======================================================================= Sigma1

Sigma1

PROGRAM SIGMA1 Sigma1

============== Sigma1

VERSION 73-1 (MARCH 1973) Sigma1

VERSION 76-1 (FEBRUARY 1976) Sigma1

VERSION 76-2 (OCTOBER 1976) Sigma1

VERSION 77-1 (JANUARY 1977) Sigma1

VERSION 78-1 (JULY 1978) Sigma1

VERSION 79-1 (JULY 1979) CDC-7600 AND CRAY-1 VERSION. Sigma1

VERSION 80-1 (MAY 1980) IBM, CDC AND CRAY VERSION Sigma1

VERSION 80-2 (DECEMBER 1980)IMPROVED BASED ON USER COMMENTS. Sigma1

VERSION 81-1 (MARCH 1981) DOUBLE PRECISION IBM VERSION Sigma1

VERSION 81-2 (AUGUST 1981) IMPROVED IBM SPEED AND STABILITY Sigma1

VERSION 82-1 (JANUARY 1982) IMPROVED COMPUTER COMPATIBILITY Sigma1

VERSION 83-1 (JANUARY 1983)\*MAJOR RE-DESIGN. Sigma1

\*PAGE SIZE INCREASED - 1002 TO 2004. Sigma1

\*ELIMINATED COMPUTER DEPENDENT CODING. Sigma1

\*NEW, MORE COMPATIBLE I/O UNIT NUMBER. Sigma1

\*ADDED STANDARD ALLOWABLE ERROR OPTION Sigma1

(CURRENTLY 0.1 PER-CENT). Sigma1

\*UNRESOLVED RESONANCE REGION COPIED. Sigma1

\*1/V EXTENSION OF CROSS SECTIONS Sigma1

OUTSIDE OF TABULATED ENERGY RANGE AND Sigma1

INTO UNRESOLVED ENERGY RANGE. Sigma1

VERSION 83-2 (OCTOBER 1983)\*IMPROVED BASED ON USER COMMENTS. Sigma1

VERSION 84-1 (APRIL 1984) \*IMPROVED NUMERICAL STABILITY. Sigma1

\*PARTIAL EVALUATION TREATMENT. Sigma1

VERSION 85-1 (APRIL 1985) \*ITERATE TO CONVERGENCE (USING THE SAME Sigma1

ENERGY GRID FOR HOT CROSS SECTION AS Sigma1

COLD CROSS SECTIONS WAS FOUND TO BE Sigma1

INACCURATE). Sigma1

\*NEW FASTER HIGH ENERGY BROADENING. Sigma1

\*UPDATED FOR ENDF/B-VI FORMATS. Sigma1

\*SPECIAL I/O ROUTINES TO GUARANTEE Sigma1

ACCURACY OF ENERGY. Sigma1

\*DOUBLE PRECISION TREATMENT OF ENERGY Sigma1

(REQUIRED FOR NARROW RESONANCES). Sigma1

VERSION 85-2 (AUGUST 1985) \*FORTRAN-77/H VERSION Sigma1

VERSION 86-1 (JANUARY 1986)\*ENERGY DEPENDENT SCATTERING RADIUS Sigma1

VERSION 88-1 (JULY 1988) \*OPTION...INTERNALLY DEFINE ALL I/O Sigma1

FILE NAMES (SEE, SUBROUTINE FILEIO Sigma1

FOR DETAILS). Sigma1

\*IMPROVED BASED ON USER COMMENTS. Sigma1

VERSION 89-1 (JANUARY 1989)\*PSYCHOANALYZED BY PROGRAM FREUD TO Sigma1

INSURE PROGRAM WILL NOT DO ANYTHING Sigma1

CRAZY. Sigma1

\*UPDATED TO USE NEW PROGRAM CONVERT Sigma1

KEYWORDS. Sigma1

\*ADDED LIVERMORE CIVIC COMPILER Sigma1

CONVENTIONS. Sigma1

VERSION 90-1 (JUNE 1990) \*UPDATED BASED ON USER COMMENTS Sigma1

\*ADDED FORTRAN SAVE OPTION Sigma1

\*NEW MORE CONSISTENT ENERGY OUTPUT Sigma1

ROUTINES Sigma1

VERSION 91-1 (JULY 1991) \*WARNING...INPUT PARAMETER FORMAT Sigma1

HAS BEEN CHANGED - SEE BELOW FOR Sigma1

DETAILS. Sigma1

\*ADDED CHARGED PARTICLE PROJECTILES Sigma1

\*OUTPUT ENERGY RANGE IS ALWAYS AT Sigma1

LEAST AS LARGE AS INPUT ENERGY RANGE. Sigma1

\*NO 1/V EXTENSION OF CROSS SECTIONS Sigma1

FROM UNRESOLVED ENERGY RANGE. Sigma1

VERSION 92-1 (JANUARY 1992)\*INSURE MINIMUM AND MAXIMUM CROSS Sigma1

SECTIONS ARE ALWAYS KEPT (NOT THINNED) Sigma1

\*MT=19 (FIRST CHANCE FISSION) TREATED Sigma1

THE SAME AS FISSION. Sigma1

\*VARIABLE MINIMUM CROSS SECTION OF Sigma1

INTEREST - TO ALLOW SMALL CROSS Sigma1

SECTIONS NEAR THRESHOLDS TO BE Sigma1

TREATED PROPERLY. Sigma1

\*ALL ENERGIES INTERNALLY ROUNDED PRIOR Sigma1

TO CALCULATIONS. Sigma1

\*COMPLETELY CONSISTENT I/O AND ROUNDING Sigma1

ROUTINES - TO MINIMIZE COMPUTER Sigma1

DEPENDENCE. Sigma1

VERSION 92-2 (JULY 1992) \*CORRECTED BUG ASSOCIATED WITH Sigma1

THRESHOLD REACTIONS. Sigma1

\*UNRESOLVED REGION COPIED WITHOUT Sigma1

THINNING (IT SHOULD BE EXACTLY THE Sigma1

SAME AT ALL TEMPERATURES). Sigma1

\*NO THINNING OF REACTIONS (MT) THAT Sigma1

WERE NOT BROADENED. Sigma1

VERSION 93-1 (APRIL 1993) \*INCREASED PAGE SIZE FROM 2004 Sigma1

TO 24000 ENERGY PONTS. Sigma1

VERSION 94-1 (JANUARY 1994)\*VARIABLE ENDF/B DATA FILENAMES Sigma1

TO ALLOW ACCESS TO FILE STRUCTURES Sigma1

(WARNING - INPUT PARAMETER FORMAT Sigma1

HAS BEEN CHANGED) Sigma1

\*CLOSE ALL FILES BEFORE TERMINATING Sigma1

(SEE, SUBROUTINE ENDIT) Sigma1

VERSION 96-1 (JANUARY 1996) \*COMPLETE RE-WRITE Sigma1

\*IMPROVED COMPUTER INDEPENDENCE Sigma1

\*ALL DOUBLE PRECISION Sigma1

\*ON SCREEN OUTPUT Sigma1

\*UNIFORM TREATMENT OF ENDF/B I/O Sigma1

\*IMPROVED OUTPUT PRECISION Sigma1

\*DEFINED SCRATCH FILE NAMES Sigma1

\*ALWAYS INCLUDE THERMAL VALUE Sigma1

VERSION 97-1 (APRIL 1997) \*OPTIONALLY SET NEGATIVE CROSS Sigma1

SECTIONS = 0 ON INPUT AND Sigma1

OUTPUT. Sigma1

\*INCREASED PAGE SIZE FROM 24000 Sigma1

TO 60000 ENERGY POINTS. Sigma1

VERSION 99-1 (MARCH 1999) \*CORRECTED CHARACTER TO FLOATING Sigma1

POINT READ FOR MORE DIGITS Sigma1

\*UPDATED TEST FOR ENDF/B FORMAT Sigma1

VERSION BASED ON RECENT FORMAT CHANGE Sigma1

\*TREAT LOW ENERGY INITIAL CROSS Sigma1

SECTIONS AS LOG-LOG INTERPOLABLE Sigma1

\*CONSTANT (RATHER THAN 1/V) EXTENSION Sigma1

TO HIGHER ENERGY. Sigma1

\*UPDATED CONSTANTS BASED ON CSEWG Sigma1

SUBCOMMITTEE RECOMMENDATIONS Sigma1

\*GENERAL IMPROVEMENTS BASED ON Sigma1

USER FEEDBACK Sigma1

VERSION 99-2 (JUNE 1999) \*EXTENDED RANGE OF INTEGRALS FROM 4 Sigma1

TO 5 UNITS ON EACH SIDE OF ENERGY Sigma1

POINT TO ALLOW FOR LARGER VARIATION Sigma1

IN THE LOCAL CROSS SECTION Sigma1

\*ASSUME ENDF/B-VI, NOT V, IF MISSING Sigma1

MF=1, MT-451. Sigma1

VERSION 99-3 (OCTOBER 1999))\*IMPROVED ERFC FUNCTION DEFINITION. Sigma1

I THANK BOB MACFARLANE (LANL) FOR Sigma1

SUPPLYING A MORE ACCURATE ERFC Sigma1

FUNCTION. Sigma1

VERS. 2000-1 (FEBRUARY 2000)\*CORRECTED LOW ENERGY INTERPOLATION Sigma1

FOR NON-POSITIVE CROSS SECTIONS Sigma1

\*GENERAL IMPROVEMENTS BASED ON Sigma1

USER FEEDBACK Sigma1

VERS. 2002-1 (MAY 2002) \*OPTIONAL INPUT PARAMETERS Sigma1

VERS. 2004-1 (JAN. 2004) \*OPTIONALLY IGNORE UNRESOLVED REGION Sigma1

\*CORRECTED PROBLEM AT THE RESOLVED/ Sigma1

UNRESOLVED ENERGY BOUNDARY. Sigma1

\*CORRECTED HIGH ENERGY CONSTANT CROSS Sigma1

SECTION EXTENSION. Sigma1

\*TIGHTER CRITERIA FOR INITIAL ENERGY Sigma1

POINT SPACING Sigma1

\*TEMPERATURE DEPENDENT ENERGY POINT Sigma1

SPACING. Sigma1

\*ADDED NEW REICH-MOORE (LRF=7) TO Sigma1

FILE2 TO ALLOW COPY TO FIND ANY Sigma1

FOLLOWING UNRESOLVED PARAMETERS Sigma1

VERS. 2005-1 (JUNE 2005) \*CORRECTED ERROR IN EHOT3 EQUIVALENCE Sigma1

TO EHOT - THIS ONLY EFFECTS VERY BIG Sigma1

OUTPUT FILES. Sigma1

VERS. 2007-1 (JAN. 2007) \*CHECKED AGAINST ALL ENDF/B-VII. Sigma1

\*INCREASED PAGE SIZE FROM 60,000 Sigma1

TO 360,000 ENERGY POINTS. Sigma1

VERS. 2008-1 (APRIL 2008) \*1/2 INITIAL ENERGY POINT SPACING Sigma1

\*72 CHARACTER FILE NAMES. Sigma1

VERS. 2010-1 (Apr. 2010) \*ASSUME LOW ENERGY LOG-LOG VARIATION Sigma1

UP TO 1/A (eV) FOR ALL BUT TOTAL AND Sigma1

ELASTIC. Sigma1

\*CHANGED DEFAULT UNCERTAINTY TO 0.01% Sigma1

FROM 0.1% Sigma1

\*ALLOW MULTIPLE, ADJACENT UNRESOLVED Sigma1

RESONANCE REGIONS = COMBINE INTO ONE Sigma1

LARGER ENERGY RANGE TO COPY. Sigma1

\*DO NOT BROADEN SECTIONS THAT START Sigma1

ABOVE 1 MILLION KT - PREVIOUSLY IT Sigma1

WAS ASSUMED TOTAL, ELASTIC, CAPTURE Sigma1

AND FISSION, AND LARGE SECTIONS (OVER Sigma1

10,000 ENERGY POINTS) WOULD BROADEN. Sigma1

VERS. 2012-1 (Aug. 2012) \*CHANGE COPY CRITERIA TO HANDLE NEW Sigma1

(N,N') DATA = THRESHOLD MAY BE VERY Sigma1

HIGH (OLD CRITERIA) BUT INCLUDES MANY Sigma1

TABULATED ENERGY POINTS (NEW ADDED Sigma1

CRITERIA). Sigma1

\*ADDED STOP IF INCIDENT PARTICLE DATA Sigma1

CANNOT BE DOPPLER BROADENED, E.G., Sigma1

PHOTON INCIDENT. Sigma1

\*Added CODENAME Sigma1

\*32 and 64 bit Compatible Sigma1

\*Added ERROR stop Sigma1

VERS. 2013-1 (Nov. 2013) \*Added NO broadening above 10 MeV - Sigma1

this is to handle newer evaluations Sigma1

that extend to higher energies and Sigma1

may do "strange" things to stop one Sigma1

MT and then include it as part of Sigma1

a sum at higher energies, e.g. this Sigma1

change will copy ALL points above Sigma1

10 MeV, thus avoiding problems near Sigma1

transistion energies at 20. 30, etc. Sigma1

MeV or higher energies. Sigma1

VERS. 2015-1 (Jan. 2015) \*Replaced ALL 3 way IF Statements. Sigma1

\*Replaced ALL LOGICAL by INTEGER. Sigma1

\*Extended OUT9. Sigma1

Sigma1

OWNED, MAINTAINED AND DISTRIBUTED BY Sigma1

------------------------------------ Sigma1

THE NUCLEAR DATA SECTION Sigma1

INTERNATIONAL ATOMIC ENERGY AGENCY Sigma1

P.O. BOX 100 Sigma1

A-1400, VIENNA, AUSTRIA Sigma1

EUROPE Sigma1

Sigma1

ORIGINALLY WRITTEN BY Sigma1

------------------------------------ Sigma1

Dermott E. Cullen Sigma1

Sigma1

PRESENT CONTACT INFORMATION Sigma1

--------------------------- Sigma1

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Sigma1

Acknowledgement 2004 Sigma1

-------------------- Sigma1

Currently almost all improvements to this code are based upon Sigma1

feedback from code users who report problems. This feedback Sigma1

benefits ALL users of this code, and ALL users are encouraged Sigma1

to report problems. Sigma1

Sigma1

Improvements on the 2004 version of this code based on user Sigma1

feedback including, Sigma1

1) Bret Beck - reported a problem at the resolved/unresolved Sigma1

energy boundary. Sigma1

2) S. Ganesan - reported a problem for small temperature changes. Sigma1

Sigma1

AUTHORS MESSAGE Sigma1

--------------- Sigma1

THE REPORT DESCRIBED ABOVE IS THE LATEST PUBLISHED DOCUMENTATION Sigma1

FOR THIS PROGRAM. HOWEVER, THE COMMENTS BELOW SHOULD BE CONSIDERED Sigma1

THE LATEST DOCUMENTATION INCLUDING ALL RECENT IMPROVEMENTS. PLEASE Sigma1

READ ALL OF THESE COMMENTS BEFORE IMPLEMENTATION, PARTICULARLY Sigma1

THE COMMENTS CONCERNING MACHINE DEPENDENT CODING. Sigma1

Sigma1

AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER Sigma1

INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE Sigma1

OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT Sigma1

IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY Sigma1

COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO Sigma1

IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF Sigma1

THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR Sigma1

COMPUTER. Sigma1

Sigma1

PURPOSE Sigma1

------- Sigma1

THIS PROGRAM IS DESIGNED TO DOPPLER BROADEN NEUTRON INDUCED Sigma1

CROSS SECTIONS. EACH SECTION OF CROSS SECTIONS (FILE 3) IS READ Sigma1

FROM THE ENDF/B FORMAT. THE DATA IS DOPPLER BROADENED, THINNED Sigma1

AND OUTPUT IN THE ENDF/B FORMAT. Sigma1

Sigma1

IN THE FOLLOWING DISCUSSION FOR SIMPLICITY THE ENDF/B TERMINOLOGY Sigma1

---ENDF/B TAPE---WILL BE USED. IN FACT THE ACTUAL MEDIUM MAY BE Sigma1

TAPE, CARDS, DISK OR ANY OTHER MEDIUM. Sigma1

Sigma1

ENDF/B FORMAT Sigma1

------------- Sigma1

THIS PROGRAM ONLY USES THE ENDF/B BCD OR CARD IMAGE FORMAT (AS Sigma1

OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION Sigma1

OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II, III, IV OR V FORMAT). Sigma1

Sigma1

IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B Sigma1

FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS Sigma1

ASSUMED THAT THE MAT, MF AND MT ON EACH CARD IS CORRECT. SEQUENCE Sigma1

NUMBERS (COLUMNS 76-80) ARE IGNORED ON INPUT, BUT WILL BE Sigma1

CORRECTLY OUTPUT ON ALL CARDS. THE FORMAT OF SECTION MF=1, MT=451 Sigma1

AND ALL SECTIONS OF MF=3 MUST BE CORRECT. THE PROGRAM COPIES ALL Sigma1

OTHER SECTION OF DATA AS HOLLERITH AND AS SUCH IS INSENSITIVE TO Sigma1

THE CORRECTNESS OR INCORRECTNESS OF ALL OTHER SECTIONS. Sigma1

Sigma1

ALL CROSS SECTIONS THAT ARE USED BY THIS PROGRAM MUST BE TABULATED Sigma1

AND LINEARLY INTERPOLABLE IN ENERGY AND CROSS SECTION (ENDF/B Sigma1

INTERPOLATION LAW 2). FILE 3 CROSS SECTIONS MAY BE MADE LINEARLY Sigma1

INTERPOLABLE BY USING PROGRAM LINEAR (UCRL-50400, VOL.17, PART A). Sigma1

FILE 2 RESONANCE PARAMETERS MAY BE USED TO RECONSTRUCT ENERGY Sigma1

DEPENDENT CROSS SECTIONS AND ADD IN FILE 3 BACKGROUND CROSS Sigma1

SECTIONS TO DEFINE LINEARLY INTERPOLABLE CROSS SECTIONS BY USING Sigma1

PROGRAM RECENT (UCRL-50400, VOL. 17, PART C). IF THIS PROGRAM Sigma1

FINDS THAT THE FILE 3 CROSS SECTIONS ARE NOT LINEARLY INTERPOLABLE Sigma1

THIS PROGRAM WILL TERMINATE EXECUTION. Sigma1

Sigma1

UNRESOLVED RESONANCE REGION Sigma1

--------------------------- Sigma1

IN THE UNRESOLVED RESONANCE REGION IT IS NOT POSSIBLE TO EXACTLY Sigma1

DEFINE THE ENERGY DEPENDENCE OF THE CROSS SECTIONS. THE AVERAGE Sigma1

WIDTHS AND SPACINGS GIVEN IN ENDF/B ARE ONLY ADEQUATE TO DEFINE Sigma1

AVERAGE VALUES OF THE CROSS SECTIONS. THEREFORE ALL CROSS SECTIONS Sigma1

IN THE ENDF/B FORMAT FOR THE UNRESOLVED REGION ARE REALLY AVERAGE Sigma1

VALUES WHICH CANNOT BE DOPPLER BROADENED USING THE SIGMA1 METHOD Sigma1

(WHICH REQUIRES TABULATED, LINEARLY INTERPOLABLE, ENERGY DEPENDENT Sigma1

CROSS SECTIONS. Sigma1

Sigma1

THEREFORE, Sigma1

(1) ALL TABULATED POINTS WITHIN THE UNRESOLVED RESONANCE REGION Sigma1

WILL BE COPIED, WITHOUT MODIFICATION OR BROADENING. ADOPTION OF Sigma1

THIS CONVENTION WILL ALLOW SUBSEQUENT PROGRAMS TO PROPERLY DEFINE Sigma1

SELF-SHIELDED, DOPPLER BROADENED CROSS SECTIONS IN THE UNRESOLVED Sigma1

RESONANCE REGION. Sigma1

(2) CROSS SECTIONS WILL BE EXTENDED AS 1/V ABOVE THE UPPER ENERGY Sigma1

LIMIT OF THE RESOLVED RESONANCE REGION AND BELOW THE LOWER ENERGY Sigma1

LIMIT OF THE CONTINUUUM REGION (I.E. INTO THE UNRESOLVED Sigma1

RESONANCE REGION). THIS CONVENTION WILL GUARANTEE A SMOOTH Sigma1

BEHAVIOR CLOSE TO THE UNRESOLVED RESONANCE REGION BOUNDARIES. Sigma1

Sigma1

OUTPUT FORMAT Sigma1

------------- Sigma1

IN THIS VERSION OF SIGMA1 ALL FILE 3 ENERGIES WILL BE OUTPUT IN Sigma1

F (INSTEAD OF E) FORMAT IN ORDER TO ALLOW ENERGIES TO BE WRITTEN Sigma1

WITH UP TO 9 DIGITS OF ACCURACY. IN PREVIOUS VERSIONS THIS WAS AN Sigma1

OUTPUT OPTION. HOWEVER USE OF THIS OPTION TO COMPARE THE RESULTS Sigma1

OF ENERGIES WRITTEN IN THE NORMAL ENDF/B CONVENTION OF 6 DIGITS Sigma1

TO THE 9 DIGIT OUTPUT FROM THIS PROGRAM DEMONSTRATED THAT FAILURE Sigma1

TO USE THE 9 DIGIT OUTPUT CAN LEAD TO LARGE ERRORS IN THE DATA Sigma1

JUST DUE TO TRANSLATION OF THE ENERGIES TO THE ENDF/B FORMAT. Sigma1

Sigma1

CONTENTS OF OUTPUT Sigma1

------------------ Sigma1

ENTIRE EVALUATIONS ARE OUTPUT, NOT JUST THE BROADENED FILE 3 Sigma1

CROSS SECTIONS, E.G. ANGULAR AND ENERGY DISTRIBUTIONS ARE ALSO Sigma1

INCLUDED. Sigma1

Sigma1

DOCUMENTATION Sigma1

------------- Sigma1

THE FACT THAT THIS PROGRAM HAS OPERATED ON THE DATA IS DOCUMENTED Sigma1

BY THE ADDITION OF THREE COMMENTS CARDS AT THE END OF EACH Sigma1

HOLLERITH SECTION IN THE FORM Sigma1

Sigma1

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* PROGRAM SIGMA1 (2015-1) \*\*\*\*\*\*\*\*\*\*\*\*\*\*\* Sigma1

DATA DOPPLER BROADENED TO 300.0 KELVIN AND Sigma1

DATA THINNED TO WITHIN AN ACCURACY OF 0.1 PER-CENT Sigma1

Sigma1

THE ORDER OF ALL SIMILAR COMMENTS (FROM LINEAR,RECENT AND GROUPY) Sigma1

REPRESENTS A COMPLETE HISTORY OF ALL OPERATIONS PERFORMED ON Sigma1

THE DATA. Sigma1

Sigma1

THESE COMMENT CARDS ARE ONLY ADDED TO EXISTING HOLLERITH SECTIONS, Sigma1

I.E., THIS PROGRAM WILL NOT CREATE A HOLLERITH SECTION. THE FORMAT Sigma1

OF THE HOLLERITH SECTION IN ENDF/B-V DIFFERS FROM THE THAT OF Sigma1

EARLIER VERSIONS OF ENDF/B. BY READING AN EXISTING MF=1, MT=451 Sigma1

IT IS POSSIBLE FOR THIS PROGRAM TO DETERMINE WHICH VERSION OF Sigma1

THE ENDF/B FORMAT THE DATA IS IN. WITHOUT HAVING A SECTION OF Sigma1

MF=1, MT=451 PRESENT IT IS IMPOSSIBLE FOR THIS PROGRAM TO Sigma1

DETERMINE WHICH VERSION OF THE ENDF/B FORMAT THE DATA IS IN, AND Sigma1

AS SUCH IT IS IMPOSSIBLE FOR THE PROGRAM TO DETERMINE WHAT FORMAT Sigma1

SHOULD BE USED TO CREATE A HOLLERITH SECTION. Sigma1

Sigma1

REACTION INDEX Sigma1

-------------- Sigma1

THIS PROGRAM DOES NOT USE THE REACTION INDEX WHICH IS GIVEN IN Sigma1

SECTION MF=1, MT=451 OF EACH EVALUATION. Sigma1

Sigma1

THIS PROGRAM DOES NOT UPDATE THE REACTION INDEX IN MF=1, MT=451. Sigma1

THIS CONVENTION HAS BEEN ADOPTED BECAUSE MOST USERS DO NOT Sigma1

REQUIRE A CORRECT REACTION INDEX FOR THEIR APPLICATIONS AND IT WAS Sigma1

NOT CONSIDERED WORTHWHILE TO INCLUDE THE OVERHEAD OF CONSTRUCTING Sigma1

A CORRECT REACTION INDEX IN THIS PROGRAM. HOWEVER, IF YOU REQUIRE Sigma1

A REACTION INDEX FOR YOUR APPLICATIONS, AFTER RUNNING THIS PROGRAM Sigma1

YOU MAY USE PROGRAM DICTIN TO CREATE A CORRECT REACTION INDEX. Sigma1

Sigma1

SECTION SIZE Sigma1

------------ Sigma1

SINCE THIS PROGRAM USES A LOGICAL PAGING SYSTEM THERE IS NO LIMIT Sigma1

TO THE NUMBER OF POINTS IN ANY SECTION, E.G., THE TOTAL CROSS Sigma1

SECTION MAY BE REPRESENTED BY 200,000 DATA POINTS. Sigma1

Sigma1

SELECTION OF DATA Sigma1

----------------- Sigma1

THE PROGRAM SELECTS MATERIALS TO BE BROADENED BASED EITHER ON Sigma1

MAT (ENDF/B MAT NO.) OR ZA. THE PROGRAM ALLOWS UP TO 100 MAT OR Sigma1

ZA RANGES TO BE SPECIFIED. THE PROGRAM WILL ASSUME THAT THE Sigma1

ENDF/B TAPE IS IN EITHER MAT OR ZA ORDER, WHICHEVER CRITERIA IS Sigma1

USED TO SELECT MATERIALS, AND WILL TERMINATE WHEN A MAT OR ZA Sigma1

IS FOUND THAT IS ABOVE THE RANGE OF ALL REQUESTS. Sigma1

Sigma1

ENERGY GRID OF BROADENED DATA Sigma1

----------------------------- Sigma1

THE ENERGY GRID FOR THE DOPPLER BROADENED CROSS SECTIONS IS Sigma1

SELECTED TO INSURE THAT THE BROADENED DATA IS LINEAR-LINEAR Sigma1

INTERPOLABLE. AS SUCH THE ENERGY GRID FOR THE BROADENED DATA Sigma1

MAY NOT BE THE SAME AS THE ENERGY GRID FOR THE ORIGINAL Sigma1

UNBROADENED DATA. GENERALLY AFTER BROADENING THERE WILL BE Sigma1

FEWER DATA POINTS IN THE RESONANCE REGION, BUT AT LOW ENERGY Sigma1

THERE MAY BE MORE POINTS, DUE TO THE 1/V LOW ENERGY EFFECT Sigma1

CREATED BY DOPPLER BROADENING. Sigma1

Sigma1

EFFECTIVE TEMERATURE INCREASE Sigma1

----------------------------- Sigma1

IF THE ORIGINAL DATA IS NOT AT ZERO KELVIN THE PROGRAM WILL Sigma1

BROADEN THE DATA BY THE EFFECTIVE TEMPERATURE DIFFENCE TO THE Sigma1

FINAL TEMPERATURE. IF THE DATA IS ALREADY AT A TEMPERATURE THAT Sigma1

IS HIGHER THAN THE FINAL TEMPERATURE DOPPLER BROADENING IS Sigma1

NATURALLY NOT PERFORMED AND THE TEMPERATURE IN THE SECTION IS LEFT Sigma1

AT ITS ORIGINAL VALUE. Sigma1

Sigma1

MULTIPLE FINAL TEMPERATURES Sigma1

--------------------------- Sigma1

THE PRESENT VERSION ONLY DOPPLER BROADENS TO ONE FINAL TEMPERATURE Sigma1

(IF THERE IS SUFFICIENT INTEREST EXPRESSED BY USERS FUTURE Sigma1

VERSION MAY BROADEN TO MULTIPLE TEMPERATURES. PLEASE Sigma1

CONTACT THE AUTHOR IF YOU ARE INTERESTED IN A MULTIPLE Sigma1

TEMPERATURE OPTION). Sigma1

Sigma1

PROGRAM OPERATION Sigma1

----------------- Sigma1

EACH SECTION OF FILE 3 DATA IS CONSIDERED SEPERATELY. THE DATA Sigma1

IS READ AND DOPPLER BROADENED A PAGE AT A TIME (ONE PAGE IS Sigma1

60000 DATA POINTS). UP TO THREE PAGES OF DATA MAY BE IN THE CORE Sigma1

AT ANY GIVEN TIME, THE PAGE BEING BROADENED, THE PAGE BELOW IT Sigma1

IN ENERGY AND THE PAGE ABOVE IT IN ENERGY. AFTER A PAGE HAS BEEN Sigma1

BROADENED IT IS THINNED, IF THE ENTIRE SECTION CONTAINS ONLY Sigma1

ONE PAGE OR LESS, IT WILL STILL BE CORE RESIDENT AND WILL BE Sigma1

WRITTEN DIRECTLY FROM CORE TO THE OUTPUT TAPE. IF THE BROADENED, Sigma1

THINNED SECTION IS LARGER THAN A PAGE, AFTER A PAGE HAS BEEN Sigma1

BROADENED AND THINNED IT IS WRITTEN TO A SCRATCH FILE. AFTER THE Sigma1

ENTIRE SECTION HAS BEEN BROADENED AND THINNED THE DATA IS READ Sigma1

FROM SCRATCH TO CORE, ONE PAGE AT A TIME, THE OUTPUT TO THE OUTPUT Sigma1

TAPE. Sigma1

Sigma1

ALLOWABLE ERROR Sigma1

--------------- Sigma1

AFTER DOPPLER BROADENING THE CROSS SECTION IN THE RESONANCE REGION Sigma1

WILL GENERALLY BE MUCH SMOOTHER THAN THE UNBROADENED DATA AND CAN Sigma1

BE REPRESENTED TO THE SAME ACCURACY BY A SMALLER NUMBER OF ENERGY Sigma1

POINTS. THEREFORE AFTER DOPPLER BROADENING THE DATA CAN BE THINNED Sigma1

WITH ESSENTIALLY NO LOSE OF INFORMATION. Sigma1

Sigma1

THE ALLOWABLE ERROR MAY BE ENERGY INDEPENDENT (CONSTANT) OR ENERGY Sigma1

DEPENDENT. THE ALLOWABLE ERROR IS DESCRIBED BY A TABULATED Sigma1

FUNCTION OF UP TO 20 (ENERGY,ERROR) PAIRS AND LINEAR INTERPOLATION Sigma1

BETWEEN TABULATED POINTS. IF ONLY ONE TABULATED POINT IS GIVEN THE Sigma1

ERROR WILL BE CONSIDERED CONSTANT OVER THE ENTIRE ENERGY RANGE. Sigma1

WITH THIS ENERGY DEPENDENT ERROR ONE MAY OPTIMIZE THE OUTPUT FOR Sigma1

ANY GIVEN APPLICATION BY USING A SMALL ERROR IN THE ENERGY RANGE Sigma1

OF INTEREST AND A LESS STRINGENT ERROR IN OTHER ENERGY RANGES. Sigma1

Sigma1

INPUT FILES Sigma1

----------- Sigma1

UNIT DESCRIPTION Sigma1

---- ----------- Sigma1

2 INPUT CARDS (BCD - 80 CHARACTERS/RECORD) Sigma1

10 ORIGINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD) Sigma1

Sigma1

OUTPUT FILES Sigma1

------------ Sigma1

UNIT DESCRIPTION Sigma1

---- ----------- Sigma1

3 OUTPUT REPORT (BCD - 120 CHARACTERS/RECORD) Sigma1

11 FINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD) Sigma1

Sigma1

SCRATCH FILES Sigma1

------------- Sigma1

UNIT DESCRIPTION Sigma1

---- ----------- Sigma1

12 SCRATCH FILE FOR BROADENED DATA Sigma1

(BINARY - 180000 WORDS/RECORD - DOUBLE PRECISION/ Sigma1

42000 WORDS/RECORD - SINLGE PRECISION) Sigma1

Sigma1

OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILEIO) Sigma1

---------------------------------------------------- Sigma1

UNIT FILE NAME Sigma1

---- ---------- Sigma1

2 SIGMA1.INP Sigma1

3 SIGMA1.LST Sigma1

10 ENDFB.IN Sigma1

11 ENDFB.OUT Sigma1

12 (SCRATCH) Sigma1

Sigma1

INPUT CARDS Sigma1

----------- Sigma1

CARD COLS. DESCRIPTION Sigma1

---- ----- ----------- Sigma1

1 1-11 SELECTION CRITERIA (0=MAT, 1=ZA) Sigma1

12-22 MONITOR MODE SELECTOR Sigma1

= 0 - NORMAL OPERATION Sigma1

= 1 - MONITOR PROGRESS OF DOPPLER BROADENING OF DATA. Sigma1

EACH TIME A PAGE OF DATA POINTS IS WRITTEN TO Sigma1

THE SCRATCH FILE PRINT OUT THE TOTAL NUMBER OF Sigma1

POINTS ON SCRATCH AND THE LOWER AND UPPER Sigma1

ENERGY LIMITS OF THE PAGE (THIS OPTION MAY BE Sigma1

USED IN ORDER TO MONITOR THE EXECUTION SPEED Sigma1

OF LONG RUNNING JOBS). Sigma1

23-33 KELVIN TEMPERATURE Sigma1

34-44 MINIMUM CROSS SECTION OF INTEREST Sigma1

(DEFAULT VALUE = 1.0E-10 BARNS). Sigma1

45-55 NEGATIVE CROSS SECTION TREATMENT Sigma1

= 0 - O.K. Sigma1

= 1 - SET = 0 Sigma1

56-66 UNRESOLVED RESONANCE REGION TREATMENT Sigma1

= 0 - COPY (NO BROADENING) Sigma1

= 1 - IGNORE (BROADEN) Sigma1

2 1-72 ENDF/B INPUT DATA FILENAME Sigma1

(STANDARD OPTION = ENDFB.IN) Sigma1

3 1-72 ENDF/B OUTPUT DATA FILENAME Sigma1

(STANDARD OPTION = ENDFB.OUT) Sigma1

4-N 1-11 LOWER MAT OR ZA LIMIT Sigma1

12-22 UPPER MAT OR ZA LIMIT Sigma1

UP TO 100 MAT OR ZA RANGES MAY BE SPECIFIED, ONE Sigma1

RANGE PER CARD. THE LIST OF RANGES IS TERMINATED BY Sigma1

A BLANK CARD. IF THE UPPER LIMIT IS LESS THAN THE Sigma1

LOWER LIMIT THE UPPER LIMIT WILL BE SET EQUAL TO THE Sigma1

LOWER LIMIT. IF THE FIRST REQUEST CARD IS BLANK IT Sigma1

WILL TERMINATE THE LIST OF REQUESTS AND CAUSE ALL Sigma1

DATA TO BE RETRIEVED (SEE EXAMPLE INPUT). Sigma1

VARY 1-11 ENERGY FOR ERROR LAW Sigma1

12-22 ERROR FOR ERROR LAW Sigma1

THE ACCEPTABLE LINEARIZING ERROR CAN BE GIVEN AS AN Sigma1

ENERGY DEPENDENT FUNCTION SPECIFIED BY UP TO 20 Sigma1

(ENERGY,ERROR) PAIRS AND LINEAR INTERPOLATION Sigma1

TABULATE POINTS. ENERGIES MUST BE IN ASCENDING ORDER. Sigma1

THE ERROR LAW IS TERMINATED BY A BLANK CARD. IF THE Sigma1

FIRST ERROR LAW CARD IS BLANK IT WILL TERMINATE THE Sigma1

ERROR LAW AND THE ERROR WILL BE TREATED AS ENERGY Sigma1

INDEPENDENT, EQUAL TO ZERO, WHICH INDICATES THAT THE Sigma1

BROADENED DATA SHOULD NOT BE THINNED. Sigma1

Sigma1

EXAMPLE INPUT NO. 1 Sigma1

------------------- Sigma1

BROADEN ALL URANIUM ISOTOPES AND THORIUM-232 TO 300 KELVIN. FROM Sigma1

0 TO 100 EV THIN OUTPUT DATA TO 0.1 PER-CENT ACCURACY. FROM 100 EV Sigma1

TO 1 KEV VARY THE ERROR BETWEEN 0.1 AND 1 PER-CENT. ABOVE 1 KEV Sigma1

USE 1 PER-CENT ACCURACY. Sigma1

Sigma1

EXPLICITLY SPECIFY THE STANDARD FILENAMES. Sigma1

Sigma1

THE FOLLOWING 11 CARDS ARE REQUIRED Sigma1

Sigma1

1 0 3.00000+ 2 Sigma1

ENDFB.IN Sigma1

ENDFB.OUT Sigma1

92000 92999 Sigma1

90232 (UPPER LIMIT WILL AUTOMATICALLY BE DEFINED) Sigma1

(BLANK CARD INDICATES END OF REQUEST LIST) Sigma1

0.00000+ 0 1.00000-03 Sigma1

1.00000+ 2 1.00000-03 Sigma1

1.00000+ 3 1.00000-02 Sigma1

1.00000+ 9 1.00000-02 Sigma1

(BLANK CARD INDICATES END OF ERROR LAW) Sigma1

Sigma1

EXAMPLE INPUT NO. 2 Sigma1

------------------- Sigma1

BROADEN ALL DATA TO 300 KELVIN AND DO NOT THIN THE BROADEN DATA. Sigma1

ALL OF THE STANDARD OPTION MAY BE INVOKED MERELY BY SPECIFYING Sigma1

THE KELVIN TEMPERATURE ON THE FIRST CARD. ALL OTHER FIELDS MAY Sigma1

BE LEFT BLANK. Sigma1

Sigma1

LEAVE THE DEFINITION OF THE FILENAMES BLANK - THE PROGRAM WILL Sigma1

THEN USE STANDARD FILENAMES. Sigma1

Sigma1

THE FOLLOWING 5 CARDS ARE REQUIRED Sigma1

Sigma1

3.00000+ 2 Sigma1

(USE STANDARD FILENAME = ENDFB.IN) Sigma1

(USE STANDARD FILENAME = ENDFB.OUT) Sigma1

(RETRIEVE ALL DATA, TERMINATE REQUEST LIST) Sigma1

(0.0 ALLOWABLE ERROR, TERMINATE ERROR LAW) Sigma1

Sigma1

EXAMPLE INPUT NO. 3 Sigma1

------------------- Sigma1

THE SAME AS ABOVE, ONLY DEFINE THE MINIMUM CROSS SECTION OF Sigma1

INTEREST TO BE 1.0E-30 BARNS (INSTEAD OF THE DEFAULT VALUE OF Sigma1

1.0E-10). Sigma1

Sigma1

READ ENDF/B DATA FROM \ENDFB6\RECENT\ZA092238 AND WRITE ENDF/B Sigma1

DATA TO \ENDFB\SIGMA1\ZA092238 Sigma1

Sigma1

THE FOLLOWING 5 CARDS ARE REQUIRED Sigma1

Sigma1

3.00000+ 2 1.00000-30 Sigma1

\ENDFB6\RECENT\ZA092238 Sigma1

\ENDFB6\SIGMA1\ZA092238 Sigma1

(RETRIEVE ALL DATA, TERMINATE REQUEST LIST) Sigma1

(0.0 ALLOWABLE ERROR, TERMINATE ERROR LAW) Sigma1

Sigma1

======================================================================= Sigma1