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========================================================================= 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 EACH   Groupie
                                 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
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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 CHANGE Groupie
                            *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 SECTION Groupie
                             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
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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 30,000 Groupie
                            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 up Groupie
                            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 range Groupie
                            (either = 0 = standard, or constant)   Groupie
                            WARNING - ENDF/B standard convention   Groupie
                            is that the cross section = 0 where it Groupie
                            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 included Groupie
                            group structures, i.e., even those     Groupie
                            that start above thremal range by      Groupie
                            ALWAYS constructing weigthing spectrum Groupie
                            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, including Groupie
                            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
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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 structure Groupie
                            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
                                                                   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
Dermott E. Cullen                                                  Groupie
1466 Hudson Way                                                    Groupie
Livermore, CA 94550                                                Groupie
U.S.A.                                                             Groupie
Telephone  925-443-1911                                            Groupie
E. Mail    RedCullen1@Comcast.net                                  Groupie
Website    RedCullen1.net/HOMEPAGE.NEW                             Groupie
                                                                   Groupie
AUTHORS MESSAGE                                                    Groupie
---------------                                                    Groupie
THE REPORT DESCRIBED ABOVE IS THE LATEST PUBLISHED DOCUMENTATION   Groupie
FOR THIS PROGRAM. HOWEVER, THE COMMENTS BELOW SHOULD BE CONSIDERED Groupie
THE LATEST DOCUMENTATION INCLUDING ALL RECENT IMPROVEMENTS. PLEASE Groupie
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 COMPUTER Groupie
INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE     Groupie
OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT Groupie
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
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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 MADE Groupie
LINEARLY INTERPOLABLE USING PROGRAM LINEAR (UCRL-50400, VOL. 17,   Groupie
PART A). THE RESONANCE CONTRIBUTION MAY BE ADDED TO THE BACKGROUND Groupie
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 (2017-1) ***************   Groupie
UNSHIELDED GROUP AVERAGES USING   69 GROUPS (WIMS)                 Groupie
MAXWELLIAN, 1/E AND FISSION 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 FORMAT Groupie
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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 WAS Groupie
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 PROGRAM Groupie
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 SEVEN BUILT-IN GROUP STRUCTURES. Groupie
(0) 175 GROUP (TART STRUCTURE) Groupie
(1) 50 GROUP (ORNL STRUCTURE) Groupie
(2) 126 GROUP (ORNL STRUCTURE) Groupie

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 (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 REPRESENTATION    Groupie
 OF THE SPECTRUM BETWEEN TABULATED DATA POINTS.                        Groupie
                                                                       Groupie
 THE PRESENT VERSION OF THE CODE HAS THREE BULIT-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)) (ABOVE 67 KEV)        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
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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 WITHIN Groupie
           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 SIGMA0 Groupie
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
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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 AVERAGED  Groupie
CROSS SECTIONS - AS DEFINED ABOVE - PRIOR TO OUTPUT THE RESULTS     Groupie
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WILL MERELY BE MULTIPLIED BY THE WIDTH OF THE GROUP ASSUMING YOU HAVE SELECTED A 1/E SPECTRUM - THERE IS NO CHECK ON THIS - THE PROGRAM MERELY MULTIPLIES THE GROUP AVERAGED CROSS SECTIONS BY,

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

WARNING - IT IS UP TO YOU TO INSURE THAT YOU FOLLOW EXACTLY THE STEPS OUTLINED ABOVE IF YOU WISH TO OBTAIN MEANINGFUL RESULTS.

NOTE - OUTPUT IN THE ENDF/B FORMAT IS ALWAYS GROUP AVERAGED CROSS SECTIONS, REGARDLESS OF WHETHER YOU ASK FOR AVERAGED CROSS SECTIONS OR RESONANCE INTEGRALS - THIS IS BECAUSE DATA IN THE ENDF/B FORMAT IS EXPLICITLY DEFINED TO BE CROSS SECTIONS.

RESONANCE INTEGRAL OUTPUT CAN ONLY BE OBTAINED IN THE LISTING FORMATS.

MINIMUM TOTAL CROSS SECTION TREATMENT

SINCE THE BONDARENKO SELF-SHIELDING DEPENDS ON 1/TOTAL CROSS SECTION, THE ALGORITHM WILL BECOME NUMERICALLY UNSTABLE IF THE TOTAL CROSS SECTION IS NEGATIVE (AS OCCURS IN MANY ENDF/B EVALUATIONS). IF THE TOTAL IS LESS THAN SOME MINIMUM ALLOWABLE VALUE (DEFINE BY OKMIN, PRESENTLY 1 MILLI-BARN) AN ERROR MESSAGE WILL BE PRINTED AND FOR THE SELF-SHIELDING CALCULATION ALL ENERGY INTERVALS IN WHICH THE TOTAL IS LESS THAN THE MINIMUM WILL BE IGNORED.

NOTE, FOR THE UNSHIELDED CALCULATIONS ALL CROSS SECTIONS WILL BE CONSIDERED WHETHER THEY ARE POSITIVE OR NEGATIVE. THEREFORE IF THE TOTAL CROSS SECTION IS NEGATIVE OR LESS THAN THE MINIMUM VALUE THERE MAY BE AN INCONSISTENCY BETWEEN THE UNSHIELDED AND THE SELF-SHIELDED CROSS SECTIONS. IF THE TOTAL CROSS SECTION IS NEGATIVE AND SELF-SHIELDED CROSS SECTIONS ARE CALCULATED THE PROGRAM WILL PRINT AN ERROR MESSAGE INDICATING THAT THE SELF-SHIELDED RESULTS ARE UNRELIABLE AND SHOULD NOT BE USED. THEREFORE IN THIS CASE THE PROGRAM WILL NOT ATTEMPT TO MODIFY THE UNSHIELDED RESULTS TO ELIMINATE THE EFFECT OF NEGATIVE CROSS SECTIONS, SINCE THE UNSHIELDED RESULTS ARE THE ONLY ONES WHICH TRULY REFLECT THE ACTUAL INPUT.

RESOLVED RESONANCE REGION

IN THE RESOLVED RESONANCE REGION (ACTUALLY EVERYWHERE BUT IN THE UNRESOLVED RESONANCE REGION) THE CROSS SECTIONS OUTPUT BY LINEAR-RECENT-SIGMA1 WILL BE ACTUAL ENERGY DEPENDENT CROSS SECTIONS AND THE CALCULATIONS BY THIS PROGRAM WILL YIELD ACTUAL SHIELDED AND UNSHIELDED CROSS SECTIONS.

UNRESOLVED RESONANCE REGION

IN THE UNRESOLVED RESONANCE REGION PROGRAM RECENT USES THE UNRESOLVED RESONANCE PARAMETERS TO CALCULATE INFINITELY DILUTE AVERAGE CROSS SECTIONS. THIS PROGRAM WILL MERELY READ THIS INFINITELY DILUTE DATA AS IF IT WERE ENERGY DEPENDENT DATA AND GROUP AVERAGE IT. AS SUCH THIS PROGRAM WILL PRODUCE THE CORRECT UNSHIELDED CROSS SECTION IN THE UNRESOLVED RESONANCE REGION, BUT IT WILL NOT PRODUCE THE CORRECT SELF-SHIELDING EFFECTS.

ACCURACY OF RESULTS

ALL INTEGRALS ARE PERFORMED ANALYTICALLY. THEREFORE NO ERROR IS INTRODUCED DUE TO THE USE OF TRAPAZOIDAL OR OTHER INTEGRATION SCHEME. THE TOTAL ERROR THAT CAN BE ASSIGNED TO THE RESULTING AVERAGES IS JUST THAT DUE TO THE ERROR IN THE CROSS SECTIONS AND ENERGY DEPENDENT WEIGHTING SPECTRUM. GENERALLY SINCE THE THE ENERGY DEPENDENT WEIGHTING SPECTRUM APPEARS IN BOTH THE NUMERATOR AND THE DENOMINATOR THE AVERAGES RAPIDLY BECOME INSENSITIVE TO THE WEIGHTING SPECTRUM AS MORE GROUPS ARE USED. SINCE THE WEIGHTING SPECTRUM IS LOADED IN THE PAGING SYSTEM THE USER CAN DESCRIBE THE SPECTRUM TO ANY REQUIRED ACCURACY USING ANY NUMBER OF ENERGY VS. SPECTRUM PAIRS.

MULTI-BAND PARAMETERS

MULTI-BAND PARAMETERS ARE CALCULATED FOR THE TOTAL, ELASTIC, CAPTURE AND FISSION REACTIONS. WITH THE NUMBER OF GROUPS THAT ARE NORMALLY USED (SEE BUILT IN GROUP STRUCTURES) ALL OTHER REACTIONS RESULT IN A NEGLIGABLE AMOUNT OF SELF-SHIELDING. AS SUCH THEIR EQUIVALENT BAND CROSS SECTION WILL MERELY BE THEIR UNSHIELDED VALUE WITHIN EACH BAND.

FOR ANY GIVEN EVALUATION, WITHIN ANY GIVEN GROUP THIS PROGRAM WILL GENERATE THE MINIMUM NUMBER OF BANDS REQUIRED WITHIN THAT GROUP. AS OUTPUT TO THE COMPUTER READABLE DISK FILE THE BAND PARAMETERS FOR EACH EVALUATION WILL BE FORMATTED TO HAVE THE SAME NUMBER OF BANDS IN ALL GROUPS (WITH ZERO WEIGHT FOR SOME BANDS WITHIN ANY GROUP). THE USER MAY DECIDE TO HAVE OUTPUT EITHER WITH THE MINIMUM NUMBER OF BANDS REQUIRED FOR EACH EVALUATION (E.G. 2 BANDS FOR HYDROGEN AND 4 BANDS FOR U-233) OR THE SAME NUMBER OF BANDS FOR ALL EVALUATIONS (E.G. 4 BANDS FOR BOTH HYDROGEN AND U-233).

FOR 2 OR FEWER BANDS THE PROGRAM USES AN ANALYTIC EXPRESSION TO DEFINE ALL MULTI-BAND PARAMETERS. FOR MORE THAN 2 BANDS THE PROGRAM PERFORMS A NON-LINEAR FIT TO SELECT THE MULTI-BAND PARAMETERS THAT MINIMIZE THE MAXIMUM FRACTIONAL ERROR AT ANY POINT ALONG THE ENTIRE SELF-SHIELDING CURVE. THE NUMBER OF BANDS REQUIRED WITHIN ANY GIVEN GROUP IS DEFINED BY INSURING THAT THE MULTI-BAND PARAMETERS CAN BE USED TO ACCURATELY DEFINE SELF-SHIELDED CROSS SECTIONS ALONG THE ENTIRE SELF-SHIELDING CURVE FROM SIGMA0 = 0 TO INFINITY. THE USER MAY DEFINE THE ACCURACY REQUIRED.

ENDF/B FORMATTED UNSHIELDED AVERAGES

UNSHIELDED MULTI-GROUP AVERAGED CROSS SECTIONS FOR ALL REACTIONS MAY BE OBTAINED IN THE ENDF/B FORTRAN IN EITHER HISTOGRAM (INTERPOLATION LAW 1) OR LINEARLY INTERPOLABLE (INTERPOLATION LAW 2) FORM. SEE INPUT BELOW FOR DETAILS.

MIXTURES OF MATERIALS AND RESONANCE OVERLAP

THE SELF-SHIELDED CROSS SECTIONS FOR THE INDIVIDUAL CONSTITUENTS OF ANY MIXTURE CAN BE CALCULATED BY THIS PROGRAM BY REALIZING THAT THIS PROGRAM ESSENTIALLY ONLY USES THE TOTAL CROSS SECTION AS A WEIGHTING FUNCTION TO ACCOUNT FOR SELF-SHIELDING EFFECTS. FOR A MIXTURE IT IS THEREFORE ONLY NECESSARY TO USE THE TOTAL CROSS SECTION FOR THE MIXTURE IN PLACE OF THE ACTUAL TOTAL CROSS SECTION FOR EACH CONSTITUENT AND TO RUN THIS PROGRAM. THIS CAN BE DONE BY FIRST RUNNING PROGRAM MIXER TO CALCULATE THE ENERGY DEPENDENT TOTAL CROSS SECTION FOR ANY COMPOSITE MIXTURE. NEXT, SUBSTITUTE THIS COMPOSITE TOTAL CROSS SECTION FOR THE ACTUAL TOTAL CROSS SECTION OF EACH CONSTITUENT (IN EACH ENDF/B FORMATTED EVALUATION).

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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
          45-55    1X,10A1  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
 31   MULTI-BAND PARAMETERS CHARACTER FILE - OPTIONAL              Groupie
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      (BCD - 80 CHARACTERS/RECORD)                                  Groupie
 32   SELF-SHIELDED CROSS SECTION LISTING - OPTIONAL                Groupie
      (BCD - 120 CHARACTERS/RECORD)                                 Groupie
 33   MULTI-BAND PARAMETER LISTING - OPTIONAL                       Groupie
      (BCD - 120 CHARACTERS/RECORD)                                 Groupie
 34   UNSHIELDED CROSS SECTION LISTING - OPTION                     Groupie
      (BCD - 120 CHARACTERS/RECORD)                                 Groupie
  3   OUTPUT REPORT (BCD - 80 CHARACTERS/RECORD)                    Groupie
 11   MULTI-GROUP ENDF/B DATA - OPTIONAL                            Groupie
      (BCD - 80 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
  8   (SCRATCH)                                                     Groupie
  9   (SCRATCH)                                                     Groupie
 10   ENDFB.IN                                                      Groupie
 11   ENDFB.OUT                                                     Groupie
 12   (SCRATCH)                                                     Groupie
 13   (SCRATCH)                                                     Groupie
 14   (SCRATCH)                                                     Groupie
 31   MULTBAND.TAB                                                  Groupie
 32   SHIELD.LST                                                    Groupie
 33   MULTBAND.LST                                                  Groupie
 34   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 34 AND 11 ARE OPTIONALLY USED DEPENDING ON THE    Groupie
 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
                     =.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
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                        =  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
                        =-11   - TART    616 GROUPS TO 20 MEV         Groupie
                        =-12   - TART    700 GROUPS TO 1 GEV          Groupie
                        =-13   - SAND-II 665 GROUPS TO 18 MEV         Groupie
                        =-14   - SAND-II 685 GROUPS TO 20 MEV         Groupie
                        =-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
                        =  0 - NO MULTI-BAND CALCULATIONS             Groupie
                        =  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
                        = 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
                        = -2    - MAXWELLIAN - UP TO 0.1 EV           Groupie
                                  1/E        - 0.1 EV TO 67 KEV       Groupie
                                  FISSION    - ABOVE 67 KEV           Groupie
05/01/20-----------------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
                        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
                        < 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. WITHIN Groupie
                                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
                         = 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   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 TEMPERATURE Groupie
                         > 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-BAND Groupie
                         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
```

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          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 UPPER Groupie
                        MF OR MT LIMIT IS ZERO IT WILL BE SET EQUAL   Groupie
                        TO ITS MAXIMUM VALUE, 99 OR 999, RESPECTIVELY Groupie
                        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
====================================================================== Groupie
```