 				Groupie
				Groupie
PROGRAM	GROUE	TT		Groupie
				Groupie
VEDGION	76-1	INCUEMBED 1976)	Croupie
VERSION	70 I 70_1	(OCTORED 1970)	CDC-7600 AND CRAV-1 VERSION	Groupie
VERSION	79-1 90_1	(UCIUBER 1979) (MAV 1000) TDM	CDC-7000 AND CRAI-I VERSION.	Groupie
VERSION	00-1 01 1	(MAI 1900) IBM	, CDC AND CRAI VERSION	Groupie
VERSION	81-1	(JANUARY 1981)	EXTENSION TO 3000 GROUPS	Groupie
VERSION	81-2	(MARCH 1981) 1	MPROVED 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	(TANUARY 1986)	*FNDF/B-VI FORMAT	Groupie
VERSION	86-2	(UNE 1986)	*RUITUT-IN MAYWEIITAN 1/E AND EISSION	Croupie
VERGION	00 2	(0000 1900)	WEICHTING SDECTDIM	Croupie
VEDCTON	00_1	(TIT V 1000)	*ODTION INTERNALLY DEFINE ALL I/O	Groupie
VERSION	00-1	(0011 1900)	ETTE NAMES (SEE SUDDOUEINES ETTO)	Groupie
			FILE NAMES (SEE, SUBROUTINES FILIOI	Groupie
			FILIOZ FOR DETAILS).	Groupie
VEDATON	001	(TANKIA D.Y. 1000)	*IMPROVED BASED ON USER COMMENTS.	Groupie
VERSION	89-1	(JANUARI 1989)	*PSICHOANALIZED 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	2)*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
		THIS MAKES OUTPUT COMPATIBLE WITH ANY STANDARD AVERAGING PROCEDURE	Groupie Groupie
VERS. 2005-1	(JAN. 2005)	THIS MAKES OUTPUT COMPATIBLE WITH ANY STANDARD AVERAGING PROCEDURE *ADDED OPTION TO CHANGE TEMPERATURE OF	Groupie Groupie Groupie
VERS. 2005-1	(JAN. 2005)	THIS MAKES OUTPUT COMPATIBLE WITH ANY STANDARD AVERAGING PROCEDURE *ADDED OPTION TO CHANGE TEMPERATURE OF BUILT-IN STANDARD SPECTRUM.	Groupie Groupie Groupie Groupie

	2007-1	(JAN.	2007)	*CHECKED AGAINST ALL ENDF/B-VII.	Groupie
				*INCREASED PAGE SIZE FROM 120,000 TO	Groupie
VERS	2008-1	(.TAN	2008)	*72 CHARACTER FILE NAMES	Groupie
V LIKO .	2000 1	(0111.	2000)	*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
VEDC	2011 1	(2011)	AND UNSHIELDED CROSS SECTIONS.	Groupie
VERS.	2011-1	(June	2011)	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
				(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
VEDC	2012-1	(7)10	2012)	constant extension is NOT RECOMMENDED.	Groupie
VERS.	2012-1	(Aug.	2012)	*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
				that start above thremal range by	Groupie
				ALWAYS constructing weigthing spectrum	Groupie
				to be AT LEAST 1.0D-5 eV to 20 MeV.	Groupie
				*East and ad OUEO	
				AEXtended OUT9	Groupie
				*Replaced ALL 3 way IF Statements.	Groupie Groupie
				*Replaced ALL 3 way IF Statements. *Generalized TART Group Structures. *Generalized SAND-II Group Structures.	Groupie Groupie Groupie
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VERS.	2015-2	(Mar.	2015)	*Replaced ALL 3 way IF Statements. *Generalized TART Group Structures. *Generalized SAND-II Group Structures. *Extended SAND-II to 60, 150, 200 MeV. *Deleted 1P from formats reading input	Groupie Groupie Groupie Groupie Groupie
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VERS.	2015-2	(Mar.	2015)	*Extended 0019 *Replaced ALL 3 way IF Statements. *Generalized TART Group Structures. *Generalized SAND-II Group Structures. *Extended SAND-II to 60, 150, 200 MeV. *Deleted 1P from formats reading input parameters, causing incorrect scaling *Changed ALL data to "D" instead of	Groupie Groupie Groupie Groupie Groupie Groupie
VERS.	2015-2	(Mar.	2015)	*Extended 0019 *Replaced ALL 3 way IF Statements. *Generalized TART Group Structures. *Generalized SAND-II Group Structures. *Extended SAND-II to 60, 150, 200 MeV. *Deleted 1P from formats reading input parameters, causing incorrect scaling *Changed ALL data to "D" instead of "E" to insure it is REAL*8 and avoid Truncation ERRORS.	Groupie Groupie Groupie Groupie Groupie Groupie Groupie Groupie
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EUROPE Groupie Groupie ORIGINALLY WRITTEN BY Groupie _____ Groupie Groupie Dermott E. Cullen 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 http://home.comcast.net/~redcullen1 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 COMPUTER. Groupie Groupie PURPOSE Groupie Groupie _____ THIS PROGRAM IS DESIGNED TO CALCULATE ANY COMBINATION OF Groupie THE FOLLOWING OUANTITIES 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 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 99 GROUP (GAM-II STRUCTURE) (8) Groupie 54 GROUP (MUFT STRUCTURE) (9)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 Groupie AVERAGE = -----(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					
THE ENERGY DEPENDENT WEIGHTING SPECTRUM IS GIVEN BY AN ARBITRARY						
TABULATED LINERLY INTERPOLABLE FUNCTION WHICH CAN BE DESCRIBED						
BY AN ARBITRARY NUMBER OF POINTS. THIS ALLOWS THE USER TO						
SPECIFY ANY DESIRED WEIGHTING SPECTRUM TO ANY GIVEN DEGREE OF	Groupie					
ACCURACI. 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						
OF THE SPECTRUM BETWEEN TABULATED DATA POINTS.	Groupie					
MUE DESCENT VEDSION OF MUE CODE UNS MUDRE DUITE IN METCUMINC	Groupie					
THE PRESENT VERSION OF THE CODE HAS THREE BULIT-IN WEIGHTING	Groupie					
SPECTRA,						
	Groupie					
(1) CONSTANT (2) 1/F	Groupie					
(2) I/E (3) MAYMETITAN = E*EXP(-E/KT)/KT (0.0 TO 4*KT)	Groupie					
$\frac{1}{F} = \frac{1}{F} = \frac{1}{F} (\frac{1}{F}) + \frac{1}{F} (\frac{1}{$	Groupie					
$= C1/E \qquad (4 \text{ KI 10 07 KEV})$ $= C2 \times EVD (= E/M\lambda) \times SINE (SODT (E \times MD)) (\lambda BOVE 67 KEV)$	Groupie					
$= 02 \text{ EXE} \left(1/\text{WK} \right) 51\text{WE} \left(52\text{KI} \left(1/\text{WL} \right) \right) \left(\text{KEV} \right)$	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) + SIGMAO) * 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					
SIGMAU - CRUSS SECTION TO REPRESENT THE EFFECT OF ALL OTHER	Groupie					
MATERIALS AND LEARAGE (DEFINED WITHIN EACH GROUP TO BE	Groupie					
A MULITPLE OF THE UNSHIELDED TOTAL CRUSS SECTION WITHI	Groupie					
M = 3 POSTUTIVE INTEGER (0 1 2 OP 3)	Groupie					
N = A POSITIVE INTEGER (0, 1, 2 OR 5). Gr						
THE PROGRAM WILL USE ONE ENERGY DEPENDENT WEIGHTING SPECTRUM S(E)						
AND 25 DIFFERENT BONDERENKO TYPE SELF-SHIELDING FACTORS (25 SIGMA) (
AND N COMBINATIONS) TO DEFINE 25 DIFFERENT AVERAGE CROSS SECTIONS. (
	- <u>-</u>					

FOR EACH REACTION, WITHIN EACH GROUP.	Groupie
	Groupie
THE 25 WEIGHTING FUNCTIONS USED ARE	Groupie
(1) - UNSHIELDED CROSS SECTIONS (N=U)	Groupie
(2-22) - PARTIALLY SHIELDED CROSS SECTIONS (N=1, VARIOUS SIGMAU)	Groupie
THE VALUES OF SIGMAU USED WILL BE EITHER,	Groupie
(A) THE VALUES OF SIGMAU 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 I MILLION, CENTERED ON THE UNSHIELDED	Groupie
(D) THE CAME CONSTANT VALUES OF STOMAD IN FACH CROUD, THE	Groupie
(B) THE SAME CONSTANT VALUES OF SIGMAU IN EACH GROUP, THE	Groupie
ADDO 2000 1000 700 400 200 100 70 40 20 10 7	Croupie
4000, 2000, 1000, 700, 400, 200, 100, 70, 40, 20, 10, 7, 40, 20, 10, 10, 10, 10, 10, 10, 10, 10, 10, 1	Groupie
THE RANGE OF SIGMAN 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
TH THIS CASE IF THE COOSS SECTION VADIES WITH ENERCY THE	Croupie
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
THAT THE ADAME REPEATED AT A ADAME AND A ADAME ADAME ADAME ADAME AND	Groupie
FROM THE ABOVE DEFINITION OF GROUP AVERAGED CROSS SECTIONS THE	Groupie
RESUNANCE INTEGRAL 15,	Groupie
$PT = \Delta VFRACE * (INTECRAL F1 TO F2) (S(F) * MT(F) * DF)$	Groupie
ντ - Υλεγνάε (ΤΝΙΕάναι ΕΙ ΙΟ Εζ) (2(Ε).ΜΙ(Ε).Ε)	Groupie
FOR A 1/E SPECTRUM AND NO SELF-SHIELDING THIS REDUCES TO.	Grounie
	Groupie
RI = AVERAGE* LOG($E2/E1$)	Groupie
	Groupie
TN ANY OBJED CIBLIANIAN INCLUDING ADCODDUTON AND/OD ENEDCY	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 = AVERAGE* LOG(E2/E1) RТ Groupie Groupie IN ORDER TO CALCULATE RESONANCE INTEGRALS YOU MUST FOLLOW THESE Groupie Groupie STEPS, 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 ACTUAL INPUT. Groupie

RESOLVED RESONANCE REGION

IN THE RESOLVED RESONANCE REGION (ACTUALLY EVERYWHERE BUT IN THE GUNRESOLVED RESONANCE REGION) THE CROSS SECTIONS OUTPUT BY LINEAR- GUNRESOLVED RESONANCE REGION) THE CROSS SECTIONS OUTPUT BY LINEAR- GUNRESOLVED AUTORS BY THIS PROGRAM WILL YIELD ACTUAL SHIELDED AND GUNSHIELDED CROSS SECTIONS. GUNRESOLVED AUTORS GUNRESOLVED AUTORS SECTIONS. GUNRESOLVED AUTORS 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

Groupie Groupie

Groupie Groupie

Groupie

Groupie

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 SIGMAO = O TO INFINITY. THE USER MAY DEFINE THE ACCURACY Groupie REOUIRED. Groupie Groupie

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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 _____

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

MULTI-BAND PARAMETER OUTPUT FORMAT

FOR VERSIONS 92-2 AND LATER VERSIONS THE MULTI-BAND PARAMETERS ARE OUTPUT IN A SIMPLE CHARACTER FORMAT, THAT CAN BE TRANSFERRED AND USED ON VIRTUALLY ANY COMPUTER.

THE BINARY FORMAT USED IN EARLIER VERSIONS OF THIS CODE IS NO LONGER USED.

CONTACT THE AUTHOR IF YOU WOULD LIKE TO RECEIVE A SIMPLE PROGRAM Groupie TO READ THE CHARACTER FORMATTED MULTI-BAND PARAMETER FILE AND CREATE A BINARY, RANDOM ACCESS FILE FOR USE ON VIRTUALLY ANY COMPUTER.

THE FORMAT OF THE CHARACTER FILE IS,

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 D11.4 ENERGY (EV) - UPPER ENERGY LIMIT OF Ν 1-11 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 OUTPUT REPORT (BCD - 80 CHARACTERS/RECORD) 3 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 CAPTURE CROSS SECTION - ONLY FOR SELF-SHIELDING CALCULATION Groupie 13 (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 10 11 12 13 14 31 32 33 34 <i>I/O</i> 	(SCRAT ENDFB. ENDFB. (SCRAT (SCRAT (SCRAT MULTBA SHIELD MULTBA UNSHIE UNITS U IS 2, 3	CH) IN OUT CH) CH) ND.TAB ND.LST LD.LST SED 8, 9 AND BOUGH 34	10 WILL ALWAYS BE USED.	Groupie Groupie Groupie Groupie Groupie Groupie Groupie Groupie Groupie Groupie Groupie Groupie
OUTH UNIT MULT	PUT REQU IS 12, 1 IIBAND O	ESTED. 3 AND 14 UTPUT IS	WILL ONLY BE USED IF SELF-SHIELDED OR REQUESTED.	Groupie Groupie Groupie Groupie
INPU	r cards			Groupie
CARD	COLS.	FORMAT	DESCRIPTION	Groupie Groupie Groupie
1	1-11 12-22	I11 I11	<pre>SELECTION CRITERIA (0=MAT, 1=ZA) NUMBER OF GROUPS. =.GT.0 - ARBITRARY GROUP BOUNDARIES ARE READ FROM INPUT FILE (N GROUPS REQUIRE N+1 GROUP BOUNDARIES). CURRENT PROGRAM MAXIMUM IS 1000 GROUPS. BUILT-IN OPTIONS INCLUDE = 0 - TART 175 GROUPS = -1 - ORNL 50 GROUPS = -2 - ORNL 126 GROUPS = -2 - ORNL 126 GROUPS = -3 - ORNL 171 GROUPS = -4 - SAND-II 620 (665) GROUPS TO 18 MEV = -5 - SAND-II 640 (685) GROUPS TO 20 MEV = -6 - WIMS 69 GROUPS = -7 - GAM-I 68 GROUPS = -7 - GAM-I 68 GROUPS = -9 - MUFT 54 GROUPS = -10 - ABEN 28 GROUPS = -11 - TART 616 GROUPS TO 20 MEV = -12 - TART 700 GROUPS TO 1 GEV = -13 - SAND-II 665 GROUPS TO 18 MEV = -14 - SAND-II 665 GROUPS TO 20 MEV = -15 - TART 666 GROUPS TO 20 MEV = -16 - SAND-II 725 GROUPS TO 200 MEV = -17 - SAND-II 755 GROUPS TO 200 MEV = -18 - SAND-II 765 GROUPS TO 200 MEV</pre>	Groupie Groupie
1	23-33	III	<pre>MULTI-BAND SELECTOR = 0 - NO MULTI-BAND CALCULATIONS = 1 - 2 BAND. CONSERVE AV(TOT), AV(1/TOT) AND AV(1/TOT**2) = 2 - 2 BAND. CONSERVE AV(TOT), AV(1/TOT) AND AV(1/(TOT+SIGMA0)) WHERE SIGMA0 = AV(TOT) IN EACH GROUP = 3-5- MULTI-BAND FIT. CONSERVE AV(TOT) AND MINIMIZE FRACTIONAL ERROR FOR ENTIRE SELF-SHIELDING CURVE (SIGMA0 = 0 TO INFINITY) IF THE SELECTOR IS POSITIVE (1 TO 5) THE MINIMUM NUMBER OF BANDS WILL BE OUTPUT FOR EACH ISOTOPE INDEPENDENTLY. IF THE SELECTOR</pre>	Groupie Groupie Groupie Groupie Groupie Groupie Groupie Groupie Groupie Groupie Groupie 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 т11 NUMBER OF POINTS USED TO DESCRIBE ENERGY Groupie DEPENDENT WEIGHTING SPECTRUM S(E). Groupie - MAXWELLIAN - UP TO 0.1 EV = -2Groupie - 0.1 EV TO 67 KEV 1/E Groupie – ABOVE 67 KEV FISSION 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 Groupie WEIGHTING SPECTRUM). = .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 45-55 D11.4 MULTI-BAND CONVERGENCE CRITERIA. Groupie 1 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 SIGMA-0 DEFINITION SELECTOR. 56-66 1 T11 Groupie < 0 - 21 VALUES OF SIGMAO 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 67-70 1 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 - 41-66 6D11.4 IF SIGMA-0 DEFINITION SELECTOR < 0, THE NEXT Groupie 4 LINES OF INPUT ARE THE 22 VALUES OF SIGMAO, Groupie 6 PER LINE. Groupie 1-72 ENDF/B INPUT DATA FILENAME 2 A72 Groupie (STANDARD OPTION = ENDFB.IN) Groupie 1-72 ENDF/B OUTPUT DATA FILENAME 3 A72 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 SELF-SHIELDED CROSS SECTION LISTING 4 1-11 I11 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 т11 UNSHIELDED CROSS SECTIONS IN ENDF/B FORMAT Groupie = 1 - HISTOGRAM FORMAT (INTERPOLATION LAW 1) Groupie = 2 - LINEAR-LINEAR (INTERPOLATION LAW 2) Groupie UNSHIELDED CROSS SECTIONS LISTING 4 45-55 I11 Groupie = 1 - CROSS SECTIONS Groupie = 2 - RESONANCE INTEGRALS Groupie 05/01/20 - ADDED THE BELOW OPTION Groupie D11.4 IF THE STANDARD BUILT-IN SPECTRA IS USED, 56-66 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 18A4 LIBRARY IDENTIFICATION. ANY TEXT THAT THE 5 1-80 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 LOWER MAT OR ZA LIMIT 1- 6 ΙG 6-N Groupie 7- 8 I2 LOWER MF LIMIT Groupie 9-11 IЗ LOWER MT LIMIT Groupie 12-17 I11 UPPER MAT OR ZA LIMIT Groupie 18-19 I2 UPPER MF LIMIT Groupie 20-22 IЗ 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 1-66 6D11.4 ENERGY GROUP BOUNDARIES. ONLY REQUIRED IF VARY 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 1-66 6D11.4 ENERGY DEPENDENT WEIGHTING SPECTRUM. ONLY VARY Groupie REQUIRED IF THE NUMBER OF POINTS INDICATED Groupie ON FIRST CARD IS MORE THAN ONE. DATA IS Groupie Groupie GIVEN IN (ENERGY, WEIGHT) PAIRS, UP TO 3 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 -2 0 1.00000-03 0 0 0 Groupie ENDFB.IN Groupie ENDFB.OUT Groupie 1 1 1 1 Groupie 1 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 -2 0 1.00000-03 0 0 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 0 Groupie -1 (USE STANDARD FILENAME = ENDFB.IN) Groupie (USE STANDARD FILENAME = ENDFB.OUT) Groupie 0 0 0 1 Ω 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