**==================================================================== GROUPIE**

**GROUPIE**

**PROGRAM GROUPIE GROUPIE**

**=============== GROUPIE**

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

**VERSION 79-1 (OCTOBER 1979) CDC-7600 AND CRAY-1 VERSION. GROUPIE**

**VERSION 80-1 (MAY 1980) IBM, CDC AND CRAY VERSION GROUPIE**

**VERSION 81-1 (JANUARY 1981) EXTENSION TO 3000 GROUPS GROUPIE**

**VERSION 81-2 (MARCH 1981) IMPROVED SPEED GROUPIE**

**VERSION 81-3 (AUGUST 1981) BUILT-IN 1/E WEIGHTING SPECTRUM GROUPIE**

**VERSION 82-1 (JANUARY 1982) IMPROVED COMPUTER COMPATIBILITY GROUPIE**

**VERSION 83-1 (JANUARY 1983)\*MAJOR RE-DESIGN. GROUPIE**

**\*ELIMINATED COMPUTER DEPENDENT CODING. GROUPIE**

**\*NEW, MORE COMPATIBLE I/O UNIT NUMBERS.GROUPIE**

**\*NEW MULTI-BAND LIBRARY BINARY FORMAT. GROUPIE**

**VERSION 83-2 (OCTOBER 1983) ADDED OPTION TO ALLOW SIGMA-0 TO BE GROUPIE**

**DEFINED EITHER AS MULTIPLES OF GROUPIE**

**UNSHIELDED TOTAL CROSS SECTION IN EACHGROUPIE**

**GROUP, OR POWERS OF 10 IN ALL GROUPS. GROUPIE**

**VERSION 84-1 (APRIL 1984) ADDED MORE BUILT IN MULTIGROUP ENERGY GROUPIE**

**STRUCTURES. GROUPIE**

**VERSION 85-1 (APRIL 1985) \*UPDATED FOR ENDF/B-VI FORMATS. GROUPIE**

**\*SPECIAL I/O ROUTINES TO GUARANTEE GROUPIE**

**ACCURACY OF ENERGY. GROUPIE**

**\*DOUBLE PRECISION TREATMENT OF ENERGY GROUPIE**

**(REQUIRED FOR NARROW RESONANCES). GROUPIE**

**\*MINIMUM TOTAL CROSS SECTION TREATMENT GROUPIE**

**VERSION 85-2 (AUGUST 1985) \*FORTRAN-77/H VERSION GROUPIE**

**VERSION 86-1 (JANUARY 1986)\*ENDF/B-VI FORMAT GROUPIE**

**VERSION 86-2 (JUNE 1986) \*BUILT-IN MAXWELLIAN, 1/E AND FISSION GROUPIE**

**WEIGHTING SPECTRUM. GROUPIE**

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

**FILE NAMES (SEE, SUBROUTINES FILIO1 GROUPIE**

**FILIO2 FOR DETAILS). GROUPIE**

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

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

**INSURE PROGRAM WILL NOT DO ANYTHING GROUPIE**

**CRAZY. GROUPIE**

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

**KEYWORDS. GROUPIE**

**\*ADDED LIVERMORE CIVIC COMPILER GROUPIE**

**CONVENTIONS. GROUPIE**

**VERSION 91-1 (JUNE 1991) \*INCREASED PAGE SIZE FROM 1002 TO 5010 GROUPIE**

**POINTS GROUPIE**

**\*UPDATED BASED ON USER COMMENTS GROUPIE**

**\*ADDED FORTRAN SAVE OPTION GROUPIE**

**\*COMPLETELY CONSISTENT ROUTINE TO READ GROUPIE**

**FLOATING POINT NUMBERS. GROUPIE**

**VERSION 92-1 (JANUARY 1992)\*ADDED RESONANCE INTEGRAL CALCULATION -GROUPIE**

**UNSHIELDED AND/OR SHIELDED - FOR GROUPIE**

**DETAILS SEE BELOW GROUPIE**

**\*INCREASED NUMBER OF ENERGY POINTS GROUPIE**

**IN BUILT-IN SPECTRA - TO IMPROVE GROUPIE**

**ACCURACY. GROUPIE**

**\*ALLOW SELECTION OF ZA/MF/MT OR GROUPIE**

**MAT/MF/MT RANGES - ALL DATA NOT GROUPIE**

**SELECTED IS SKIPPED ON INPUT AND GROUPIE**

**NOT WRITTEN AS OUTPUT. GROUPIE**

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

**TO MINIMIZE COMPUTER DEPENDENCE. GROUPIE**

**\*NOTE, CHANGES IN INPUT PARAMETER GROUPIE**

**FORMAT - FOR ZA/MF/MT OR MAT/MF/MT GROUPIE**

**RANGES. GROUPIE**

**VERSION 92-2 (JUNE 1992) \*MULTIBAND PARAMETERS OUTOUT AS GROUPIE**

**CHARACTER (RATHER THAN BINARY) FILE. GROUPIE**

**VERSION 93-1 (APRIL 1993) \*INCREASED PAGE SIZE FROM 5010 TO GROUPIE**

**30000 POINTS GROUPIE**

**\*ELIMINATED COMPUTER DEPENDENCE. GROUPIE**

**VERSION 94-1 (JANUARY 1994)\*VARIABLE ENDF/B DATA FILENAMES GROUPIE**

**TO ALLOW ACCESS TO FILE STRUCTURES GROUPIE**

**(WARNING - INPUT PARAMETER FORMAT GROUPIE**

**HAS BEEN CHANGED) GROUPIE**

**\*CLOSE ALL FILES BEFORE TERMINATING GROUPIE**

**(SEE, SUBROUTINE ENDIT) GROUPIE**

**VERSION 95-1 (JANUARY 1994)\*CORRECTED MAXWELLIAN WEIGHTING GROUPIE**

**\*CHANGING WEIGHTING SPECTRUM FROM GROUPIE**

**0.1 TO 0.001 % UNCERTAINTY GROUPIE**

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

**\*IMPROVED COMPUTER INDEPENDENCE GROUPIE**

**\*ALL DOUBLE PRECISION GROUPIE**

**\*ON SCREEN OUTPUT GROUPIE**

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

**\*IMPROVED OUTPUT PRECISION GROUPIE**

**\*DEFINED SCRATCH FILE NAMES GROUPIE**

**\*UP TO 1000 GROUP MULTI-BAND GROUPIE**

**CALCULATION (PREVIOUSLY 175) GROUPIE**

**\*MAXIMUM NUMBER OF GROUPS REDUCED GROUPIE**

**FROM 3,000 TO 1,000 GROUPIE**

**\*UP TO 1000 MATERIALS GROUPIE**

**(PREVIOUSLY 100) GROUPIE**

**\*CORRECTED USE OF MAXWELLIAN + GROUPIE**

**1/E + FISSION SPECTRUM GROUPIE**

**\*ONLY 2 BAND VERSION DISTRIBUTED GROUPIE**

**(CONTACT AUTHOR FOR DETAILS) GROUPIE**

**\*DEFINED SCRATCH FILE NAMES GROUPIE**

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

**POINT READ FOR MORE DIGITS GROUPIE**

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

**VERSION BASED ON RECENT FORMAT CHANGEGROUPIE**

**\*GENERAL IMPROVEMENTS BASED ON GROUPIE**

**USER FEEDBACK GROUPIE**

**VERSION 99-2 (JUNE 1999) \*ASSUME ENDF/B-VI, NOT V, IF MISSING GROUPIE**

**MF=1, MT-451. GROUPIE**

**VERS. 2000-1 (FEBRUARY 2000)\*ADDED MF=10, ACTIVATION CROSS SECTIONGROUPIE**

**PROCESSING. GROUPIE**

**\*GENERAL IMPROVEMENTS BASED ON GROUPIE**

**USER FEEDBACK GROUPIE**

**VERS. 2002-1 (FEBRUARY 2002)\*ADDED TART 700 GROUP STRUCTURE GROUPIE**

**\*ADDED VARIABLE SIGMA0 INPUT OPTION GROUPIE**

**(MAY 2002) \*OPTIONAL INPUT PARAMETERS GROUPIE**

**(NOV. 2002) \*ADDED SAND-II EXTENDED DOWN TO GROUPIE**

**1.0D-5 EV. GROUPIE**

**(JUNE 2003) \*CORRECTED SAND-II 620 AND 640 GROUP GROUPIE**

**ENERGY BOUNDARIES DEFINITIONS. GROUPIE**

**VERS. 2004-1 (SEPT. 2004) \*INCREASED PAGE SIZE FROM 30000 TO GROUPIE**

**120000 POINTS GROUPIE**

**\*ADDED "OTHER" AS ADDITIONAL REACTION GROUPIE**

**TO IMPROVE MULTI-BAND FITTING GROUPIE**

**\*ADDED ITERATION FOR "BEST" PARTIAL GROUPIE**

**PARAMETERS. GROUPIE**

**\*DO NOT SKIP LOW TOTAL ENERGY RANGES GROUPIE**

**WHEN DEFINING AVERAGE CROSS SECTIONS -GROUPIE**

**THIS MAKES OUTPUT COMPATIBLE WITH GROUPIE**

**ANY STANDARD AVERAGING PROCEDURE GROUPIE**

**VERS. 2005-1 (JAN. 2005) \*ADDED OPTION TO CHANGE TEMPERATURE OF GROUPIE**

**BUILT-IN STANDARD SPECTRUM. GROUPIE**

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

**\*INCREASED PAGE SIZE FROM 120,000 TO GROUPIE**

**600,000 POINTS GROUPIE**

**VERS. 2008-1 (JAN. 2008) \*72 CHARACTER FILE NAMES. GROUPIE**

**\*GENERAL UPDATES GROUPIE**

**VERS. 2010-1 (Apr. 2010) \*INCREASED WEIGHTING SPECTRUM TO 30,000GROUPIE**

**FROM 3,000 ENERGY POINTS. GROUPIE**

**\*ADDED OUTPUT TO PLOT/COMPARE SHIELDED GROUPIE**

**AND UNSHIELDED CROSS SECTIONS. GROUPIE**

**VERS. 2011-1 (June 2011) \*Corrected TART 700 groups to extend upGROUPIE**

**to 1 GeV (1,000 MeV) - previously it GROUPIE**

**was ERRONEOUSLY cutoff at 20 MeV. GROUPIE**

**VERS. 2011-2 (Nov. 2011) \*Corrected TART 616 groups lowest GROUPIE**

**energy from 1.0D-4 eV to 1.0D-5 eV. GROUPIE**

**\*Added TART 666 to 200 MeV (for TENDL).GROUPIE**

**\*Optional high energy cross section GROUPIE**

**extension above tabulated energy rangeGROUPIE**

**(either = 0 = standard, or constant) GROUPIE**

**WARNING - ENDF/B standard convention GROUPIE**

**is that the cross section = 0 where itGROUPIE**

**is not explicitly defined - extension GROUPIE**

**= 0 is standard, constant is NOT, so GROUPIE**

**constant extension is NOT RECOMMENDED.GROUPIE**

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

**\*32 and 64 bit Compatible GROUPIE**

**\*Added ERROR stop. GROUPIE**

**VERS. 2013-1 (Nov. 2013) \*Extended OUT9. GROUPIE**

**\*Uses OUTG, not OUT10 for energies. GROUPIE**

**VERS. 2015-1 (Jan. 2015) \*Corrected SPECTM - handle ALL includedGROUPIE**

**group structures, i.e., even those GROUPIE**

**that start above thremal range by GROUPIE**

**ALWAYS constructing weigthing spectrumGROUPIE**

**to be AT LEAST 1.0D-5 eV to 20 MeV. GROUPIE**

**\*Extended OUTG GROUPIE**

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

**\*Generalized TART Group Strructures. GROUPIE**

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

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

**VERS. 2015-2 (Mar. 2015) \*Deleted 1P from formats reading input GROUPIE**

**parameters, causing incorrect scaling GROUPIE**

**\*Changed ALL data to "D" instead of GROUPIE**

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

**Truncation ERRORS. GROUPIE**

**VERS. 2015-3 (July 2015) \*Insure no 10 digit output - not GROUPIE**

**needed for multi-group and this makes GROUPIE**

**listings simpler. GROUPIE**

**\*Corrected High Energy Extension = GROUPIE**

**Can effect highest energy group. GROUPIE**

**VERS. 2016-1 (July 2016) \*Added UKAEA 1102 Group Structure. GROUPIE**

**\*Increased storage to accommodate GROUPIE**

**much larger group structures = GROUPIE**

**up to 20,000 Groups. GROUPIE**

**\*Added output listing of the complete GROUPIE**

**input parameters for URRFIT, includingGROUPIE**

**the NJOY parameters LSSF and ICOMP. GROUPIE**

**\*Changed multiple IF statements to GROUPIE**

**accommodate compiler optimizer GROUPIE**

**\*Cosmetic changes based on FREUD GROUPIE**

**psychoanalysis. GROUPIE**

**\*Updated multi-band treatment to GROUPIE**

**explcitly handle small shielding GROUPIE**

**limit - without this update the small GROUPIE**

**limit becomes numerically unstable. GROUPIE**

**VERS. 2017-1 (May 2017) \*Increased max. points to 3,000,000. GROUPIE**

**\*METHODB was incorrecctly named GROUPIE**

**METHOD in one routine = corrected. GROUPIE**

**\*Default multi-band is method #2 = GROUPIE**

**conserve <x>, <1/(x+<x>>, <1/x>. GROUPIE**

**\*Definition of built-in group structureGROUPIE**

**using SUBROUTINE GROPE is identical GROUPIE**

**for GROUPIE and VIRGIN. GROUPIE**

**\*All floating input parameters changed GROUPIE**

**to character input + IN9 conversion. GROUPIE**

**\*Output report identfies MF now that GROUPIE**

**this code does more than just MF=3. GROUPIE**

**\*Added NRO = energy dependent scatter GROUPIE**

**radius to copying FILE2 parameters GROUPIE**

**to define unresolved energy range. GROUPIE**

**\*Corrected energy dependent scatter GROUPIE**

**for all resonance types (see, above GROUPIE**

**comments) = for multi-band output GROUPIE**

**VERS. 2018-1 (Jan. 2018) \*Added on-line output for ALL ENDERROR GROUPIE**

**VERS. 2019-1 (June 2019) \*Major re-write to re-order output to GROUPIE**

**include Unresolved Resonance Region GROUPIE**

**self-shielding. GROUPIE**

**\*Added Unresolved self-shielding by GROUPIE**

**Extrapolating cross section moments GROUPIE**

**from Resolved (supersedes URRDO and GROUPIE**

**URRFIT codes). GROUPIE**

**\*Added entire self-shielding array to GROUPIE**

**memory - previously only one group GROUPIE**

**results were in memory - saving ALL GROUPIE**

**greatly simplifies the logic. GROUPIE**

**\*Additional Interpolation Law Tests GROUPIE**

**\*Check maximum Tabulated Energy of MTs GROUPIE**

**to insure they ALL end at the same GROUPIE**

**energy. GROUPIE**

**\*Multi-band = 1 no longer allowed. GROUPIE**

**The only allowed values are, GROUPIE**

**0 = no multi-band calculations, or, GROUPIE**

**2 = Conserve 1/[total + <total>] GROUPIE**

**\*Unresolved Resonance Region GROUPIE**

**Self-Shielding Requires all of these, GROUPIE**

**1) Unresolved data with ENDF input GROUPIE**

**2) 616 TART Groups (input -11) GROUPIE**

**3) Define Sigma0 standard (input = 0) GROUPIE**

**\*Unresolved Resonance Region GROUPIE**

**Self-Shielding Always Outputs, GROUPIE**

**1) LSSF = 0 = Output cross sections GROUPIE**

**2) INTUNR = 2 = Interpolation law GROUPIE**

**\*Added ZAzzzaaa to filenames. GROUPIE**

**VERS. 2020-1 (Aug. 2020) \*Major re-write to update for new URR GROUPIE**

**self-shielding, MF/MT=2/152 and 2/153.GROUPIE**

**\*Corrected BOTH ends of unresolved GROUPIE**

**for MF/MT=2/152 and 2/153 output. GROUPIE**

**\*Unresolved extrapolation ONLY to GROUPIE**

**groups completely inside the URR + GROUPIE**

**per ends for MF/MT=2/152 & 153 output.GROUPIE**

**\*Small shielding < 0.1 % = accuracy GROUPIE**

**of reconstructed data. GROUPIE**

**\*Forced no self-shielding at upper end GROUPIE**

**of unresolved = match high energy GROUPIE**

**tabulated. GROUPIE**

**\*Corrected PLOTTAB output if no URR GROUPIE**

**fit - it was outputting EMPTY tables GROUPIE**

**for original and fit moments, which GROUPIE**

**in this case did not exist. GROUPIE**

**\*Only 2 band, Method#2 [sigt + <sigt>] GROUPIE**

**alloed for multi-band calculation. GROUPIE**

**\*WARNING - if input Requested MF range GROUPIE**

**prevents unresolved region calculationGROUPIE**

**\*Added Target Isomer Flag GROUPIE**

**\*Correct MULTBAND.LST output format. GROUPIE**

**VERS. 2021-1 (Jan. 2021) \*Updated for FORTRAN 2018 GROUPIE**

**GROUPIE**

**2020-1 Acknowledgment GROUPIE**

**===================== GROUPIE**

**I Thank Jean-Christophe Sublet (NDS, IAEA, Vienna, Austria) for GROUPIE**

**reporting the ERROR in GROUPIE (2019-1) that led to the update in GROUPIE**

**GROUPIE (2020-1) to correctly define the PLOTTAB output, whether GROUPIE**

**or not Unresolved Resonance Region (URR) fit was performed. GROUPIE**

**GROUPIE**

**2015-2 Acknowledgment GROUPIE**

**===================== GROUPIE**

**I thank Chuck Whitmer (TerraPower,WA) and Andrej Trkov (NDS,IAEA) GROUPIE**

**for reporting the errors that led to the 2015-2 Improvements in GROUPIE**

**this code. GROUPIE**

**GROUPIE**

**I thank Jean-Christophe Sublet (UKAEA) for contributing MAC GROUPIE**

**executables and Bojan Zefran (IJS, Slovenia) for contributing GROUPIE**

**LINUX (32 or 63 bit) executables. And most of all I must thank GROUPIE**

**Andrej Trkov (NDS, IAEA) for overseeing the entire PREPRO project GROUPIE**

**at IAEA, Vienna. This was a truly International team who worked GROUPIE**

**together to produce PREPRO 2015-2. GROUPIE**

**GROUPIE**

**OWNED, MAINTAINED AND DISTRIBUTED BY GROUPIE**

**------------------------------------ GROUPIE**

**THE NUCLEAR DATA SECTION GROUPIE**

**INTERNATIONAL ATOMIC ENERGY AGENCY GROUPIE**

**P.O. BOX 100 GROUPIE**

**A-1400, VIENNA, AUSTRIA GROUPIE**

**EUROPE GROUPIE**

**GROUPIE**

**ORIGINALLY WRITTEN BY GROUPIE**

**------------------------------------ GROUPIE**

**Dermott E. Cullen GROUPIE**

**GROUPIE**

**PRESENT CONTACT INFORMATION GROUPIE**

**--------------------------- GROUPIE**

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**GROUPIE**

**AUTHORS MESSAGE GROUPIE**

**--------------- GROUPIE**

**THE REPORT DESCRIBED ABOVE IS THE LATEST PUBLISHED DOCUMENTATION GROUPIE**

**FOR THIS PROGRAM. HOWEVER, THE COMMENTS BELOW SHOULD BE CONSIDEREDGROUPIE**

**THE LATEST DOCUMENTATION INCLUDING ALL RECENT IMPROVEMENTS. PLEASEGROUPIE**

**READ ALL OF THESE COMMENTS BEFORE IMPLEMENTATION, PARTICULARLY GROUPIE**

**THE COMMENTS CONCERNING MACHINE DEPENDENT CODING. GROUPIE**

**GROUPIE**

**AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTERGROUPIE**

**INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE GROUPIE**

**OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECTGROUPIE**

**IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY GROUPIE**

**COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO GROUPIE**

**IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF GROUPIE**

**THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR GROUPIE**

**COMPUTER. GROUPIE**

**GROUPIE**

**PURPOSE GROUPIE**

**------- GROUPIE**

**THIS PROGRAM IS DESIGNED TO CALCULATE ANY COMBINATION OF GROUPIE**

**THE FOLLOWING QUANTITIES FROM LINEARLY INTERPOLABLE TABULATED GROUPIE**

**CROSS SECTIONS IN THE ENDF/B FORMAT GROUPIE**

**GROUPIE**

**(1) UNSHIELDED GROUP AVERAGED CROSS SECTIONS GROUPIE**

**(2) BONDARENKO SELF-SHIELDED GROUP AVERAGED CROSS SECTIONS GROUPIE**

**(3) MULTI-BAND PARAMETERS GROUPIE**

**GROUPIE**

**IN THE FOLLOWING FOR SIMPLICITY THE ENDF/B TERMINOLOGY--ENDF/B GROUPIE**

**TAPE--WILL BE USED. IN FACT THE ACTUAL MEDIUM MAY BE TAPE, CARDS, GROUPIE**

**DISK OR ANY OTHER MEDIUM. GROUPIE**

**GROUPIE**

**ENDF/B FORMAT GROUPIE**

**------------- GROUPIE**

**THIS PROGRAM ONLY USES THE ENDF/B BCD OR CARD IMAGE FORMAT (AS GROUPIE**

**OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION GROUPIE**

**OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II,III, IV OR V FORMAT). GROUPIE**

**GROUPIE**

**IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B GROUPIE**

**FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS GROUPIE**

**ASSUMED THAT THE MAT, MF AND MT ON EACH CARD IS CORRECT. SEQUENCE GROUPIE**

**NUMBERS (COLUMNS 76-80) ARE IGNORED ON INPUT, BUT WILL BE GROUPIE**

**CORRECTLY OUTPUT ON ALL CARDS. THE FORMAT OF SECTION MF=1, MT=451 GROUPIE**

**AND ALL SECTIONS OF MF= 3 MUST BE CORRECT. THE PROGRAM COPIES ALL GROUPIE**

**OTHER SECTION OF DATA AS HOLLERITH AND AS SUCH IS INSENSITIVE TO GROUPIE**

**THE CORRECTNESS OR INCORRECTNESS OF ALL OTHER SECTIONS. GROUPIE**

**GROUPIE**

**ALL FILE 3 CROSS SECTIONS THAT ARE USED BY THIS PROGRAM MUST BE GROUPIE**

**LINEARLY INTERPOLABLE IN ENERGY AND CROSS SECTION (ENDF/B GROUPIE**

**INTERPOLATION LAW 2). FILE 3 BACKGROUND CROSS SECTIONS MAY BE MADEGROUPIE**

**LINEARLY INTERPOLABLE USING PROGRAM LINEAR (UCRL-50400, VOL. 17, GROUPIE**

**PART A). THE RESONANCE CONTRIBUTION MAY BE ADDED TO THE BACKGROUNDGROUPIE**

**CROSS SECTIONS USING PROGRAM RECENT (UCRL-50400, VOL. 17, PART B).GROUPIE**

**IF THIS PROGRAM FINDS THAT THE FILE 3 CROSS SECTIONS ARE NOT GROUPIE**

**LINEARLY INTERPOLABLE THIS PROGRAM WILL TERMINATE EXECUTION. GROUPIE**

**GROUPIE**

**CONTENTS OF OUTPUT GROUPIE**

**------------------ GROUPIE**

**IF ENDF/B FORMATTED OUTPUT IS REQUESTED ENTIRE EVALUATIONS ARE GROUPIE**

**OUTPUT, NOT JUST THE MULTI-GROUPED FILE 3 CROSS SECTIONS, E.G. GROUPIE**

**ANGULAR AND ENERGY DISTRIBUTIONS ARE ALSO INCLUDED. GROUPIE**

**GROUPIE**

**DOCUMENTATION GROUPIE**

**------------- GROUPIE**

**THE FACT THAT THIS PROGRAM HAS OPERATED ON THE DATA IS DOCUMENTED GROUPIE**

**BY THE ADDITION OF THREE COMMENT CARDS AT THE END OF EACH GROUPIE**

**HOLLERITH SECTION TO DESCRIBE THE GROUP STRUCTURE AND WEIGHTING GROUPIE**

**SPECTRUM, E.G. GROUPIE**

**GROUPIE**

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* PROGRAM GROUPIE (2021-1) \*\*\*\*\*\*\*\*\*\*\*\*\*\*\* GROUPIE**

**UNSHIELDED GROUP AVERAGES USING 69 GROUPS (WIMS) GROUPIE**

**MAXWELLIAN, 1/E, FISSION TO CONSTANT WEIGHTING SPECTRUM GROUPIE**

**GROUPIE**

**THE ORDER OF ALL SIMILAR COMMENTS (FROM LINEAR, RECENT AND SIGMA1)GROUPIE**

**REPRESENTS A COMPLETE HISTORY OF ALL OPERATIONS PERFORMED ON GROUPIE**

**THE DATA. GROUPIE**

**GROUPIE**

**THESE COMMENT CARDS ARE ONLY ADDED TO EXISTING HOLLERITH SECTIONS,GROUPIE**

**I.E., THIS PROGRAM WILL NOT CREATE A HOLLERITH SECTION. THE FORMATGROUPIE**

**OF THE HOLLERITH SECTION IN ENDF/B-V DIFFERS FROM THE THAT OF GROUPIE**

**EARLIER VERSIONS OF ENDF/B. BY READING AN EXISTING MF=1, MT=451 GROUPIE**

**IT IS POSSIBLE FOR THIS PROGRAM TO DETERMINE WHICH VERSION OF GROUPIE**

**THE ENDF/B FORMAT THE DATA IS IN. WITHOUT HAVING A SECTION OF GROUPIE**

**MF=1, MT=451 PRESENT IT IS IMPOSSIBLE FOR THIS PROGRAM TO GROUPIE**

**DETERMINE WHICH VERSION OF THE ENDF/B FORMAT THE DATA IS IN, AND GROUPIE**

**AS SUCH IT IS IMPOSSIBLE FOR THE PROGRAM TO DETERMINE WHAT FORMAT GROUPIE**

**SHOULD BE USED TO CREATE A HOLLERITH SECTION. GROUPIE**

**GROUPIE**

**REACTION INDEX GROUPIE**

**-------------- GROUPIE**

**THIS PROGRAM DOES NOT USE THE REACTION INDEX WHICH IS GIVEN IN GROUPIE**

**SECTION MF=1, MT=451 OF EACH EVALUATION. GROUPIE**

**GROUPIE**

**THIS PROGRAM DOES NOT UPDATE THE REACTION INDEX IN MF=1, MT=451. GROUPIE**

**THIS CONVENTION HAS BEEN ADOPTED BECAUSE MOST USERS DO NOT GROUPIE**

**REQUIRE A CORRECT REACTION INDEX FOR THEIR APPLICATIONS AND IT WASGROUPIE**

**NOT CONSIDERED WORTHWHILE TO INCLUDE THE OVERHEAD OF CONSTRUCTING GROUPIE**

**A CORRECT REACTION INDEX IN THIS PROGRAM. HOWEVER, IF YOU REQUIRE GROUPIE**

**A REACTION INDEX FOR YOUR APPLICATIONS, AFTER RUNNING THIS PROGRAMGROUPIE**

**YOU MAY USE PROGRAM DICTIN TO CREATE A CORRECT REACTION INDEX. GROUPIE**

**GROUPIE**

**SECTION SIZE GROUPIE**

**------------ GROUPIE**

**SINCE THIS PROGRAM USES A LOGICAL PAGING SYSTEM THERE IS NO LIMIT GROUPIE**

**TO THE NUMBER OF POINTS IN ANY SECTION, E.G., THE TOTAL CROSS GROUPIE**

**SECTION MAY BE REPRESENTED BY 200,000 DATA POINTS. GROUPIE**

**GROUPIE**

**SELECTION OF DATA GROUPIE**

**----------------- GROUPIE**

**THE PROGRAM SELECTS MATERIALS TO BE PROCESSED BASED EITHER ON GROUPIE**

**MAT (ENDF/B MAT NO.) OR ZA. THE PROGRAM ALLOWS UP TO 100 MAT OR GROUPIE**

**ZA RANGES TO BE SPECIFIED. THE PROGRAM WILL ASSUME THAT THE GROUPIE**

**ENDF/B TAPE IS IN EITHER MAT OR ZA ORDER, WHICHEVER CRITERIA IS GROUPIE**

**USED TO SELECT MATERIALS, AND WILL TERMINATE WHEN A MAT OR ZA GROUPIE**

**IS FOUND THAT IS ABOVE THE RANGE OF ALL REQUESTS. GROUPIE**

**GROUPIE**

**ENERGY ORDER AND UNITS GROUPIE**

**---------------------- GROUPIE**

**ALL ENERGIES (FOR CROSS SECTIONS, WEIGHTING SPECTRUM OR GROUP GROUPIE**

**BOUNDARIES) MUST BE IN UNITS OF EV AND MUST BE IN ASCENDING GROUPIE**

**NUMERICAL ORDER. GROUPIE**

**GROUPIE**

**ENERGY GRID GROUPIE**

**----------- GROUPIE**

**ALTHOUGH ALL REACTIONS MUST TO LINEARLY INTERPOLABLE, THEY DO NOT GROUPIE**

**ALL HAVE TO USE THE SAME ENERGY GRID. EACH REACTION CAN BE GIVEN GROUPIE**

**BY AN INDEPENDENT ENERGY GRID. THIS PROGRAM WILL PROCEED FROM GROUPIE**

**THE LOWEST TO HIGHEST ENERGY SELECTING EACH ENERGY INTERVAL OVER GROUPIE**

**WHICH ALL DATA, FOR ANY GIVEN CALCULATION, ARE ALL LINEARLY GROUPIE**

**INTERPOLABLE. GROUPIE**

**GROUPIE**

**GROUP STRUCTURE GROUPIE**

**--------------- GROUPIE**

**THIS PROGRAM IS DESIGNED TO USE AN ARBITRARY ENERGY GROUP GROUPIE**

**STRUCTURE WHERE THE ENERGIES ARE IN EV AND ARE IN INCREASING GROUPIE**

**ENERGY ORDER. THE MAXIMUM NUMBER OF GROUPS IS 20,000. GROUPIE**

**GROUPIE**

**THE USER MAY INPUT AN ARBITRARY GROUP STRUCTURE OR THE USER MAY GROUPIE**

**USE USE ONE OF THE BUILT-IN GROUP STRUCTURES. GROUPIE**

**(0) 175 GROUP (TART STRUCTURE) GROUPIE**

**(1) 50 GROUP (ORNL STRUCTURE) GROUPIE**

**(2) 126 GROUP (ORNL STRUCTURE) GROUPIE**

**(3) 171 GROUP (ORNL STRUCTURE) GROUPIE**

**(4) 620 GROUP (SAND-II STRUCTURE, UP TO 18 MEV) GROUPIE**

**(5) 640 GROUP (SAND-II STRUCTURE, UP TO 20 MEV) GROUPIE**

**(6) 69 GROUP (WIMS STRUCTURE) GROUPIE**

**(7) 68 GROUP (GAM-I STRUCTURE) GROUPIE**

**(8) 99 GROUP (GAM-II STRUCTURE) GROUPIE**

**(9) 54 GROUP (MUFT STRUCTURE) GROUPIE**

**(10) 28 GROUP (ABBN STRUCTURE) GROUPIE**

**(11) 616 GROUP (TART STRUCTURE TO 20 MeV) GROUPIE**

**(12) 700 GROUP (TART STRUCTURE TO 1 GEV) GROUPIE**

**(13) 665 GROUP (SAND-II STRUCTURE, 1.0D-5 eV, UP TO 18 MEV) GROUPIE**

**(14) 685 GROUP (SAND-II STRUCTURE, 1.0D-5 eV, UP TO 20 MEV) GROUPIE**

**(15) 666 GROUP (TART STRUCTURE TO 200 MeV) GROUPIE**

**(16) 725 GROUP (SAND-II STRUCTURE, 1.0D-5 eV, UP TO 60 MEV) GROUPIE**

**(17) 755 GROUP (SAND-II STRUCTURE, 1.0D-5 eV, UP TO 150 MEV) GROUPIE**

**(18) 765 GROUP (SAND-II STRUCTURE, 1.0D-5 eV, UP TO 200 MEV) GROUPIE**

**(19)1102 GROUP (UKAEA STRUCTURE, 1.0D-5 eV, UP TO 1 GeV) GROUPIE**

**GROUPIE**

**GROUP AVERAGES GROUPIE**

**-------------- GROUPIE**

**THIS PROGRAM DEFINES GROUP AVERAGED CROSS SECTIONS AS... GROUPIE**

**GROUPIE**

**(INTEGRAL E1 TO E2) (SIGMA(E)\*S(E)\*WT(E)\*DE) GROUPIE**

**AVERAGE = ----------------------------------------- GROUPIE**

**(INTEGRAL E1 TO E2) (S(E)\*WT(E)\*DE) GROUPIE**

**WHERE... GROUPIE**

**GROUPIE**

**AVERAGE = GROUP AVERAGED CROSS SECTION GROUPIE**

**E1, E2 = ENERGY LIMITS OF THE GROUP GROUPIE**

**SIGMA(E) = ENERGY DEPENDENT CROSS SECTION FOR ANY GIVEN REACTION GROUPIE**

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

**WT(E) = ENERGY DEPENDENT SELF-SHIELDING FACTOR. GROUPIE**

**GROUPIE**

**ENERGY DEPENDENT WEIGHTING SPECTRUM GROUPIE**

**----------------------------------- GROUPIE**

**THE ENERGY DEPENDENT WEIGHTING SPECTRUM IS GIVEN BY AN ARBITRARY GROUPIE**

**TABULATED LINERLY INTERPOLABLE FUNCTION WHICH CAN BE DESCRIBED GROUPIE**

**BY AN ARBITRARY NUMBER OF POINTS. THIS ALLOWS THE USER TO GROUPIE**

**SPECIFY ANY DESIRED WEIGHTING SPECTRUM TO ANY GIVEN DEGREE OF GROUPIE**

**ACCURACY. REMEMBER THAT THE PROGRAM WILL ASSUME THAT THE SPECTRUM GROUPIE**

**IS LINEARLY INTERPOLABLE BETWEEN TABULATED POINTS. THEREFORE THE GROUPIE**

**USER SHOULD USE ENOUGH POINTS TO INSURE AN ADEQUATE REPRESENTATIONGROUPIE**

**OF THE SPECTRUM BETWEEN TABULATED DATA POINTS. GROUPIE**

**GROUPIE**

**THE PRESENT VERSION OF THE CODE HAS THREE BUILT-IN WEIGHTING GROUPIE**

**SPECTRA, GROUPIE**

**GROUPIE**

**(1) CONSTANT GROUPIE**

**(2) 1/E GROUPIE**

**(3) MAXWELLIAN = E\*EXP(-E/KT)/KT (0.0 TO 4\*KT) GROUPIE**

**1/E = C1/E (4\*KT TO 67 KeV) GROUPIE**

**FISSION = C2\*EXP(-E/WA)\*SINH(SQRT(E\*WB)) (67 KeV, 10 MeV) GROUPIE**

**CONSTANT = Equal to Fission at 10 MeV (above 10 MeV) GROUPIE**

**GROUPIE**

**KT = 0.253 EV (293 KELVIN) GROUPIE**

**WA = 9.65D+5 GROUPIE**

**WB = 2.29D-6 GROUPIE**

**C1, C2 = DEFINED TO MAKE SPECTRUM CONTINUOUS GROUPIE**

**GROUPIE**

**FISSION SPECTRUM CONSTANTS FROM GROUPIE**

**A.F.HENRY, NUCLEAR REACTOR ANALYSIS, P. 11, MIT PRESS (1975) GROUPIE**

**GROUPIE**

**UNSHIELDED GROUP AVERAGES GROUPIE**

**------------------------- GROUPIE**

**FOR UNSHIELDED AVERAGES THE SELF-SHIELDING FACTOR (WT(E)) IS SET GROUPIE**

**TO UNITY. THIS PROGRAM ALLOWS UP TO 20,000 GROUPS. GROUPIE**

**GROUPIE**

**SELF-SHIELDED GROUP AVERAGES GROUPIE**

**---------------------------- GROUPIE**

**IF SELF-SHIELDED AVERAGES AND/OR MULTI-BAND PARAMETERS ARE GROUPIE**

**CALCULATED THIS PROGRAM ALLOWS UP TO 20,000 GROUPS. SELF-SHIELDED GROUPIE**

**AVERAGES AND/OR MULTI-BAND PARAMETERS ARE CALCULATED FOR THE GROUPIE**

**TOTAL, ELASTIC, CAPTURE AND FISSION. GROUPIE**

**GROUPIE**

**FOR THE TOTAL, ELASTIC, CAPTURE AND FISSION THE PROGRAM USES A GROUPIE**

**WEIGHTING FUNCTION THAT IS A PRODUCT OF THE ENERGY DEPENDENT GROUPIE**

**WEIGHTING SPECTRUM TIMES A BONDERENKO TYPE SELF-SHIELDING FACTOR. GROUPIE**

**GROUPIE**

**WT(E) = S(E)/(TOTAL(E)+SIGMA0)\*\*N GROUPIE**

**GROUPIE**

**WHERE... GROUPIE**

**GROUPIE**

**S(E) - ENERGY DEPENDENT WEIGHTING SPECTRUM (DEFINED BY GROUPIE**

**TABULATED VALUES AND LINEAR INTERPOLATION BETWEEN GROUPIE**

**TABULATED VALUES). GROUPIE**

**TOTAL(E) - ENERGY DEPENDENT TOTAL CROSS SECTION FOR ONE MATERIAL GROUPIE**

**(DEFINED BY TABULATED VALUES AND LINEAR INTERPOLATION GROUPIE**

**BETWEEN TABULATED VALUES). GROUPIE**

**SIGMA0 - CROSS SECTION TO REPRESENT THE EFFECT OF ALL OTHER GROUPIE**

**MATERIALS AND LEAKAGE (DEFINED WITHIN EACH GROUP TO BE GROUPIE**

**A MULTIPLE OF THE UNSHIELDED TOTAL CROSS SECTION WITHINGROUPIE**

**THAT GROUP OR POWERS OF 10 - INPUT OPTION). GROUPIE**

**N - A POSITIVE INTEGER (0, 1, 2 OR 3). GROUPIE**

**GROUPIE**

**THE PROGRAM WILL USE ONE ENERGY DEPENDENT WEIGHTING SPECTRUM S(E) GROUPIE**

**AND 25 DIFFERENT BONDERENKO TYPE SELF-SHIELDING FACTORS (25 SIGMA0GROUPIE**

**AND N COMBINATIONS) TO DEFINE 25 DIFFERENT AVERAGE CROSS SECTIONS,GROUPIE**

**FOR EACH REACTION, WITHIN EACH GROUP. GROUPIE**

**GROUPIE**

**THE 25 WEIGHTING FUNCTIONS USED ARE.... GROUPIE**

**(1) - UNSHIELDED CROSS SECTIONS (N=0) GROUPIE**

**(2-22)- PARTIALLY SHIELDED CROSS SECTIONS (N=1 ,VARIOUS SIGMA0) GROUPIE**

**THE VALUES OF SIGMA0 USED WILL BE EITHER, GROUPIE**

**(A) THE VALUES OF SIGMA0 THAT ARE USED VARY FROM 1024 GROUPIE**

**TIMES THE UNSHIELDED TOTAL CROSS SECTIONS IN STEPS OF 1/2 GROUPIE**

**DOWN TO 1/1024 TIMES THE UNSHIELDED TOTAL CROSS SECTION GROUPIE**

**(A RANGE OF OVER 1 MILLION, CENTERED ON THE UNSHIELDED GROUPIE**

**TOTAL CROSS SECTION WITHIN EACH GROUP). GROUPIE**

**(B) THE SAME CONSTANT VALUES OF SIGMA0 IN EACH GROUP. THE GROUPIE**

**VALUES OF SIGMA0 USED INCLUDE 40000, 20000, 10000, 7000, GROUPIE**

**4000, 2000, 1000, 700, 400, 200, 100, 70, 40, 20, 10, 7, GROUPIE**

**4, 2, 1, 0.7, 0.4 (A RANGE OF 100,000 SPANNING MORE THAN GROUPIE**

**THE RANGE OF SIGMA0 VALUES THAT MAY BE ENCOUNTERED IN GROUPIE**

**ACTUAL APPLICATIONS) GROUPIE**

**(23) - TOTALLY SHIELDED FLUX WEIGHTED CROSS SECTION GROUPIE**

**(N=1, SIGMA0=0) GROUPIE**

**(24) - TOTALLY SHIELDED CURRENT WEIGHTED CROSS SECTION GROUPIE**

**(N=2, SIGMA0=0) GROUPIE**

**(25) - TOTALLY SHIELDED COSINE SQUARED WEIGHTED CROSS SECTION GROUPIE**

**(N=3, SIGMA0=0) GROUPIE**

**GROUPIE**

**FOR ALL OTHER REACTIONS (EXCEPT TOTAL, ELASTIC, CAPTURE AND GROUPIE**

**FISSION) THE PROGRAM WILL USE THE ENERGY DEPENDENT WEIGHTING GROUPIE**

**SPECTRUM S(E) TO DEFINE THE UNSHIELDED (BONDERENKO N=0) GROUPIE**

**AVERAGED CROSS SECTION WITHIN EACH GROUP. GROUPIE**

**GROUPIE**

**CALCULATION OF RESONANCE INTEGRALS GROUPIE**

**---------------------------------- GROUPIE**

**IN A PURE ELASTIC ISOTROPICALLY SCATTERING MATERIAL WITH A GROUPIE**

**CONSTANT CROSS SECTION THE SPECTRUM WILL BE 1/E AND THERE WILL GROUPIE**

**BE NO SELF-SHIELDING. GROUPIE**

**GROUPIE**

**IN THIS CASE IF THE CROSS SECTION VARIES WITH ENERGY THE GROUPIE**

**SPECTRUM WILL STILL BE 1/E AND THE SELF-SHIELDING FACTOR WILL GROUPIE**

**BE EXACTLY 1/SIG-TOT(E) - WHERE SIG-TOT(E) = SIG-EL(E), SINCE GROUPIE**

**THERE IS ONLY SCATTERING. GROUPIE**

**GROUPIE**

**IF WE HAVE AN INFINITELY DILUTE AMOUNT OF A MATERIAL UNIFORMLY GROUPIE**

**MIXED WITH A PURE ELASTIC ISOTROPICALLY SCATTERING MATERIAL WITH GROUPIE**

**A CONSTANT CROSS SECTION THE STANDARD DEFINITION OF THE RESONANCE GROUPIE**

**INTEGRAL CAN BE USED TO DEFINE REACTION RATES FOR EACH REACTION. GROUPIE**

**GROUPIE**

**THE RESONANCE INTEGRAL IS DEFINED AS, GROUPIE**

**GROUPIE**

**RI = (INTEGRAL E1 TO E2) (SIGMA(E)\*S(E)\*WT(E)\*DE) GROUPIE**

**GROUPIE**

**WHERE NORMALLY, GROUPIE**

**S(E) = 1/E GROUPIE**

**WT(E) = 1 - NO SELF-SHIELDING GROUPIE**

**GROUPIE**

**FROM THE ABOVE DEFINITION OF GROUP AVERAGED CROSS SECTIONS THE GROUPIE**

**RESONANCE INTEGRAL IS, GROUPIE**

**GROUPIE**

**RI = AVERAGE \* (INTEGRAL E1 TO E2) (S(E)\*WT(E)\*DE) GROUPIE**

**GROUPIE**

**FOR A 1/E SPECTRUM AND NO SELF-SHIELDING THIS REDUCES TO, GROUPIE**

**GROUPIE**

**RI = AVERAGE\* LOG(E2/E1) GROUPIE**

**GROUPIE**

**IN ANY OTHER SITUATION, INCLUDING ABSORPTION AND/OR ENERGY GROUPIE**

**DEPENDENT CROSS SECTIONS, THE SPECTRUM WILL NOT BE 1/E - GROUPIE**

**ABSORPTION WILL TEND TO DECREASE THE SPECTRUM PROGRESSIVELY GROUPIE**

**MORE AT LOWER ENERGIES - ENERGY DEPENDENCE OF THE CROSS SECTION GROUPIE**

**WILL LEAD TO SELF-SHIELDING. GROUPIE**

**GROUPIE**

**HERE WE WILL NOT ATTEMPT TO PERFORM A DETAILED SPECTRUM GROUPIE**

**CALCULATION TO ACCOUNT FOR ABSORPTION. GROUPIE**

**GROUPIE**

**HOWEVER, WE WILL EXTEND THE DEFINITION OF THE RESONANCE INTEGRAL GROUPIE**

**TO ACCOUNT FOR SELF-SHIELDING EFFECTS BY ALLOWING FOR INCLUSION GROUPIE**

**OF SELF-SHIELDING EFFECTS IN THE DEFINITION OF GROUP AVERAGES GROUPIE**

**AND THEN DEFINING THE RESONANCE INTEGRAL AS, GROUPIE**

**GROUPIE**

**RI = AVERAGE\* LOG(E2/E1) GROUPIE**

**GROUPIE**

**IN ORDER TO CALCULATE RESONANCE INTEGRALS YOU MUST FOLLOW THESE GROUPIE**

**STEPS, GROUPIE**

**GROUPIE**

**1) SELECT A 1/E SPECTRUM - ON FIRST LINE OF INPUT PARAMETERS. GROUPIE**

**2) SELECT THE ENERGY BOUNDARIES - NORMALLY ONLY 1 GROUP FROM GROUPIE**

**0.5 EV UP TO 20 MEV - HOWEVER, YOU ARE FREE TO SELECT ANY GROUPIE**

**ENERGY RANGE THAT YOU WISH - YOU MAY EVEN SELECT MORE THAN GROUPIE**

**1 GROUP MERELY BY SPECIFYING MORE THAN 1 GROUP AS INPUT - GROUPIE**

**THIS CAN BE USED TO DEFINE THE CONTRIBUTIONS TO THE RESONANCE GROUPIE**

**INTEGRAL FROM INDIVIDUAL ENERGY RANGES. GROUPIE**

**3) SELECT THIS OPTION FOR THE UNSHIELDED AND/OR SHIELDED OUTPUT GROUPIE**

**LISTING - ON THE SECOND LINE OF INPUT PARAMETERS. GROUPIE**

**GROUPIE**

**WHEN THIS OPTION IS USED THE PROGRAM WILL CALCULATE GROUP AVERAGEDGROUPIE**

**CROSS SECTIONS - AS DEFINED ABOVE - PRIOR TO OUTPUT THE RESULTS GROUPIE**

**WILL MERELY BE MULTIPLIED BY THE WIDTH OF THE GROUP ASSUMING YOU GROUPIE**

**HAVE SELECTED A 1/E SPECTRUM - THERE IS NO CHECK ON THIS - THE GROUPIE**

**PROGRAM MERELY MULTIPLIES THE GROUP AVERAGED CROSS SECTIONS BY, GROUPIE**

**GROUPIE**

**LOG(E2/E1) - WHERE E2 AND E1 ARE THE GROUP ENERGY BOUNDARIES. GROUPIE**

**GROUPIE**

**WARNING - IT IS UP TO YOU TO INSURE THAT YOU FOLLOW EXACTLY THE GROUPIE**

**STEPS OUTLINED ABOVE IF YOU WISH TO OBTAIN MEANINGFUL GROUPIE**

**RESULTS. GROUPIE**

**GROUPIE**

**NOTE - OUTPUT IN THE ENDF/B FORMAT IS ALWAYS GROUP AVERAGED CROSS GROUPIE**

**SECTIONS, REGARDLESS OF WHETHER YOU ASK FOR AVERAGED CROSS GROUPIE**

**SECTIONS OR RESONANCE INTEGRALS - THIS IS BECAUSE DATA IN GROUPIE**

**THE ENDF/B FORMAT IS EXPLICITLY DEFINED TO BE CROSS GROUPIE**

**SECTIONS. GROUPIE**

**GROUPIE**

**RESONANCE INTEGRAL OUTPUT CAN ONLY BE OBTAINED IN THE GROUPIE**

**LISTING FORMATS. GROUPIE**

**GROUPIE**

**MINIMUM TOTAL CROSS SECTION TREATMENT GROUPIE**

**------------------------------------- GROUPIE**

**SINCE THE BONDARENKO SELF-SHIELDING DEPENDS ON 1/TOTAL CROSS GROUPIE**

**SECTION, THE ALGORITHM WILL BECOME NUMERICALLY UNSTABLE IF THE GROUPIE**

**TOTAL CROSS SECTION IS NEGATIVE (AS OCCURS IN MANY ENDF/B GROUPIE**

**EVALUATIONS). IF THE TOTAL IS LESS THAN SOME MINIMUM ALLOWABLE GROUPIE**

**VALUE (DEFINE BY OKMIN, PRESENTLY 1 MILLI-BARN) AN ERROR MESSAGE GROUPIE**

**WILL BE PRINTED AND FOR THE SELF-SHIELDING CALCULATION ALL ENERGY GROUPIE**

**INTERVALS IN WHICH THE TOTAL IS LESS THAN THE MINIMUM WILL BE GROUPIE**

**IGNORED. GROUPIE**

**GROUPIE**

**NOTE, FOR THE UNSHIELDED CALCULATIONS ALL CROSS SECTIONS WILL BE GROUPIE**

**CONSIDERED WHETHER THEY ARE POSITIVE OR NEGATIVE. THEREFORE IF GROUPIE**

**THE TOTAL CROSS SECTION IS NEGATIVE OR LESS THAN THE MINIMUM GROUPIE**

**VALUE THERE MAY BE AN INCONSISTENCY BETWEEN THE UNSHIELDED AND GROUPIE**

**THE SELF-SHIELDED CROSS SECTIONS. IF THE TOTAL CROSS SECTION IS GROUPIE**

**NEGATIVE AND SELF-SHIELDED CROSS SECTIONS ARE CALCULATED THE GROUPIE**

**PROGRAM WILL PRINT AN ERROR MESSAGE INDICATING THAT THE SELF- GROUPIE**

**SHIELDED RESULTS ARE UNRELIABLE AND SHOULD NOT BE USED. THEREFORE GROUPIE**

**IN THIS CASE THE PROGRAM WILL NOT ATTEMPT TO MODIFY THE UNSHIELDEDGROUPIE**

**RESULTS TO ELIMINATE THE EFFECT OF NEGATIVE CROSS SECTIONS, SINCE GROUPIE**

**THE UNSHIELDED RESULTS ARE THE ONLY ONES WHICH TRULY REFLECT THE GROUPIE**

**ACTUAL INPUT. GROUPIE**

**GROUPIE**

**RESOLVED RESONANCE REGION GROUPIE**

**------------------------- GROUPIE**

**IN THE RESOLVED RESONANCE REGION (ACTUALLY EVERYWHERE BUT IN THE GROUPIE**

**UNRESOLVED RESONANCE REGION) THE CROSS SECTIONS OUTPUT BY LINEAR- GROUPIE**

**RECENT-SIGMA1 WILL BE ACTUAL ENERGY DEPENDENT CROSS SECTIONS AND GROUPIE**

**THE CALCULATIONS BY THIS PROGRAM WILL YIELD ACTUAL SHIELDED AND GROUPIE**

**UNSHIELDED CROSS SECTIONS. GROUPIE**

**GROUPIE**

**UNRESOLVED RESONANCE REGION GROUPIE**

**--------------------------- GROUPIE**

**IN THE UNRESOLVED RESONANCE REGION PROGRAM RECENT USES THE GROUPIE**

**UNRESOLVED RESONANCE PARAMETERS TO CALCULATE INFINITELY DILUTE GROUPIE**

**AVERAGE CROSS SECTIONS. THIS PROGRAM WILL MERELY READ THIS GROUPIE**

**INFINITELY DILUTE DATA AS IF IT WERE ENERGY DEPENDENT DATA AND GROUPIE**

**GROUP AVERAGE IT. AS SUCH THIS PROGRAM WILL PRODUCE THE CORRECT GROUPIE**

**UNSHIELDED CROSS SECTION IN THE UNRESOLVED RESONANCE REGION, BUT GROUPIE**

**IT WILL NOT PRODUCE THE CORRECT SELF-SHIELDING EFFECTS. GROUPIE**

**GROUPIE**

**ACCURACY OF RESULTS GROUPIE**

**------------------- GROUPIE**

**ALL INTEGRALS ARE PERFORMED ANALYTICALLY. THEREFORE NO ERROR IS GROUPIE**

**INTRODUCED DUE TO THE USE OF TRAPAZOIDAL OR OTHER INTEGRATION GROUPIE**

**SCHEME. THE TOTAL ERROR THAT CAN BE ASSIGNED TO THE RESULTING GROUPIE**

**AVERAGES IS JUST THAT DUE TO THE ERROR IN THE CROSS SECTIONS GROUPIE**

**AND ENERGY DEPENDENT WEIGHTING SPECTRUM. GENERALLY SINCE THE GROUPIE**

**THE ENERGY DEPENDENT WEIGHTING SPECTRUM APPEARS IN BOTH THE GROUPIE**

**NUMERATOR AND THE DENOMINATOR THE AVERAGES RAPIDLY BECOME GROUPIE**

**INSENSITIVE TO THE WEIGHTING SPECTRUM AS MORE GROUPS ARE USED. GROUPIE**

**SINCE THE WEIGHTING SPECTRUM IS LOADED IN THE PAGING SYSTEM THE GROUPIE**

**USER CAN DESCRIBE THE SPECTRUM TO ANY REQUIRED ACCURACY USING GROUPIE**

**ANY NUMBER OF ENERGY VS. SPECTRUM PAIRS. GROUPIE**

**GROUPIE**

**MULTI-BAND PARAMETERS GROUPIE**

**--------------------- GROUPIE**

**MULTI-BAND PARAMETERS ARE CALCULATED FOR THE TOTAL, ELASTIC, GROUPIE**

**CAPTURE AND FISSION REACTIONS. WITH THE NUMBER OF GROUPS THAT GROUPIE**

**ARE NORMALLY USED (SEE BUILT IN GROUP STRUCTURES) ALL OTHER GROUPIE**

**REACTIONS RESULT IN A NEGLIGABLE AMOUNT OF SELF-SHIELDING. AS GROUPIE**

**SUCH THEIR EQUIVALENT BAND CROSS SECTION WILL MERELY BE THEIR GROUPIE**

**UNSHIELDED VALUE WITHIN EACH BAND. GROUPIE**

**GROUPIE**

**FOR ANY GIVEN EVALUATION, WITHIN ANY GIVEN GROUP THIS PROGRAM GROUPIE**

**WILL GENERATE THE MINIMUM NUMBER OF BANDS REQUIRED WITHIN THAT GROUPIE**

**GROUP. AS OUTPUT TO THE COMPUTER READABLE DISK FILE THE BAND GROUPIE**

**PARAMETERS FOR EACH EVALUATION WILL BE FORMATTED TO HAVE THE GROUPIE**

**SAME NUMBER OF BANDS IN ALL GROUPS (WITH ZERO WEIGHT FOR SOME GROUPIE**

**BANDS WITHIN ANY GROUP). THE USER MAY DECIDE TO HAVE OUTPUT GROUPIE**

**EITHER WITH THE MINIMUM NUMBER OF BANDS REQUIRED FOR EACH GROUPIE**

**EVALUATION (E.G. 2 BANDS FOR HYDROGEN AND 4 BANDS FOR U-233) OR GROUPIE**

**THE SAME NUMBER OF BANDS FOR ALL EVALUATIONS (E.G. 4 BANDS FOR GROUPIE**

**BOTH HYDROGEN AND U-233). GROUPIE**

**GROUPIE**

**FOR 2 OR FEWER BANDS THE PROGRAM USES AN ANALYTIC EXPRESSION GROUPIE**

**TO DEFINE ALL MULTI-BAND PARAMETERS. FOR MORE THAN 2 BANDS THE GROUPIE**

**PROGRAM PERFORMS A NON-LINEAR FIT TO SELECT THE MULTI-BAND GROUPIE**

**PARAMETERS THAT MINIMIZE THE MAXIMUM FRACTIONAL ERROR AT ANY GROUPIE**

**POINT ALONG THE ENTIRE SELF-SHIELDING CURVE. THE NUMBER OF BANDS GROUPIE**

**REQUIRED WITHIN ANY GIVEN GROUP IS DEFINED BY INSURING THAT THE GROUPIE**

**MULTI-BAND PARAMETERS CAN BE USED TO ACCURATELY DEFINE SELF- GROUPIE**

**SHIELDED CROSS SECTIONS ALONG THE ENTIRE SELF-SHIELDING CURVE GROUPIE**

**FROM SIGMA0 = 0 TO INFINITY. THE USER MAY DEFINE THE ACCURACY GROUPIE**

**REQUIRED. GROUPIE**

**GROUPIE**

**ENDF/B FORMATTED UNSHIELDED AVERAGES GROUPIE**

**------------------------------------ GROUPIE**

**UNSHIELDED MULTI-GROUP AVERAGED CROSS SECTIONS FOR ALL REACTIONS GROUPIE**

**MAY BE OBTAINED IN THE ENDF/B FORTRAN IN EITHER HISTOGRAM GROUPIE**

**(INTERPOLATION LAW 1) OR LINEARLY INTERPOLABLE (INTERPOLATION GROUPIE**

**LAW 2) FORM. SEE INPUT BELOW FOR DETAILS. GROUPIE**

**GROUPIE**

**MIXTURES OF MATERIALS AND RESONANCE OVERLAP GROUPIE**

**------------------------------------------- GROUPIE**

**THE SELF-SHIELDED CROSS SECTIONS FOR THE INDIVIDUAL CONSTITUENTS GROUPIE**

**OF ANY MIXTURE CAN BE CALCULATED BY THIS PROGRAM BY REALIZING THATGROUPIE**

**THIS PROGRAM ESSENTIALLY ONLY USES THE TOTAL CROSS SECTION AS A GROUPIE**

**WEIGHTING FUNCTION TO ACCOUNT FOR SELF-SHIELDING EFFECTS. FOR A GROUPIE**

**MIXTURE IT IS THEREFORE ONLY NECESSARY TO USE THE TOTAL CROSS GROUPIE**

**SECTION FOR THE MIXTURE IN PLACE OF THE ACTUAL TOTAL CROSS SECTIONGROUPIE**

**FOR EACH CONSTITUENT AND TO RUN THIS PROGRAM. THIS CAN BE DONE BY GROUPIE**

**FIRST RUNNING PROGRAM MIXER TO CALCULATE THE ENERGY DEPENDENT GROUPIE**

**TOTAL CROSS SECTION FOR ANY COMPOSITE MIXTURE. NEXT, SUBSTITUTE GROUPIE**

**THIS COMPOSITE TOTAL CROSS SECTION FOR THE ACTUAL TOTAL CROSS GROUPIE**

**SECTION OF EACH CONSTITUENT (IN EACH ENDF/B FORMATTED EVALUATION).GROUPIE**

**FINALLY, RUN THIS PROGRAM TO CALCULATE THE SELF-SHIELDED CROSS GROUPIE**

**SECTION FOR EACH CONSTITUENT, PROPERLY ACCOUNTING FOR RESONANCE GROUPIE**

**OVERLAP BETWEEN THE RESONANCES OF ALL OF THE CONSTITUENTS OF THE GROUPIE**

**MIXTURE. DURING THE SAME RUN THESE SELF-SHIELDED CROSS SECTIONS GROUPIE**

**CAN IN TURN BE USED TO CALCULATE FULLY CORRELATED MULT-BAND GROUPIE**

**GROUPIE**

**MULTI-BAND PARAMETER OUTPUT FORMAT GROUPIE**

**---------------------------------- GROUPIE**

**FOR VERSIONS 92-2 AND LATER VERSIONS THE MULTI-BAND PARAMETERS GROUPIE**

**ARE OUTPUT IN A SIMPLE CHARACTER FORMAT, THAT CAN BE TRANSFERRED GROUPIE**

**AND USED ON VIRTUALLY ANY COMPUTER. GROUPIE**

**GROUPIE**

**THE BINARY FORMAT USED IN EARLIER VERSIONS OF THIS CODE IS NO GROUPIE**

**LONGER USED. GROUPIE**

**GROUPIE**

**CONTACT THE AUTHOR IF YOU WOULD LIKE TO RECEIVE A SIMPLE PROGRAM GROUPIE**

**TO READ THE CHARACTER FORMATTED MULTI-BAND PARAMETER FILE AND GROUPIE**

**CREATE A BINARY, RANDOM ACCESS FILE FOR USE ON VIRTUALLY ANY GROUPIE**

**COMPUTER. GROUPIE**

**GROUPIE**

**THE FORMAT OF THE CHARACTER FILE IS, GROUPIE**

**GROUPIE**

**RECORD COLUMNS FORMAT DESCRIPTION GROUPIE**

**1 1-72 18A4 LIBRARY DESCRIPTION (AS READ) GROUPIE**

**2 1-11 I11 MATERIAL ZA GROUPIE**

**12-22 I11 NUMBER GROUPS GROUPIE**

**23-33 I11 NUMBER OF BANDS GROUPIE**

**34-44 E11.4 TEMPERATURE (KELVIN) GROUPIE**

**45-57 1X,12A1 HOLLERITH DESCRIPTION OF ZA GROUPIE**

**3 1-11 E11.4 ENERGY (EV) - GROUP BOUNDARY. GROUPIE**

**12-22 E11.4 TOTAL (FIRST BAND) GROUPIE**

**23-33 E11.4 ELASTIC GROUPIE**

**34-44 E11.4 CAPTURE GROUPIE**

**35-55 E11.4 FISSION GROUPIE**

**4 1-11 ----- BLANK GROUPIE**

**12-22 E11.4 TOTAL (SECOND BAND) GROUPIE**

**23-33 E11.4 ELASTIC GROUPIE**

**34-44 E11.4 CAPTURE GROUPIE**

**35-55 E11.4 FISSION GROUPIE**

**GROUPIE**

**LINES 3 AND 4 ARE REPEATED FOR EACH GROUP. THE LAST LINE FOR EACH GROUPIE**

**MATERIAL (ZA) IS, GROUPIE**

**GROUPIE**

**N 1-11 E11.4 ENERGY (EV) - UPPER ENERGY LIMIT OF GROUPIE**

**LAST GROUP. GROUPIE**

**GROUPIE**

**FOR EXAMPLE, A 175 GROUP, 2 BAND FILE, FOR EACH MATERIAL WILL GROUPIE**

**CONTAIN 352 LINES = 1 HEADER LINE, 175 \* 2 LINES OF PARAMETERS, GROUPIE**

**AND 1 FINAL LINE WITH THE UPPER ENERGY LIMIT GROUPIE**

**OF THE LAST GROUP. GROUPIE**

**GROUPIE**

**INPUT FILES GROUPIE**

**----------- GROUPIE**

**UNIT DESCRIPTION GROUPIE**

**---- ----------- GROUPIE**

**2 INPUT DATA (BCD - 80 CHARACTERS/RECORD) GROUPIE**

**10 ORIGINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD) GROUPIE**

**GROUPIE**

**OUTPUT FILES GROUPIE**

**------------ GROUPIE**

**UNIT DESCRIPTION GROUPIE**

**---- ----------- GROUPIE**

**3 OUTPUT REPORT (BCD - 80 CHARACTERS/RECORD) GROUPIE**

**11 MULTI-GROUP ENDF/B DATA - OPTIONAL GROUPIE**

**(BCD - 80 CHARACTERS/RECORD) GROUPIE**

**16 PLOTTAB FORMATTED SELF-SHIELDING RESULTS GROUPIE**

**(BCD - 80 CHARACTERS/RECORD) GROUPIE**

**31 MULTI-BAND PARAMETERS CHARACTER FILE - OPTIONAL GROUPIE**

**(BCD - 80 CHARACTERS/RECORD) GROUPIE**

**32 UNRESOLVED FSELF-SHIELDED PSEUDO ENDF FORMAT - OPTIONAL GROUPIE**

**(BCD - 120 CHARACTERS/RECORD) GROUPIE**

**33 SELF-SHIELDED CROSS SECTION LISTING - OPTIONAL GROUPIE**

**(BCD - 120 CHARACTERS/RECORD) GROUPIE**

**34 MULTI-BAND PARAMETER LISTING - OPTIONAL GROUPIE**

**(BCD - 120 CHARACTERS/RECORD) GROUPIE**

**35 UNSHIELDED CROSS SECTION LISTING - OPTION GROUPIE**

**(BCD - 120 CHARACTERS/RECORD) GROUPIE**

**GROUPIE**

**SCRATCH FILES GROUPIE**

**------------- GROUPIE**

**UNIT FILENAME DESCRIPTION GROUPIE**

**---- -------- ----------- GROUPIE**

**8 ENERGY DEPENDENT WEIGHTING SPECTRUM GROUPIE**

**(BINARY - 40080 WORDS/BLOCK) GROUPIE**

**9 TOTAL CROSS SECTION GROUPIE**

**(BINARY - 40080 WORDS/BLOCK) GROUPIE**

**12 ELASTIC CROSS SECTION - ONLY FOR SELF-SHIELDING CALCULATION GROUPIE**

**(BINARY - 40080 WORDS/BLOCK) GROUPIE**

**13 CAPTURE CROSS SECTION - ONLY FOR SELF-SHIELDING CALCULATION GROUPIE**

**(BINARY - 40080 WORDS/BLOCK) GROUPIE**

**14 FISSION CROSS SECTION - ONLY FOR SELF-SHIELDING CALCULATION GROUPIE**

**(BINARY - 40080 WORDS/BLOCK) GROUPIE**

**GROUPIE**

**OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINES FILIO1 AND FILIO2) GROUPIE**

**---------------------------------------------------------------- GROUPIE**

**UNIT FILE NAME GROUPIE**

**---- ---------- GROUPIE**

**2 GROUPIE.INP GROUPIE**

**3 GROUPIE.LST GROUPIE**

**---------------------- GROUPIE**

**8 (SCRATCH) GROUPIE**

**9 (SCRATCH) GROUPIE**

**10 ENDFB.IN GROUPIE**

**11 ENDFB.OUT GROUPIE**

**12 (SCRATCH) GROUPIE**

**13 (SCRATCH) GROUPIE**

**14 (SCRATCH) GROUPIE**

**-----2019/6/23 - New Filenames (added ZAzzzaaa at Beginning)-----------GROUPIE**

**-----------(OLD)-------------(NEW)-------------------------------------GROUPIE**

**16 PLOTTAB.CUR ZAzzzaaa.PLOT.CUR GROUPIE**

**31 MULTBAND.TAB ZAzzzaaa.MULTBAND.TAB GROUPIE**

**32 ZAzzzaaa.URR.ENDF GROUPIE**

**33 SHIELD.LST ZAzzzaaa.SHIELD.LST GROUPIE**

**34 MULTBAND.LST ZAzzzaaa.MULTBAND.LST GROUPIE**

**35 UNSHIELD.LST ZAzzzaaa.UNSHIELD.LST GROUPIE**

**GROUPIE**

**I/O UNITS USED GROUPIE**

**-------------- GROUPIE**

**UNITS 2, 3 8, 9 AND 10 WILL ALWAYS BE USED. GROUPIE**

**UNITS 31 THROUGH 35, 11 AND 16 ARE OPTIONALLY USED DEPENDING GROUPIE**

**ON THE OUTPUT REQUESTED. GROUPIE**

**UNITS 12, 13 AND 14 WILL ONLY BE USED IF SELF-SHIELDED OR GROUPIE**

**MULTIBAND OUTPUT IS REQUESTED. GROUPIE**

**GROUPIE**

**INPUT CARDS GROUPIE**

**----------- GROUPIE**

**CARD COLS. FORMAT DESCRIPTION GROUPIE**

**---- ----- ------ ----------- GROUPIE**

**1 1-11 I11 SELECTION CRITERIA (0=MAT, 1=ZA) GROUPIE**

**1 12-22 I11 NUMBER OF GROUPS. GROUPIE**

**--------------------------2019/6/23 -11 (TART 616 groups) required for GROUPIE**

**Unresolved Resonance Region Self-Shielding GROUPIE**

**calculation. GROUPIE**

**=.GT.0 - ARBITRARY GROUP BOUNDARIES ARE READ GROUPIE**

**FROM INPUT FILE (N GROUPS REQUIRE GROUPIE**

**N+1 GROUP BOUNDARIES). CURRENT GROUPIE**

**PROGRAM MAXIMUM IS 20,000 GROUPS. GROUPIE**

**BUILT-IN OPTIONS INCLUDE.... GROUPIE**

**= 0 - TART 175 GROUPS GROUPIE**

**= -1 - ORNL 50 GROUPS GROUPIE**

**= -2 - ORNL 126 GROUPS GROUPIE**

**= -3 - ORNL 171 GROUPS GROUPIE**

**= -4 - SAND-II 620 (665) GROUPS TO 18 MEV GROUPIE**

**= -5 - SAND-II 640 (685) GROUPS TO 20 MEV GROUPIE**

**= -6 - WIMS 69 GROUPS GROUPIE**

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

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

**= -9 - MUFT 54 GROUPS GROUPIE**

**=-10 - ABBN 28 GROUPS GROUPIE**

**Current TART Standard =-11 - TART 616 GROUPS TO 20 MEV GROUPIE**

**(-11 is required for =-12 - TART 700 GROUPS TO 1 GEV GROUPIE**

**unresolved resonance =-13 - SAND-II 665 GROUPS TO 18 MEV GROUPIE**

**region self-shielding=-14 - SAND-II 685 GROUPS TO 20 MEV GROUPIE**

**calculations) =-15 - TART 666 GROUPS TO 200 MEV GROUPIE**

**=-16 - SAND-II 725 GROUPS TO 60 MEV GROUPIE**

**=-17 - SAND-II 755 GROUPS TO 150 MEV GROUPIE**

**=-18 - SAND-II 765 GROUPS TO 200 MEV GROUPIE**

**=-19 - UKAEA 1102 GROUPS TO 1 GeV GROUPIE**

**1 23-33 I11 MULTI-BAND SELECTOR GROUPIE**

**--------------------------2019/6/23 - ONLY 0 or 2 allowed = the = 1 GROUPIE**

**option has proven to give very poor results, GROUPIE**

**and therefore is no longer allowed. GROUPIE**

**= 0 - NO MULTI-BAND CALCULATIONS GROUPIE**

**No longer allowed = 1 - 2 BAND. CONSERVE AV(TOT), AV(1/TOT) GROUPIE**

**AND AV(1/TOT\*\*2) GROUPIE**

**= 2 - 2 BAND. CONSERVE AV(TOT), AV(1/TOT) GROUPIE**

**AND AV(1/(TOT+SIGMA0)) WHERE GROUPIE**

**SIGMA0 = AV(TOT) IN EACH GROUP GROUPIE**

**No longer allowed = 3-5- MULTI-BAND FIT. CONSERVE AV(TOT) AND GROUPIE**

**MINIMIZE FRACTIONAL ERROR FOR ENTIRE GROUPIE**

**SELF-SHIELDING CURVE (SIGMA0 = 0 TO GROUPIE**

**INFINITY) GROUPIE**

**IF THE SELECTOR IS POSITIVE (1 TO 5) THE GROUPIE**

**MINIMUM NUMBER OF BANDS WILL BE OUTPUT FOR GROUPIE**

**EACH ISOTOPE INDEPENDENTLY. IF THE SELECTOR GROUPIE**

**IS NEGATIVE (-1 TO -5) THE SAME NUMBER OF GROUPIE**

**BANDS (ABS(SELECTOR)) WILL BE OUTPUT FOR GROUPIE**

**ALL ISOTOPES. GROUPIE**

**1 34-44 I11 NUMBER OF POINTS USED TO DESCRIBE ENERGY GROUPIE**

**DEPENDENT WEIGHTING SPECTRUM S(E). GROUPIE**

**= 0 or 1 - Flat (Constant) GROUPIE**

**= -1 - 1/E at ALL energies GROUPIE**

**= -2 - MAXWELLIAN - UP TO 0.1 eV GROUPIE**

**1/E - 0.1 eV TO 67 KeV GROUPIE**

**FISSION - 67 KeV to 10 MeV GROUPIE**

**CONSTANT - Above 10 MeV GROUPIE**

**= > 1 - Read input table GROUPIE**

**2005/01/20---------------ADDED OPTION TO ALLOW TEMPERATURE OF THE GROUPIE**

**MAXWELLIAN TO BE CHANGED - SEE INPUT LINE 4, GROUPIE**

**COLUMNS 55 - 66. GROUPIE**

**= -1 - 1/E GROUPIE**

**= 0 OR 1- ENERGY INDEPENDENT (SO CALLED FLAT GROUPIE**

**WEIGHTING SPECTRUM). GROUPIE**

**= .GT.1 - READ THIS MANY POINTS FROM INPUT GROUPIE**

**TO DESCRIBE WEIGHTING SPECTRUM. GROUPIE**

**NO LIMIT TO THE NUMBER OF POINTS GROUPIE**

**USED TO DESCRIBE WEIGHTING. GROUPIE**

**1 45-55 E11.4 MULTI-BAND CONVERGENCE CRITERIA. GROUPIE**

**--------------------------2019/6/23 - No longer used now that code GROUPIE**

**is restricted to no more than 2 bands. GROUPIE**

**ONLY USED FOR 3 OR MORE BANDS. THE NUMBER OF GROUPIE**

**BANDS IN EACH GROUPS IS SELECTED TO INSURE GROUPIE**

**THAT THE ENTIRE SELF-SHIELDING CURVE CAN BE GROUPIE**

**REPRODUCED TO WITHIN THIS FRACTIONAL ERROR. GROUPIE**

**= .LT. 0.0001 - USE STANDARD 0.001 GROUPIE**

**(0.1 PER-CENT) GROUPIE**

**= .GE. 0.0001 - USE AS CONVERGENCE CRITERIA GROUPIE**

**1 56-66 I11 SIGMA-0 DEFINITION SELECTOR. GROUPIE**

**--------------------------2019/6/23 - For multi-band calculations GROUPIE**

**only 0 is alllowed = mulriples of unshielded GROUPIE**

**total in each group = This is required for GROUPIE**

**the BEST self-shielding results. GROUPIE**

**< 0 - 21 VALUES OF SIGMA0 ARE READ INPUT AND GROUPIE**

**INTERPRETED AS FIXED VALUES = SAME AS GROUPIE**

**= 1 DESCRIPTION BELOW GROUPIE**

**INPUT VALUES MUST ALL BE, GROUPIE**

**1) GREATER THAN 0 GROUPIE**

**2) IN DESCENDING VALUE ORDER GROUPIE**

**= 0 - SIGMA-0 WILL BE DEFINED AS A MULTIPLE GROUPIE**

**OF THE UNSHIELDED TOTAL CROSS SECTION GROUPIE**

**IN EACH GROUP (VALUES OF 1/1024 TO GROUPIE**

**1024 IN STEPS OF A FACTOR OF 2 WILL GROUPIE**

**BE USED AS THE MULTIPLIER). GROUPIE**

**= 1 - SIGMA-0 WILL BE DEFINED AS THE SAME GROUPIE**

**NUMBER OF BARNS IN EACH GROUP (VALUES GROUPIE**

**40000 TO 0.4 BARNS WILL BE USED. WITHINGROUPIE**

**EACH DECADE VALUES OF 10, 7, 4, 2, 1 GROUPIE**

**BARNS WILL BE USED). GROUPIE**

**1 67-70 I4 High energy extension = definition of cross GROUPIE**

**section above highest tabulated energy. GROUPIE**

**--------------------------2019/6/23 - Ignored - will always use ENDF GROUPIE**

**Standard Definition = 0. GROUPIE**

**= 0 = cross section = 0 (standard ENDF/B) GROUPIE**

**= 1 = cross section = constant (equal to GROUPIE**

**value at highest tabulated energy). GROUPIE**

**2-4 1-66 6E11.4 SIGMA-0 Definition GROUPIE**

**--------------------------2019/6/23 - Only the GROUPIE standard = 0 GROUPIE**

**in allowed for Unresolved Resonance Region GROUPIE**

**Self-Shielding calculation GROUPIE**

**IF SIGMA-0 DEFINITION SELECTOR < 0, THE NEXT GROUPIE**

**4 LINES OF INPUT ARE THE 22 VALUES OF SIGMA0,GROUPIE**

**6 PER LINE. GROUPIE**

**2 1-72 A72 ENDF/B INPUT DATA FILENAME GROUPIE**

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

**3 1-72 A72 ENDF/B OUTPUT DATA FILENAME GROUPIE**

**(STANDARD OPTION = ENDFB.OUT) GROUPIE**

**GROUPIE**

**THE FOURTH INPUT CARD IS USED TO SELECT ALL DESIRED OUTPUT MODES. GROUPIE**

**EACH OUTPUT DEVICE MAY BE TURNED OFF (0) OR ON (1). THEREFORE GROUPIE**

**THEREFORE EACH OF THE FOLLOWING INPUT PARAMETERS MAY BE EITHER GROUPIE**

**ZERO TO INDICATE NO OUTPUT OR NON-ZERO TO INDICATE OUTPUT. GROUPIE**

**GROUPIE**

**4 1-11 I11 SELF-SHIELDED CROSS SECTION LISTING GROUPIE**

**= 1 - CROSS SECTIONS GROUPIE**

**= 2 - RESONANCE INTEGRALS GROUPIE**

**4 12-22 I11 MULTI-BAND PARAMETER LISTING GROUPIE**

**4 23-33 I11 MULTI-BAND PARAMETERS COMPUTER READABLE GROUPIE**

**4 34-44 I11 UNSHIELDED CROSS SECTIONS IN ENDF/B FORMAT GROUPIE**

**= 1 - HISTOGRAM FORMAT (INTERPOLATION LAW 1) GROUPIE**

**= 2 - LINEAR-LINEAR (INTERPOLATION LAW 2) GROUPIE**

**4 45-55 I11 UNSHIELDED CROSS SECTIONS LISTING GROUPIE**

**= 1 - CROSS SECTIONS GROUPIE**

**= 2 - RESONANCE INTEGRALS GROUPIE**

**05/01/20 - ADDED THE BELOW OPTION GROUPIE**

**4 56-66 E11.4 IF THE STANDARD BUILT-IN SPECTRA IS USED, GROUPIE**

**INPUT LINE 1, COLUMNS 34-44 = 2, THIS FIELD GROUPIE**

**CAN BE USED TO OPTIONALLY CHANGE TEMPERATURE GROUPIE**

**OF THE MAXWELLIAN. GROUPIE**

**INPUT IS IN EV (0.0253 EV = ROOM TEMPERATURE)GROUPIE**

**= 0 - USE DEFAULT 0.0253 EV, ROOM TEMPERATUREGROUPIE**

**> 0 - USE THIS AS THE TEMPERATURE GROUPIE**

**RESTRICTION - TEMPERATURE CANNOT EXCEED GROUPIE**

**1000 EV. GROUPIE**

**GROUPIE**

**5 1-80 18A4 LIBRARY IDENTIFICATION. ANY TEXT THAT THE GROUPIE**

**USER WISHES TO IDENTIFY THE MULTI-BAND GROUPIE**

**PARAMETERS. THIS LIBRARY IDENTIFICATION IS GROUPIE**

**WRITTEN INTO THE COMPUTER READABLE MULTI-BANDGROUPIE**

**DATA FILE. GROUPIE**

**GROUPIE**

**6-N 1- 6 I6 LOWER MAT OR ZA LIMIT GROUPIE**

**7- 8 I2 LOWER MF LIMIT GROUPIE**

**9-11 I3 LOWER MT LIMIT GROUPIE**

**12-17 I11 UPPER MAT OR ZA LIMIT GROUPIE**

**18-19 I2 UPPER MF LIMIT GROUPIE**

**20-22 I3 UPPER MT LIMIT GROUPIE**

**UP TO 100 RANGES MAY BE SPECIFIED, ONE RANGE GROUPIE**

**PER LINE. THE LIST OF RANGES IS TERMINATED GROUPIE**

**BY A BLANK CARD. IF THE UPPER MAT OR ZA GROUPIE**

**LIMIT IS LESS THAN THE LOWER LIMIT THE UPPER GROUPIE**

**IS SET EQUAL TO THE LOWER LIMIT. IF THE UPPERGROUPIE**

**MF OR MT LIMIT IS ZERO IT WILL BE SET EQUAL GROUPIE**

**TO ITS MAXIMUM VALUE, 99 OR 999, RESPECTIVELYGROUPIE**

**IF THE FIRST REQUEST LINE IS BLANK IT WILL GROUPIE**

**TERMINATE THE LIST OF REQUESTS AND CAUSE ALL GROUPIE**

**DATA TO BE RETRIEVED (SEE EXAMPLE INPUT). GROUPIE**

**GROUPIE**

**VARY 1-66 6E11.4 ENERGY GROUP BOUNDARIES. ONLY REQUIRED IF GROUPIE**

**THE NUMBER OF GROUPS INDICATED ON THE FIRST GROUPIE**

**INPUT CARD IS POSITIVE. ALL ENERGIES MUST GROUPIE**

**BE IN ASCENDING ENERGY IN EV. THE PRESENT GROUPIE**

**LIMITS ARE 1 TO 20,000 GROUPS. FOR N GROUPS GROUPIE**

**N+1 BOUNDARIES WILL BE READ FROM THE GROUPIE**

**INPUT FILE, E.G. IF THE FIRST INPUT CARD GROUPIE**

**INDICATES 20 GROUPS, 21 ENERGY BOUNDARIES GROUPIE**

**WILL BE READ FROM THE INPUT FILE. GROUPIE**

**GROUPIE**

**VARY 1-66 6E11.4 ENERGY DEPENDENT WEIGHTING SPECTRUM. ONLY GROUPIE**

**REQUIRED IF THE NUMBER OF POINTS INDICATED GROUPIE**

**ON FIRST CARD IS MORE THAN ONE. DATA IS GROUPIE**

**GIVEN IN (ENERGY, WEIGHT) PAIRS, UP TO 3 GROUPIE**

**PAIRS PER CARD, USING ANY NUMBER OF CARDS GROUPIE**

**REQUIRED. ENERGIES MUST BE IN ASCENDING GROUPIE**

**ORDER IN EV. THE SPECTRUM VALUES MUST BE GROUPIE**

**NON-NEGATIVE. THE ENERGY RANGE OF SPECTRUM GROUPIE**

**MUST AT LEAST SPAN THE ENERGY RANGE OF THE GROUPIE**

**ENERGY GROUPS. SINCE SPECTRUM IS STORED IN GROUPIE**

**PAGING SYSTEM THERE IS NO LIMIT TO NUMBER GROUPIE**

**OF POINTS THAT CAN BE USED TO DESCRIBE THE GROUPIE**

**WEIGHTING SPECTRUM. GROUPIE**

**GROUPIE**

**EXAMPLE INPUT NO. 1 GROUPIE**

**------------------- GROUPIE**

**REQUEST DATA BY MAT AND PROCESS ALL DATA (ALL MAT BETWEEN 1 AND GROUPIE**

**9999). USE THE TART 175 GROUP STRUCTURE, GENERATE 2 BAND GROUPIE**

**PARAMETERS (THE FOR ALL ISOTOPES) TO 0.1 PER-CENT ACCURACY GROUPIE**

**IN THE SELF-SHIELDING CURVE. OUTPUT ALL LISTING, COMPUTER GROUPIE**

**READABLE AND ENDF/B FORMAT GROUP AVERAGES. GROUPIE**

**GROUPIE**

**EXPLICITLY SPECIFY THE STANDARD FILENAMES. GROUPIE**

**GROUPIE**

**THE FOLLOWING 7 INPUT LINES ARE REQUIRED. GROUPIE**

**GROUPIE**

**0 0 -2 0 1.00000-03 0 GROUPIE**

**ENDFB.IN GROUPIE**

**ENDFB.OUT GROUPIE**

**1 1 1 1 1 GROUPIE**

**TART 175 GROUP, 2 BAND LIBRARY TO 0.1 PER-CENT ACCURACY GROUPIE**

**1 1 1 9999 0 0 GROUPIE**

**(BLANK CARD TERMINATES REQUEST LIST) GROUPIE**

**GROUPIE**

**EXAMPLE INPUT NO. 2 GROUPIE**

**------------------- GROUPIE**

**THE SAME EXAMPLE 1, AS ABOVE, ONLY THE ENDF/B DATA WILL BE READ GROUPIE**

**FROM \ENDFB6\SIGMA1\K300\ZA092238 (U-238 AT 300 KELVIN) AND GROUPIE**

**WRITTEN TO \ENDFB6\GROUPIE\K300\ZA092238 GROUPIE**

**GROUPIE**

**THE FOLLOWING 7 INPUT LINES ARE REQUIRED. GROUPIE**

**GROUPIE**

**0 0 -2 0 1.00000-03 0 GROUPIE**

**\ENDFB6\SIGMA1\K300\ZA092238 GROUPIE**

**\ENDFB6\GROUPIE\K300\ZA092238 GROUPIE**

**1 1 1 1 1 GROUPIE**

**TART 175 GROUP, 2 BAND LIBRARY TO 0.1 PER-CENT ACCURACY GROUPIE**

**1 1 1 9999 0 0 GROUPIE**

**(BLANK CARD TERMINATES REQUEST LIST) GROUPIE**

**GROUPIE**

**EXAMPLE INPUT NO. 3 GROUPIE**

**------------------- GROUPIE**

**PROCESS ALL DATA. USE 1/E WEIGHTING IN ORDER TO CALCULATE GROUPIE**

**UNSHIELDED ONE GROUP CROSS SECTIONS OVER THE ENERGY RANGE 0.5 EV GROUPIE**

**TO 1 MEV (NOTE THAT THE RESULTS ARE SIMPLY PROPORTIONAL TO THE GROUPIE**

**RESONANCE INTEGRAL FOR EACH REACTION). OUTPUT UNSHIELDED LISTING. GROUPIE**

**GROUPIE**

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

**THEN USE STANDARD FILENAMES. GROUPIE**

**GROUPIE**

**THE FOLLOWING 7 INPUT CARDS ARE REQUIRED. GROUPIE**

**GROUPIE**

**0 0 1 -1 0 GROUPIE**

**(USE STANDARD FILENAME = ENDFB.IN) GROUPIE**

**(USE STANDARD FILENAME = ENDFB.OUT) GROUPIE**

**0 0 0 0 1 GROUPIE**

**RESONANCE INTEGRAL CALCULATION (FROM 0.5 EV TO 1 MEV) GROUPIE**

**(RETRIEVE ALL DATA, TERMINATE REQUEST LIST) GROUPIE**

**5.00000-01 1.00000+06 GROUPIE**

**GROUPIE**

**EXAMPLE INPUT NO. 4 GROUPIE**

**------------------- GROUPIE**

**THIS EXAMPLE USES A USER DEFINED GROUP STRUCTURE AND WEIGHTING GROUPIE**

**FUNCTION - THESE ARE NOT REALISTIC IN TERMS OF ACTUAL ENERGIES GROUPIE**

**AND WEIGHTS - THEY ARE ONLY INTENDED TO ILLUSTRATE THE ORDER OF GROUPIE**

**THE INPUT PARAMETERS. GROUPIE**

**GROUPIE**

**0 11 0 6 0 GROUPIE**

**RECENT.OUT GROUPIE**

**GROUPIE.OUT GROUPIE**

**1 1 1 1 1 GROUPIE**

**Example with users defined groupus and spectrum weighting GROUPIE**

**1 1 1 999999999 GROUPIE**

**(blabk line terminates request list) GROUPIE**

**1.00000-05 1.00000-04 1.00000-03 1.00000-02 1.00000-01 1.00000+00 grouGROUPIE**

**1.00000+01 1.00000+02 1.00000+03 1.00000+04 1.00000+05 1.00000+06 grouGROUPIE**

**1.00000-05 1.0 1.00000-02 0.1 1.00000+00 0.01 weigGROUPIE**

**1.00000+02 0.001 1.00000+04 0.0001 1.00000+06 0.000001 weigGROUPIE**

**GROUPIE**

**=======================================================================GROUPIE**