======================================================================= 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

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

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 OUT9, 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 OUT9 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**

**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

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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 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

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 (2015-2) \*\*\*\*\*\*\*\*\*\*\*\*\*\*\* 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

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 1000. 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

(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

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

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

TO UNITY. THIS PROGRAM ALLOWS UP TO 1000 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 1000 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

---------------------------------- 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 AVERAGED Groupie

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 UNSHIELDED Groupie

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 THAT Groupie

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 SECTION Groupie

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 D11.4 TEMPERATURE (KELVIN) Groupie

45-55 1X,10A1 HOLLERITH DESCRIPTION OF ZA Groupie

3 1-11 D11.4 ENERGY (EV) - GROUP BOUNDARY. Groupie

12-22 D11.4 TOTAL (FIRST BAND) Groupie

23-33 D11.4 ELASTIC Groupie

34-44 D11.4 CAPTURE Groupie

35-55 D11.4 FISSION Groupie

4 1-11 ----- BLANK Groupie

12-22 D11.4 TOTAL (SECOND BAND) Groupie

23-33 D11.4 ELASTIC Groupie

34-44 D11.4 CAPTURE Groupie

35-55 D11.4 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 D11.4 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

(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 1000 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

=-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

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 D11.4 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 6D11.4 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 D11.4 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

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 6D11.4 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 1000 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 6D11.4 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/V 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