERELY BE SCALED BY THESE DENSITIES VIRGIN**

 **TO DEFINE THE OPTICAL PATH LENGTH. VIRGIN**

 **VIRGIN**

 **THE VARIATION OF THE DENSITY THROUGH THE LAYER MAY BE DEFINED VIRGIN**

 **BY SETTING X = 0 OR X = T TO FIND, VIRGIN**

 **X = 0 X = T VIRGIN**

 **----- ----- VIRGIN**

 **1) C C VIRGIN**

 **2) 0 2\*C VIRGIN**

 **3) 2\*C 0 VIRGIN**

 **4) 0 3\*C VIRGIN**

 **5) 3\*C/2 0 VIRGIN**

 **6) 0 4\*C VIRGIN**

 **7) 4\*C/3 0 VIRGIN**

 **VIRGIN**

 **THE OPTICAL PATH THROUGH A LAYER OF THICKNESS T MAY BE DEFINED VIRGIN**

 **FROM THE ABOVE EXPRESSIONS BY SETTING X=T TO FIND THAT IN ALL VIRGIN**

 **CASES THE ANSWER WILL BY C\*T. THE CONSTANTS IN THE ABOVE VIRGIN**

 **EXPRESSIONS HAVE BEEN INTRODUCED IN ORDER TO FORCE THIS RESULT. VIRGIN**

 **WITH THESE FACTORS THE OPTICAL PATH LENGTH THROUGH THE LAYER VIRGIN**

 **WILL EXACTLY CORRESPOND TO AN AVERAGE DENSITY CORRESPONDING TO VIRGIN**

 **THAT INPUT FOR THE TOTAL AND/OR REACTION, I.E., C CORRESPONDS VIRGIN**

 **TO THE INPUT DENSITY. VIRGIN**

 **VIRGIN**

 **NOTE - FOR THE SAME OPTICAL PATH LENGTHS THROUGH THE LAYER THE VIRGIN**

 **TRANSMISSION WILL BE EXACTLY THE SAME. HOWEVER, VARYING THE VIRGIN**

 **DENSITY WILL ALLOW YOU TO MODIFY THE REACTION RATES AT SPECIFIC VIRGIN**

 **DEPTHS INTO THE LAYER. VIRGIN**

 **VIRGIN**

 **COMPUTATION OF INTEGRALS VIRGIN**

 **------------------------ VIRGIN**

 **STARTING FROM TOTAL CROSS SECTIONS, REACTION CROSS SECTIONS AND VIRGIN**

 **A SOURCE SPECTRUM ALL OF WHICH ARE GIVEN IN TABULAR FORM WITH VIRGIN**

 **LINEAR INTERPOLATION BETWEEN TABULATED POINTS ALL REQUIRED VIRGIN**

 **INTEGRALS CAN BE DEFINED BY ANALYTICAL EXPRESSIONS INVOLVING VIRGIN**

 **NOTHING MORE COMPLICATED THAN EXPONENTIALS. THE INTEGRALS THAT VIRGIN**

 **MUST BE EVALUATED ARE OF THE FORM... VIRGIN**

 **VIRGIN**

 **FLUX VIRGIN**

 **---- VIRGIN**

 **(INTEGRAL EK TO EK+1) (S(E)\* EXP(-XCT(E)\*Z)\*DE) VIRGIN**

 **VIRGIN**

 **REACTIONS VIRGIN**

 **--------- VIRGIN**

 **(INTEGRAL EK TO EK+1) (S(E)\*XCR(E)\*EXP(-XCT(E)\*Z)\*DE) VIRGIN**

 **VIRGIN**

 **WHERE.. VIRGIN**

 **EK TO EK+1 = LONGEST ENERGY INTERVAL OVER WHICH S(E), XCT(E) AND VIRGIN**

 **XCR(E) ARE ALL LINEARLY INTERPOLABLE. VIRGIN**

 **S(E) = ENERGY DEPENDENT WEIGHTING SPECTRUM VIRGIN**

 **XCR(E) = REACTION CROSS SECTION VIRGIN**

 **XCT(E) = OPTICAL PATH LENGTH (BASED ON TOTAL CROSS SECTION) VIRGIN**

 **Z = MATERIAL THICKNESS VIRGIN**

 **VIRGIN**

 **S(E), XCR(E) AND XCT(E) ARE ALL ASSUMED TO BE GIVEN IN TABULAR VIRGIN**

 **FORM WITH LINEAR INTERPOLATION USED BETWEEN TABULATED POINTS. VIRGIN**

 **IN OTHER WORDS BETWEEN TABULATED POINTS EACH OF THESE THREE IS VIRGIN**

 **DEFINED BY A FUNCTION OF THE FORM... VIRGIN**

 **VIRGIN**

 **F(E)=((E - EK)\*FK+1 + (EK+1 - E)\*FK)/(EK+1 - EK) VIRGIN**

 **VIRGIN**

 **EACH OF THESE THREE CAN BE CONVERTED TO NORMAL FORM BY THE VIRGIN**

 **CHANGE OF VARIABLES.... VIRGIN**

 **VIRGIN**

 **X=(E - 0.5\*(EK+1 + EK))/(EK+1 - EK) VIRGIN**

 **VIRGIN**

 **IN WHICH CASE X WILL VARY FROM -1 (AT EK) TO +1 (AT EK+1) AND VIRGIN**

 **EACH FUNCTION REDUCES TO THE NORMAL FORM... VIRGIN**

 **VIRGIN**

 **F(X)=0.5\*(FK\*(1 - X) + FK+1\*(1 + X)) VIRGIN**

 **=0.5\*(FK+1 + FK) + 0.5\*(FK+1 - FK)\*X VIRGIN**

 **VIRGIN**

 **BY DEFINING THE AVERAGE VALUE AND 1/2 THE CHANGE ACROSS THE VIRGIN**

 **INTERVAL. VIRGIN**

 **VIRGIN**

 **AVF=0.5\*(FK+1 + FK) VIRGIN**

 **DF= 0.5\*(FK+1 - FK) VIRGIN**

 **DE= 0.5\*(EK+1 - EK) VIRGIN**

 **VIRGIN**

 **EACH OF THE THREE FUNCTIONS REDUCES TO THE SIMPLE FORM... VIRGIN**

 **VIRGIN**

 **F(X)=AVF+DF\*X VIRGIN**

 **VIRGIN**

 **AND THE TWO REQUIRED INTEGRALS REDUCE TO... VIRGIN**

 **VIRGIN**

 **FLUX VIRGIN**

 **---- VIRGIN**

 **DE\*EXP(-AVXCT\*Z) \* (INTEGRAL -1 TO +1) VIRGIN**

 **((AVS+DS\*X)\*EXP(-DXCT\*Z\*X)\*DX) VIRGIN**

 **VIRGIN**

 **REACTION VIRGIN**

 **-------- VIRGIN**

 **DE\*EXP(-AVXCT\*Z) \* (INTEGRAL -1 TO +1) VIRGIN**

 **((AVS\*AVXCR+(AVS\*DXCR+AVXCR\*DS)\*X+DS\*DXCR\*X\*X)\*EXP(-DXCT\*Z\*X)\*DX) VIRGIN**

 **VIRGIN**

 **WHERE VIRGIN**

 **VIRGIN**

 **AVXCT = AVERAGE VALUE OF THE TOTAL CROSS SECTION VIRGIN**

 **AVXCR = AVERAGE VALUE OF THE REACTION CROSS SECTION VIRGIN**

 **AVS = AVERAGE VALUE OF THE SOURCE VIRGIN**

 **DXCT = 1/2 THE CHANGE IN THE TOTAL CROSS SECTION VIRGIN**

 **DXCR = 1/2 THE CHANGE IN THE REACTION CROSS SECTION VIRGIN**

 **DS = 1/2 THE CHANGE IN THE SOURCE VIRGIN**

 **DE = 1/2 THE CHANGE IN THE ENERGY VIRGIN**

 **VIRGIN**

 **NOTE THAT IN THIS FORM THE ENERGY ONLY APPEARS IN FRONT OF THE VIRGIN**

 **INTEGRALS AND THE INTEGRALS ARE EXPRESSED ONLY IN TERMS OF THE VIRGIN**

 **TABULATED VALUES OF S(E), XCT(E) AND XCR(E). IN PARTICULAR NO VIRGIN**

 **DERIVATIVES ARE USED, SO THAT THERE ARE NO NUMERICAL INSTABILITY VIRGIN**

 **PROBLEMS IN THE VACINITY OF DISCONTINUITIES IN S(E), XCT(E) OR VIRGIN**

 **XCR(E). INDEED, SINCE (EK+1 - EK) APPEARS IN FRONT OF THE INTEGRALVIRGIN**

 **POINTS OF DISCONTINUITY AUTOMATICALLY MAKE ZERO CONTRIBUTION TO VIRGIN**

 **THE INTEGRALS. VIRGIN**

 **VIRGIN**

 **THE REQUIRED INTEGRALS CAN BE EXPRESSED IN TERMS OF THE THREE VIRGIN**

 **INTEGRALS IN NORMAL FORM.... VIRGIN**

 **VIRGIN**

 **F(A,N) = (INTEGRAL -1 TO 1) (X\*\*N\*EXP(-A\*X)\*DX), N=0,1 AND 2. VIRGIN**

 **VIRGIN**

 **THESE THREE INTEGRALS CAN BE EVALUATED TO FIND... VIRGIN**

 **VIRGIN**

 **N=0 VIRGIN**

 **--- VIRGIN**

 **F(A,0) = (EXP(A)-EXP(-A))/A VIRGIN**

 **VIRGIN**

 **N=1 VIRGIN**

 **--- VIRGIN**

 **F(A,1) = ((1-A)\*EXP(A)-(1+A)\*EXP(-A))/(A\*A) VIRGIN**

 **VIRGIN**

 **N=2 VIRGIN**

 **--- VIRGIN**

 **F(A,2) = ((2-2\*A+A\*A)\*EXP(A)-(2+2\*A+A\*A)\*EXP(-A))/(A\*A\*A) VIRGIN**

 **VIRGIN**

 **HOWEVER THESE EXPRESSIONS ARE NUMERICALLY UNSTABLE FOR SMALL VIRGIN**

 **VALUES OF A. THEREFORE FOR SMALL A THE EXPONENTIAL IN THE VIRGIN**

 **INTEGRALS ARE EXPANDED IN A POWER SERIES... VIRGIN**

 **VIRGIN**

 **EXP(-AX)=1.0-(AX)+(AX)\*\*2/2-(AX)\*\*3/6+(AX)\*\*4/24-........ VIRGIN**

 **=(SUM K=0 TO INFINITY) (-AX)\*\*K/(K FACTORIAL) VIRGIN**

 **VIRGIN**

 **AND THE INTEGRAL REDUCES TO THE FORM.... VIRGIN**

 **VIRGIN**

 **(SUM K=0 TO INFINITY) ((-A)\*\*K/(K FACTORIAL)) \* VIRGIN**

 **(INTEGRAL -1 TO 1) (X\*\*(N+K))\*DX VIRGIN**

 **VIRGIN**

 **WHICH CAN BE ANALYTICALLY EVAULATED TO FIND.... VIRGIN**

 **(K(N) = K FACTORIAL) VIRGIN**

 **VIRGIN**

 **N=0 VIRGIN**

 **--- VIRGIN**

 **F(A,0) = 2\*(1+(A\*\*2)/K(3)+(A\*\*4)/K(5)+(A\*\*6)/K(7)+.... VIRGIN**

 **VIRGIN**

 **N=1 VIRGIN**

 **--- VIRGIN**

 **F(A,1) = -2\*A\*(2/K(3)+4\*(A\*\*2)/K(5)+6\*(A\*\*4)/K(7)+8\*(A\*\*6)/K(9)+..VIRGIN**

 **VIRGIN**

 **N=2 VIRGIN**

 **--- VIRGIN**

 **F(A,2) = 2\*(2/K(3)+3\*4\*(A\*\*2)/K(5)+5\*6\*(A\*\*4)/K(7)+ VIRGIN**

 **7\*8\*(A\*\*6)/K(9)+.... VIRGIN**

 **VIRGIN**

 **THESE EXPANSIONS ARE USED WHEN THE ABSOLUTE VALUE OF A IS LESS VIRGIN**

 **THAN 0.1. BY TRUNCATING THE ABOVE SERIES BEFORE A\*\*8 THE ERROR VIRGIN**

 **RELATIVE TO THE LEADING TERM OF THE SERIES WILL BE 10\*\*(-10), VIRGIN**

 **YIELDING 10 DIGIT ACCURACY. VIRGIN**

 **VIRGIN**

 **AFTER EVALUATING THE ABOVE FUNCTIONS, EITHER DIRECTLY OR BY USING VIRGIN**

 **THE EXPANSION THE TWO REQUIRED INTEGRALS CAN BE WRITTEN AS... VIRGIN**

 **VIRGIN**

 **FLUX VIRGIN**

 **---- VIRGIN**

 **DE\*EXP(-AVXCT\*Z)\*(AVS\*F(A,0) + DS\*F(A,1)) VIRGIN**

 **VIRGIN**

 **REACTIONS VIRGIN**

 **--------- VIRGIN**

 **DE\*EXP(-AVXCT\*Z)\* VIRGIN**

 **(AVS\*AVXCR\*F(A,0) + (AVS\*DXCR+AVXCR\*DS)\*F(A,1) + DS\*DXCR\*F(A,2)) VIRGIN**

 **VIRGIN**

 **INPUT FILES VIRGIN**

 **----------- VIRGIN**

 **FILENAME UNIT DESCRIPTION VIRGIN**

 **-------- ---- ----------- VIRGIN**

 **INPUT 2 INPUT LINES VIRGIN**

 **ENDFIN 10 EVALUATED DATA IN ENDF/B FORMAT VIRGIN**

 **VIRGIN**

 **OUTPUT FILES VIRGIN**

 **------------ VIRGIN**

 **FILENAME UNIT DESCRIPTION VIRGIN**

 **-------- ---- ----------- VIRGIN**

 **OUTPUT 3 OUTPUT LISTING VIRGIN**

 **VIRGIN**

 **SCRATCH FILES VIRGIN**

 **------------- VIRGIN**

 **FILENAME UNIT DESCRIPTION VIRGIN**

 **-------- ---- ----------- VIRGIN**

 **SCR1 12 REACTION, FLUX AND CROSS SECTION RESULTS (BCD) VIRGIN**

 **(SORTED AT END OF RUN AND OUTPUT SEPARATELY) VIRGIN**

 **SCR2 13 TALLY GROUP ENERGY BOUNDARIES (BINARY) VIRGIN**

 **SCR3 14 SOURCE SPECTRUM (BINARY) VIRGIN**

 **SCR4 15 TOTAL CROSS SECTION (BINARY) VIRGIN**

 **SCR5 16 REACTION CROSS SECTION (BINARY) VIRGIN**

 **VIRGIN**

 **OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILIO1 AND FILEIO2) VIRGIN**

 **---------------------------------------------------------------- VIRGIN**

 **UNIT FILE NAME FORMAT VIRGIN**

 **---- ---------- ------ VIRGIN**

 **2 VIRGIN.INP BCD VIRGIN**

 **3 VIRGIN.LST BCD VIRGIN**

 **10 ENDFB.IN BCD VIRGIN**

 **11-15 (SCRATCH) BINARY VIRGIN**

 **16 PLOTTAB.CUR PLOTTAB OUTPUT FORMAT DATA VIRGIN**

 **VIRGIN**

 **INPUT LINES VIRGIN**

 **----------- VIRGIN**

 **ANY NUMBER OF CASES MAY BE RUN ONE AFTER THE OTHER. AFTER THE VIRGIN**

 **FIRST CASE HAS BEEN RUN THE FOLLOWING CASES MAY USE THE SAME VIRGIN**

 **THICKNESSES, GROUP STRUCTURE AND SPECTRUM AS THE PRECEDING CASE. VIRGIN**

 **IN ADDITION THE TRANSMITTED SPECTRUM FROM ONE CASE MAY BE USED VIRGIN**

 **AS THE INCIDENT SPECTRUM IN THE NEXT CASE, TO ALLOW MULTIPLE VIRGIN**

 **LAYERS OF DIFFERENT MATERIALS. VIRGIN**

 **VIRGIN**

 **LINE COLS. FORMAT DESCRIPTION VIRGIN**

 **---- ----- ------ ---------- VIRGIN**

 **1 1-60 ENDF/B INPUT DATA FILENAME VIRGIN**

 **(STANDARD OPTION = ENDFB.IN) VIRGIN**

 **VIRGIN**

 **LEAVE THE DEFINITION OF THE FILENAMES BLANK - THE PROGRAM WILL VIRGIN**

 **THEN USE STANDARD FILENAMES. VIRGIN**

 **VIRGIN**

 **2-3 1-72 18A4 TWO LINE TITLE DESCRIBING PROBLEM VIRGIN**

 **4 1- 6 I6 ZA (1000\*Z+A) OF TARGET FOR TOTAL VIRGIN**

 **7-11 I5 MT OF TOTAL VIRGIN**

 **12-22 E11.4 DENSITY FOR TOTAL VIRGIN**

 **23-28 I6 ZA (1000\*Z+A) OF TARGET FOR REACTION VIRGIN**

 **29-33 I5 MT OF REACTION VIRGIN**

 **= 0 - NO REACTION CALCULATION (ONLY FLUX). VIRGIN**

 **= GREATER THAN 0 - CALCULATE REACTIONS. VIRGIN**

 **34-44 E11.4 DENSITY FOR REACTION VIRGIN**

 **45-50 I6 NUMBER OF TARGET THICKNESSES VIRGIN**

 **= GREATER THAN 0 = READ FROM INPUT VIRGIN**

 **(1 TO 2000 ALLOWED) VIRGIN**

 **= 0 = SAME AS LAST CASE VIRGIN**

 **51-55 I5 NUMBER OF TALLY GROUPS VIRGIN**

 **(REMEMBER NUMBER OF GROUP BOUNDARIES VIRGIN**

 **IS ONE MORE THAN THE NUMBER OF GROUPS) VIRGIN**

 **UP TO 2000 GROUPS ARE ALLOWED VIRGIN**

 **BUILT-IN GROUP STRUCTURES. VIRGIN**

 **= GREATER THAN 0 = READ FROM INPUT VIRGIN**

 **= 0 TART 175 GROUPS VIRGIN**

 **= -1 ORNL 50 GROUPS VIRGIN**

 **= -2 ORNL 126 GROUPS VIRGIN**

 **= -3 ORNL 171 GROUPS VIRGIN**

 **= -4 SAND-II 620 GROUPS..1.0D-4 eV TO 18 MEV VIRGIN**

 **= -5 SAND-II 640 GROUPS..1.0D-4 eV TO 20 MEV VIRGIN**

 **= -6 WIMS 69 GROUPS VIRGIN**

 **= -7 GAM-I 68 GROUPS VIRGIN**

 **= -8 GAM-II 99 GROUPS VIRGIN**

 **= -9 MUFT 54 GROUPS VIRGIN**

 **=-10 ABBN 28 GROUPS VIRGIN**

 **=-11 TART 616 GROUPS TO 20 MeV VIRGIN**

 **=-12 TART 700 GROUPS TO 1 GeV VIRGIN**

 **=-13 SAND-II 665 GROUPS..1.0D-5 eV TO 18 MEV VIRGIN**

 **=-14 SAND-II 685 GROUPS..1.0D-5 eV TO 20 MEV VIRGIN**

 **=-15 TART 666 GROUPS TO 200 MeV VIRGIN**

 **=-16 SAND-II 725 GROUPS..1.0D-5 eV TO 60 MEVVIRGIN**

 **=-17 SAND-II 755 GROUPS..1.0D-5 eV TO 150 MEVVIRGIN**

 **=-18 SAND-II 765 GROUPS..1.0D-5 eV TO 200 MEVVIRGIN**

 **=-19 UKAEA 1102 GROUPS..1.0D-5 eV to 1 GeVVIRGIN**

 **56-60 I5 NUMBER OF POINTS IN SOURCE SPECTRUM VIRGIN**

 **(MUST BE AT LEAST TWO POINTS) VIRGIN**

 **= GREATER THAN 1 = READ FROM INPUT VIRGIN**

 **= 0 = SAME AS LAST CASE VIRGIN**

 **= -1 = CONSTANT (ENERGY INDEPENDENT) VIRGIN**

 **= -2 = 1/E VIRGIN**

 **= -3 = BLACKBODY - PHOTON SPECTRUM VIRGIN**

 **= -4 = BLACKBODY - ENERGY SPECTRUM VIRGIN**

 **= -5 = TRANSMITTED SPECTRUM FROM LAST CASE VIRGIN**

 **NOTE, ALL SPECTRA, EXCEPT THE TRANSMITTED VIRGIN**

 **SPECTRUM FROM THE LAST CASE, WILL BE VIRGIN**

 **NORMALIZED SUCH THAT ITS INTEGRAL OVER VIRGIN**

 **ENERGY WILL BE UNITY. VIRGIN**

 **61-64 1X,3I1 SPATIALLY DEPENDENT OUTOUT VIRGIN**

 **= 0 = NO VIRGIN**

 **= 1 = YES VIRGIN**

 **FOR THE 3 QUANTITIES VIRGIN**

 **COLUMN 67 FLUX VIRGIN**

 **68 REACTIONS VIRGIN**

 **69 AVERAGE CROSS SECTION VIRGIN**

 **65-65 I1 ENERGY DEPENDENT OUTOUT VIRGIN**

 **= 0 = NONE VIRGIN**

 **= 1 = INCIDENT SPECTRUM VIRGIN**

 **= 2 = TRANSMITTED SPECTRUM VIRGIN**

 **= 3 = INCIDENT REACTIONS VIRGIN**

 **= 4 = TRANSMIITED REACTIONS VIRGIN**

 **= 5 = TOTAL CROSS SECTION VIRGIN**

 **= 6 = REACTION CROSS SECTION VIRGIN**

 **5 1-11 E11.4 BLACKBODY TEMPERATURE IN eV VIRGIN**

 **12-22 E11.4 FLUX NORMALIZATION VIRGIN**

 **23-33 E11.4 REACTION NORMALIZATION VIRGIN**

 **CALCULATIONS WILL BE BASED ON THE SPECTRUM VIRGIN**

 **AND CROSS SECTIONS AS READ. AT OUTPUT THE VIRGIN**

 **RESULTS WILL BE MULTIPLIED BY THESE VIRGIN**

 **NORMALIZATION FACTORS. VIRGIN**

 **34-44 I11 DENSITY PROFILE VIRGIN**

 **= 0 - UNIFORM - BASED ON TOTAL DENSITY VIRGIN**

 **= 1 - UNIFORM - TOTAL + REACTION DENSITY VIRGIN**

 **= 2 - TOTAL + LINEAR REACTION VIRGIN**

 **= 3 - LINEAR (TOTAL + REACTION) VIRGIN**

 **= 4 - TOTAL + SQUARE REACTION VIRGIN**

 **= 5 - SQUARE (TOTAL + REACTION) VIRGIN**

 **= 6 - TOTAL + CUBIC REACTION VIRGIN**

 **= 7 - CUBIC (TOTAL + REACTION) VIRGIN**

 **6-N 1-66 6E11.4 TARGET THICKNESSES IN CM VIRGIN**

 **IF SAME AS LAST CASE THIS SECTION IS NOT VIRGIN**

 **INCLUDED IN THE INPUT. VIRGIN**

 **VARY 1-66 6E11.4 TALLY GROUP ENERGY BOUNDARIES VIRGIN**

 **(NUMBER OF BOUNDARIES IS ONE MORE THAN VIRGIN**

 **THE NUMBER OF TALLY GROUPS) VIRGIN**

 **IF THE STANDARD OPTION (-14 TO 0) IS VIRGIN**

 **SELECTED THIS SECTION IS NOT INCLUDED VIRGIN**

 **IN THE INPUT VIRGIN**

 **VARY 1-66 6E11.4 SOURCE SPECTRUM IN ENERGY (eV)-SOURCE PAIRS VIRGIN**

 **(MUST BE AT LEAST TWO POINTS) VIRGIN**

 **IF STANDARD OPTION (-5 TO 0) IS SELECTED THISVIRGIN**

 **SECTION IS NOT INCLUDED IN THE INPUT VIRGIN**

 **VIRGIN**

 **ANY NUMBER OF CASES MAY BE RUN ONE AFTER ANOTHER. VIRGIN**

 **VIRGIN**

 **EXAMPLE INPUT NO. 1 VIRGIN**

 **------------------- VIRGIN**

 **CALCULATE THE UNCOLLIDED FLUX AND CAPTURE (MT=102) THROUGH VIRGIN**

 **30 CM OF IRON (DENSITY 7.87 G/CC). TALLY THE RESULTS USING VIRGIN**

 **THE TART 175 GROUP STRUCTURE. THE SOURCE WILL BE CONSTANT VIRGIN**

 **FROM 1 KEV TO 20 MEV. USE THE STANDARD ENDF/B INPUT DATA VIRGIN**

 **FILENAME. VIRGIN**

 **VIRGIN**

 **ENDFB.IN VIRGIN**

 **IRON 0 TO 30 CM THICK. VIRGIN**

 **CONSTANT SOURCE FROM 1 KEV TO 20 MEV. VIRGIN**

 **26000 1 7.8700D+ 0 26000 102 7.8700D+ 0 2 0 2 1100 VIRGIN**

 **0.0000D+ 0 1.0000D+ 0 1.0000D+ 0 0 0.0000D+00 VIRGIN**

 **0.0000D+00 3.0000D+01 VIRGIN**

 **1.0000D+03 1.0000D+00 2.0000D+07 1.0000D+00 VIRGIN**

 **VIRGIN**

 **EXAMPLE INPUT NO. 2 VIRGIN**

 **------------------- VIRGIN**

 **CALCULATE THE UNCOLLIDED PHOTON FLUX THROUGH A MIXTURE OF SILICON VIRGIN**

 **AND IRON FOR 100 MEV PHOTONS INCIDENT. THE TRANSMISSION WILL BE VIRGIN**

 **CALCULATED FOR 21 THICKNESSES VARYING BETWEEN 0 AND 1 CM. THERE VIRGIN**

 **WILL BE ONLY 1 TALLY GROUP SPANNING A VERY NARROW ENERGY RANGE VIRGIN**

 **NEAR 100 MEV, AND THE SOURCE SPECTRUM WILL BE CONSTANT OVER THE VIRGIN**

 **SAME ENERGY RANGE. USE THE STANDARD ENDF/B INPUT DATA FILENAME VIRGIN**

 **BY LEAVING THE FIRST INPUT LINE BLANK. VIRGIN**

 **VIRGIN**

 **(THIS IS A BLANK LINE TO USE THE STANDARD INPUT FILENAME) VIRGIN**

 **100 MEV PHOTONS VIRGIN**

 **SILICON + 5 % IRON VIRGIN**

 **14000 521 2.30000+ 0 26000 521 1.15000- 1 21 1 2 1000 VIRGIN**

 **0.00000+ 0 1.00000+ 0 1.00000+ 0 1 0.00000+00 VIRGIN**

 **0.00000+00 5.00000-01 1.00000+00 1.50000+00 2.00000+00 2.50000+00VIRGIN**

 **3.00000+00 3.50000+00 4.00000+00 4.50000+00 5.00000+00 5.50000+00VIRGIN**

 **6.00000+00 6.50000+00 7.00000+00 7.50000+00 8.00000+00 8.50000+00VIRGIN**

 **9.00000+00 9.50000+00 1.00000+01 VIRGIN**

 **9.99000+ 7 1.00100+ 8 VIRGIN**

 **9.99000+ 7 1.00000+ 4 1.00100+ 8 1.00000+ 4 VIRGIN**

 **VIRGIN**

 **=======================================================================VIRGIN**