```
====================================================================== Recent
                                                                       Recent
     PROGRAM RECENT                                                    Recent
     VERSION 79-1 (OCTOBER 1979)  CDC-7600                             Recent
     VERSION 80-1 (MAY 1980)      IBM, CDC AND CRAY VERSION            Recent
     VERSION 80-2 (DECEMBER 1980) IMPROVED TREATMENT OF UNRESOLVED     Recent
                                  REGION TO COMPUTE ALL REACTIONS AT   Recent
                                  THE SAME TIME.                       Recent
     VERSION 81-1 (MARCH 1981)  IMPROVED BASED ON USER COMMENTS.       Recent
     VERSION 81-2 (AUGUST 1981) ADDED MONITOR MODE. ADDED SPEED OPTION Recent
                                TO BYPASS BACKWARDS THINNING IF FILE 3 Recent
                                ALLOWABLE ERROR = 0.0 (NOTE THIS OPTION Recent
                                WILL RESULT IN ALL TABULATED POINTS    Recent
                                FROM THE EVALUATION BEING KEPT IN THE  Recent
                                OUTPUT FROM THIS PROGRAM).             Recent
     VERSION 82-1 (JANUARY 1982) IMPROVED COMPUTER COMPATIBILITY.      Recent
     VERSION 83-1 (JANUARY 1983)*MAJOR RE-DESIGN.                      Recent
                                *PAGE SIZES INCREASED.                 Recent
                                *ELIMINATED COMPUTER DEPENDENT CODING. Recent
                                *NEW, MORE COMPATIBLE I/O UNIT NUMBERS. Recent
                                *ADDED OPTION TO KEEP ALL RECONSTRUCTED Recent
                                 AND BACKGROUND ENERGY POINTS.         Recent
                                *ADDED STANDARD ALLOWABLE ERROR OPTIONS Recent
                                 (CURRENTLY 0.1 PER-CENT RECONSTRUCTION Recent
                                 AND 0.0 PER-CENT THINNING).           Recent
     VERSION 83-2 (OCTOBER 1983) IMPROVED BASED ON USER COMMENTS.      Recent
     VERSION 84-1 (JANUARY 1984) IMPROVED INTERVAL HALFING CONVERGENCE. Recent
     VERSION 85-1 (APRIL 1985)  *A BRAND NEW PROGRAM WHICH COMPLETELY  Recent
                                 SUPERCEDES ALL PREVIOUS VERSIONS OF   Recent
                                 THIS PROGRAM.                         Recent
                                *UPDATED FOR ENDF/B-VI FORMATS.        Recent
                                *ADDED GENERAL REICH-MOORE FORMALISM   Recent
                                 (WITH TWO FISSION CHANNELS).          Recent
                                *DECREASED RUNNING TIME.               Recent
                                *SPECIAL I/O ROUTINES TO GUARANTEE     Recent
                                 ACCURACY OF ENERGY.                   Recent
                                *DOUBLE PRECISION TREATMENT OF ENERGY  Recent
                                 (REQUIRED FOR NARROW RESONANCES).     Recent
     VERSION 85-2 (AUGUST 1985) *FORTRAN-77/H VERSION                  Recent
     VERSION 86-1 (JANUARY 1986)*ENERGY DEPENDENT SCATTERING RADIUS    Recent
     VERSION 86-2 (JUNE 1986)   *IF FIRST CHANCE FISSION (MT=19)       Recent
                                 BACKGROUND IS PRESENT ADD RESONANCE   Recent
                                 CONTRIBUTION OF FISSION TO IT.        Recent
     VERSION 86-3 (OCTOBER 1986)*MULTI-LEVEL OR REICH-MOORE..CORRECT   Recent
                                 POTENTIAL SCATTERING CROSS SECTION FOR Recent
                                 MISSING AND/OR FICTICIOUS (L,J)       Recent
                                 SEQUENCES.                            Recent
     VERSION 87-1 (JANUARY 1987)*IMPROVED COMBINING FILE 2+3           Recent
     VERSION 87-2 (MARCH 1987)  *CORRECTED ADLER-ADLER CALCULATIONS.   Recent
     VERSION 88-1 (JULY 1988)   *UPDATED REICH-MOORE ENDF/B-VI FORMAT  Recent
                                 TO BE THE SAME AS REICH-MOORE FORMAT  Recent
                                 IN EARLIER VERSIONS OF ENDF/B FORMAT. Recent
                                *CHECK FOR PRELIMINARY ENDF/B-VI       Recent
                                 REICH-MOORE FORMAT (NOW ABANDONED)    Recent
                                 AND TERMINATE EXECUTION IF DATA IS    Recent
                                 IN THIS FORMAT.                       Recent
                                *CALCULATE CHANNEL RADIUS OR SET IT    Recent
                                 EQUAL TO THE SCATTERING RADIUS.       Recent
                                *IMPLEMENTED HYBRID R-FUNCTION WITH THE Recent
                                 FOLLOWING RESTRICTIONS                Recent
                                 - ONLY INELASTIC COMPETITION (NO      Recent
                                   CHARGED PARTICLES)                  Recent
                                 - NO TABULATED FILE 2 BACKGROUND      Recent
                                 - NO TABULATED OPTICAL MODEL PHASE    Recent
                                   SHIFT                               Recent
                                *PROGRAM EXIT IF GENERAL R-MATRIX IN   Recent
                                 THE EVALUATION (THIS FORMALISM WILL   Recent
                                 BE IMPLEMENTED ONLY AFTER THE AUTHOR  Recent
                                 RECEIVES REAL EVALUATIONS WHICH USE   Recent
                                 THIS FORMALISM...UNTIL THEN IT IS     Recent
                                 IMPOSSIBLE TO ADEQUATELY TEST THAT    Recent
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                          THE CODING FOR THIS FORMALISM IS       Recent
                          CORRECT).                              Recent
                         *INCREASED MAXIMUM NUMBER OF RESONANCES Recent
                          FROM 1002 TO 4008.                     Recent
                         *DOUBLE PRECISION RESONANCE REGION      Recent
                          LIMITS.                                Recent
                         *FILE 2 AND FILE 3 ENERGIES WHICH ARE   Recent
                          NEARLY EQUAL ARE TREATED AS EQUAL      Recent
                          (I.E., SAME TO ABOUT 9 DIGITS).        Recent
                         *CHECK FILE 3 BACKGROUND CROSS SECTIONS Recent
                          IN EDIT MODE.                          Recent
                         *OPTION...INTERNALLY DEFINE FILENAMES   Recent
                          (SEE SUBROUTINE FILEIO FOR DETAILS).   Recent
VERSION 89-1 (JANUARY 1989)*PSYCHOANALYZED BY PROGRAM FREUD TO   Recent
                          INSURE PROGRAM WILL NOT DO ANYTHING    Recent
                          CRAZY.                                 Recent
                         *UPDATED TO USE NEW PROGRAM CONVERT     Recent
                          KEYWORDS.                              Recent
                         *CORRECTED MULTILEVEL, REICH-MOORE AND  Recent
                          HYBRID R-FUNCTION POTENTIAL SCATTER    Recent
                          TO ACCOUNT FOR REPEATED J-VALUES FOR   Recent
                          THE SAME TARGET SPIN AND L-VALUE.      Recent
                         *ADDED LIVERMORE CIVIC COMPILER         Recent
                          CONVENTIONS.                           Recent
                         *UPDATED TO USE NEW ENDF/B-VI           Recent
                          CONVENTION TO ALLOW UNRESOLVED         Recent
                          RESONANCE CONTRIBUTION TO ALREADY      Recent
                          BE INCLUDED IN THE FILE 3 CROSS        Recent
                          SECTIONS (INFINITELY DIULUTE           Recent
                          CONTRIBUTION).                         Recent
VERSION 90-1 (JUNE 1990)  *UPDATED BASED ON USER COMMENTS        Recent
                         *ADDED FORTRAN SAVE OPTION              Recent
                         *NEW MORE CONSISTENT ENERGY OUTPUT      Recent
                          ROUTINE                                Recent
VERSION 91-1 (JULY 1991)  *NEW UNIFORM TREATMENT OF ALL RESONANCE Recent
                          FORMALISMS (SEE, COMMENTS BELOW)       Recent
                         *NEW REICH-MOORE ALGORITHM              Recent
                         *MORE EXTENSIVE ERROR CHECKING AND      Recent
                          ERROR MESSAGE EXPLANATIONS             Recent
VERSION 92-1 (JANUARY 1992)*MAJOR RESTRUCTING TO IMPROVE ACCURACY Recent
                          AND COMPUTER INDEPENDENCE.             Recent
                         *INCREASED ENERGY POINT PAGE SIZE FROM  Recent
                          1002 TO 4008.                          Recent
                         *NO MORE THAN 2 ENERGY POINTS WHERE     Recent
                          CROSS SECTION IS ZERO AT BEGINNING     Recent
                          OF A SECTION FOR EACH REACTION,E.G.,   Recent
                          THRESHOLD FISSION.                     Recent
                         *PROCESS ONLY A PORTION OF RESONANCE    Recent
                          REGION - SEE EXPLANATION BELOW         Recent
                         *ALL ENERGIES INTERNALLY ROUNDED PRIOR  Recent
                          TO CALCULATIONS.                       Recent
                         *COMPLETELY CONSISTENT I/O AND ROUNDING Recent
                          ROUTINES - TO MINIMIZE COMPUTER        Recent
                          DEPENDENCE.                            Recent
VERSION 93-1 (MARCH 1993) *UPDATED REICH-MOORE TREATMENT TO USE  Recent
                          L DEPENDENT SCATTERING RADIUS (APL)    Recent
                          RATHER THAN SCATTERING RADIUS (AP)     Recent
                          (SEE, ENDF/B-VI FORMATS AND            Recent
                           PROCEDURES MANUAL, PAGE 2.6)          Recent
                         *INCREASED PAGE SIZE FROM 4008 TO       Recent
                          20040 DATA POINTS.                     Recent
                         *INCREASED MAXIMUM NUMBER OF RESONANCES Recent
                          FROM 4008 TO 20040.                    Recent
VERSION 94-1 (JANUARY 1994)*VARIABLE ENDF/B DATA FILENAMES       Recent
                          TO ALLOW ACCESS TO FILE STRUCTURES     Recent
                          (WARNING - INPUT PARAMETER FORMAT      Recent
                          HAS BEEN CHANGED).                     Recent
                         *CLOSE ALL FILES BEFORE TERMINATING     Recent
                          (SEE, SUBROUTINE ENDIT)                Recent
VERSION 94-2 (AUGUST 1994) *CORRECTED ADDJ FOR ENERGY DEPENDENT  Recent
                          (TABULATED) SCATTERING RADIUS CASE.    Recent
```

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VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                      Recent
                            *IMPROVED COMPUTER INDEPENDENCE         Recent
                            *ALL DOUBLE PRECISION                   Recent
                            *ON SCREEN OUTPUT                       Recent
                            *UNIFORM TREATMENT OF ENDF/B I/O        Recent
                            *IMPROVED OUTPUT PRECISION              Recent
                            *ALWAYS INCLUDE THERMAL VALUE           Recent
                            *DEFINED SCRATCH FILE NAMES             Recent
VERSION 97-1 (APRIL 1997)   *OPTIONAL MAKE NEGATIVE CROSS           Recent
                             SECTION = 0 FOR OUTPUT                 Recent
                           *INCREASED PAGE SIZE FROM 20040 TO       Recent
                            120000 DATA POINTS.                     Recent
                           *INCREASED MAXIMUM NUMBER OF RESONANCES  Recent
                            FROM 20040 TO 120000.                   Recent
VERSION 99-1 (MARCH 1999)   *CORRECTED CHARACTER TO FLOATING        Recent
                             POINT READ FOR MORE DIGITS             Recent
                            *UPDATED TEST FOR ENDF/B FORMAT         Recent
                             VERSION BASED ON RECENT FORMAT CHANGE  Recent
                            *UPDATED CONSTANTS BASED ON CSEWG       Recent
                             SUBCOMMITTEE RECOMMENDATIONS           Recent
                            *GENERAL IMPROVEMENTS BASED ON          Recent
                             USER FEEDBACK                          Recent
VERSION 99-2 (JUNE 1999)    *IMPLEMENTED NEW REICH-MOORE FORMALISM  Recent
                             TO ALLOW DEFINITION OF (L,J,S) FOR     Recent
                             EACH SEQUENCE.                         Recent
                            *ASSUME ENDF/B-VI, NOT V, IF MISSING    Recent
                             MF=1, MT-451.                          Recent
VERS. 2000-1 (FEBRUARY 2000)*GENERAL IMPROVEMENTS BASED ON          Recent
                             USER FEEDBACK                          Recent
VERS. 2002-1 (MAY 2002)     *OPTIONAL INPUT PARAMETERS              Recent
             (SEPT. 2002)   *OUTPUT RESONANCE WITH 9 DIGITS         Recent
                            *TO BE C AND C++ COMPATIBLE OUTPUT      Recent
VERS. 2004-1 (JAN. 2004)    *ADDED INCLUDE 'recent.h'               Recent
                            *MADE ENDF/B-VII READY                  Recent
                            *UPDATED FOR NEW REICH-MOORE LRF=7      Recent
                             PARAMETERS WITH COMPETITION            Recent
                            *ADDED COULOMB PENETRATION FACTORS FOR  Recent
                             LRF=7 COMPETITIVE CHANNELS.            Recent
                            *EXTENDED DEFINITIONS OF PENETRATION    Recent
                             FACTOR, LEVEL SHIFT FACTOR, AND        Recent
                             POTENTIAL SCATTERING PHASE SHIFT       Recent
                             ABOVE L = 5 TO INFINITY.               Recent
                            *ADDED QUICK CALCULATION - IF THE       Recent
                             INPUT ALLOWABLE ERROR IS 1.0 OR MORE   Recent
                             (100 % OR MORE) THERE IS NO ITERATION  Recent
                             TO CONVERGENCE - CROSS SECTION ARE     Recent
                             QUICKLY CALCULATED ONLY AT A FIXED     Recent
                             SET OF ENERGY POINTS, BASED ON THE     Recent
                             ENERGY AND WIDTH OF ALL RESONANCES.    Recent
                             THIS CAN BE USED TO QUICKLY "SEE"      Recent
                             NEW EVALUATIONS THAT MAY CONTAIN       Recent
                             ERRORS, THAT WOULD OTHERWISE CAUSE     Recent
                             THIS CODE TO RUN FOR AN EXCESSIVELY    Recent
                             LONG TIME.                             Recent
                                                                    Recent
OWNED, MAINTAINED AND DISTRIBUTED BY                                Recent
-----------------------------------                                 Recent
THE NUCLEAR DATA SECTION                                            Recent
INTERNATIONAL ATOMIC ENERGY AGENCY                                  Recent
P.O. BOX 100                                                        Recent
A-1400, VIENNA, AUSTRIA                                             Recent
EUROPE                                                              Recent
                                                                    Recent
ORIGINALLY WRITTEN BY                                               Recent
---------------------------------                                   Recent
DERMOTT E. CULLEN                                                   Recent
UNIVERSITY OF CALIFORNIA                                            Recent
LAWRENCE LIVERMORE NATIONAL LABORATORY                              Recent
L-159                                                               Recent
P.O. BOX 808                                                        Recent
LIVERMORE, CA 94550                                                 Recent
```

```
U.S.A.                                                          Recent
TELEPHONE  925-423-7359                                         Recent
E. MAIL    CULLEN1@LLNL.GOV                                     Recent
WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                          Recent
                                                                Recent
Acknowledgement (Version 2004-1)                                Recent
================================================================ Recent
The author thanks Nancy Larson, ORNL, for providing her SAMRML  Recent
code for comparison to RECENT output for Reich-Moore evaluations, Recent
in particular to verify results for the new LFR=7 evaluations. I Recent
also thank her for providing guidance to help me understand and Recent
implement this new teatment for Reich-Moore parameters.         Recent
                                                                Recent
ACKNOWLEDGEMENT (VERSION 92-1)                                  Recent
================================================================ Recent
THE AUTHOR THANKS SOL PEARLSTEIN (BROOKHAVEN NATIONAL LAB) FOR  Recent
SIGNIFICANTLY CONTRIBUTING TOWARD IMPROVING THE ACCURACY AND     Recent
COMPUTER INDEPENDENCE OF THIS CODE - THANKS, SOL                Recent
================================================================ Recent
                                                                Recent
AUTHORS MESSAGE                                                 Recent
================================================================ Recent
THE REPORT DESCRIBED ABOVE IS THE LATEST PUBLISHED DOCUMENTATION Recent
FOR THIS PROGRAM. HOWEVER, THE COMMENTS BELOW SHOULD BE CONSIDERED Recent
THE LATEST DOCUMENTATION INCLUDING ALL RECENT IMPROVEMENTS. PLEASE Recent
READ ALL OF THESE COMMENTS BEFORE IMPLEMENTATION, PARTICULARLY  Recent
THE COMMENTS CONCERNING MACHINE DEPENDENT CODING.               Recent
                                                                Recent
AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER Recent
INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE  Recent
OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT Recent
IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY    Recent
COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO Recent
IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF Recent
THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR      Recent
COMPUTER.                                                       Recent
                                                                Recent
PURPOSE                                                         Recent
================================================================ Recent
THIS PROGRAM IS DESIGNED TO RECONSTRUCT THE RESONANCE CONTRIBUTION Recent
TO THE CROSS SECTION IN LINEARLY INTERPOLABLE FORM, ADD IN ANY  Recent
LINEARLY INTERPOLABLE BACKGROUND CROSS SECTION AND OUTPUT THE   Recent
RESULT IN THE ENDF/B FORMAT. THE CROSS SECTIONS OUTPUT BY THIS  Recent
PROGRAM WILL BE LINEARLY INTERPOLABLE OVER THE ENTIRE ENERGY RANGE Recent
                                                                Recent
THE RESONANCE CONTRIBUTION IS CALCULATED FOR TOTAL (MT=1),      Recent
ELASTIC (MT=2), CAPTURE (MT=102) AND FISSION (MT=18), ADDED     Recent
TO THE BACKGROUND (IF ANY) AND OUTPUT. IN ADDITION, IF THERE    Recent
IS A FIRST CHANCE FISSION (MT=19) BACKGROUND PRESENT THE RESONANCE Recent
CONTRIBUTION OF FISSION WILL BE ADDED TO THE BACKGROUND AND     Recent
OUTPUT. IF THERE IS NO FIRST CHANCE FISSION (MT=19) BACKGROUND  Recent
PRESENT THE PROGRAM WILL NOT OUTPUT MT=19.                      Recent
                                                                Recent
IN THE FOLLOWING FOR SIMPLICITY THE ENDF/B TERMINOLOGY--ENDF/B  Recent
TAPE--WILL BE USED. IN FACT THE ACTUAL MEDIUM MAY BE TAPE, CARDS, Recent
DISK OR ANY OTHER MEDIUM.                                       Recent
                                                                Recent
PROCESSING DATA IN THE ENDF/B-VI FORMAT                         Recent
================================================================ Recent
IT HAS NOW BEEN CONFIRMED (PRIVATE COMMUNICATION, CHARLES DUNFORD, Recent
APRIL, 1991) THAT THE PROPER PROCEDURE TO FOLLOW WHEN THERE ARE Recent
MISSING OR DUPLICATE J VALUES IS TO IN ALL CASES ADD A SEQUENCE Recent
WITH NO RESONANCES TO ACCOUNT FOR THE CONTRIBUTION OF THE SEQUENCE Recent
TO THE POTENTIAL SCATTERING CROSS SECTION.                      Recent
                                                                Recent
THIS IS THE PROCEDURE WHICH WAS FOLLOWED BY ALL VERSIONS OF RECENT Recent
SINCE 86-3 AND WILL CONTINUE TO BE THE PROCEDURE.               Recent
                                                                Recent
INPUT ENDF/B FORMAT AND CONVENTIONS                             Recent
================================================================ Recent
ENDF/B FORMAT                                                   Recent
```

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------------                                                      Recent
THIS PROGRAM ONLY USES THE ENDF/B BCD OR LINE IMAGE FORMAT (AS    Recent
OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION  Recent
OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II,III, IV, V OR VI FORMAT). Recent
                                                                  Recent
IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B      Recent
FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS    Recent
ASSUMED THAT THE MAT, MF AND MT ON EACH LINE IS CORRECT. SEQUENCE Recent
NUMBERS (COLUMNS 76-80) ARE IGNORED ON INPUT, BUT WILL BE         Recent
CORRECTLY OUTPUT ON ALL CARDS. THE FORMAT OF SECTION MF=1, MT=451 Recent
AND ALL SECTIONS OF MF=2 AND 3 MUST BE CORRECT. THE PROGRAM COPIES Recent
ALL OTHER SECTION OF DATA AS HOLLERITH AND AS SUCH IS INSENSITIVE Recent
TO THE CORRECTNESS OR INCORRECTNESS OF ALL OTHER SECTIONS.         Recent
                                                                  Recent
ENDF/B FORMAT VERSION                                             Recent
--------------------                                              Recent
THE FORMATS AND CONVENTIONS FOR READING AND INTERPRETING THE DATA  Recent
VARIES FROM ONE VERSION OF ENDF/B TO THE NEXT. HOWEVER, IF THE     Recent
HOLLERITH SECTION (MF=1, MT=451) IS PRESENT IT IS POSSIBLE FOR     Recent
THIS PROGRAM TO DISTINGUISH BETWEEN DATA IN THE ENDF/B-IV, V AND   Recent
VI FORMATS AND TO USE THE APPROPRIATE CONVENTIONS FOR EACH         Recent
ENDF/B VERSION (SEE, SUBROUTINE FILE1 FOR A DESCRIPTION OF HOW     Recent
THIS IS DONE). IF THE HOLLERITH SECTION IS NOT PRESENT THE         Recent
PROGRAM WILL ASSUME THE DATA IS IN THE ENDF/B-VI FORMAT AND USE    Recent
ALL CONVENTIONS APPROPRIATE TO ENDF/B-V. USERS ARE ENCOURAGED TO   Recent
INSURE THAT THE HOLLERITH SECTION (MF=1, MT=451) IS PRESENT IN     Recent
ALL EVALUATIONS.                                                  Recent
                                                                  Recent
INPUT OF ENERGIES                                                 Recent
-----------------                                                 Recent
ALL ENERGIES ARE READ IN DOUBLE PRECISION (BY SPECIAL FORTRAN I/O  Recent
ROUTINES) AND ARE TREATED IN DOUBLE PRECISION IN ALL CALCULATIONS. Recent
                                                                  Recent
OUTPUT ENDF/B FORMAT AND CONVENTIONS                              Recent
================================================================= Recent
CONTENTS OF OUTPUT                                                Recent
------------------                                                Recent
ENTIRE EVALUATIONS ARE OUTPUT, NOT JUST THE RECONSTRUCTED FILE     Recent
3 CROSS SECTIONS, E.G. ANGULAR AND ENERGY DISTRIBUTIONS ARE       Recent
ALSO INCLUDED.                                                    Recent
                                                                  Recent
DOCUMENTATION                                                     Recent
-------------                                                     Recent
THE FACT THAT THIS PROGRAM HAS OPERATED ON THE DATA IS DOCUMENTED  Recent
BY THE ADDITION OF COMMENT CARDS AT THE END OF EACH HOLLERITH      Recent
SECTION IN THE FORM                                               Recent
                                                                  Recent
***************** RECENT (VERSION 2004-1) ***************         Recent
RESONANCE CONTRIBUTION RECONSTRUCTED TO WITHIN   0.100 PER-CENT   Recent
COMBINED DATA NOT THINNED (ALL RESONANCE + BACKGROUND DATA KEPT)  Recent
                                                                  Recent
THE ORDER OF ALL SIMILAR COMMENTS (FROM LINEAR, SIGMA1 AND GROUPY) Recent
REPRESENTS A COMPLETE HISTORY OF ALL OPERATIONS PERFORMED ON       Recent
THE DATA, INCLUDING WHICH VERSION OF EACH PROGRAM WAS USED.       Recent
                                                                  Recent
THESE COMMENT CARDS ARE ONLY ADDED TO EXISTING HOLLERITH SECTIONS, Recent
I.E., THIS PROGRAM WILL NOT CREATE A HOLLERITH SECTION. THE FORMAT Recent
OF THE HOLLERITH SECTION IN ENDF/B-V DIFFERS FROM THE THAT OF      Recent
EARLIER VERSIONS OF ENDF/B. BY READING AN EXISTING MF=1, MT=451    Recent
IT IS POSSIBLE FOR THIS PROGRAM TO DETERMINE WHICH VERSION OF      Recent
THE ENDF/B FORMAT THE DATA IS IN. WITHOUT HAVING A SECTION OF      Recent
MF=1, MT=451 PRESENT IT IS IMPOSSIBLE FOR THIS PROGRAM TO          Recent
DETERMINE WHICH VERSION OF THE ENDF/B FORMAT THE DATA IS IN, AND   Recent
AS SUCH IT IS IMPOSSIBLE FOR THE PROGRAM TO DETERMINE WHAT FORMAT  Recent
SHOULD BE USED TO CREATE A HOLLERITH SECTION.                     Recent
                                                                  Recent
REACTION INDEX                                                    Recent
--------------                                                    Recent
THIS PROGRAM DOES NOT USE THE REACTION INDEX WHICH IS GIVEN IN     Recent
SECTION MF=1, MT=451 OF EACH EVALUATION.                          Recent
                                                                  Recent
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THIS PROGRAM DOES NOT UPDATE THE REACTION INDEX IN MF=1, MT=451.   Recent
THIS CONVENTION HAS BEEN ADOPTED BECAUSE MOST USERS DO NOT         Recent
REQUIRE A CORRECT REACTION INDEX FOR THEIR APPLICATIONS AND IT WAS Recent
NOT CONSIDERED WORTHWHILE TO INCLUDE THE OVERHEAD OF CONSTRUCTING  Recent
A CORRECT REACTION INDEX IN THIS PROGRAM. HOWEVER, IF YOU REQUIRE  Recent
A REACTION INDEX FOR YOUR APPLICATIONS, AFTER RUNNING THIS PROGRAM Recent
YOU MAY USE PROGRAM DICTIN TO CREATE A CORRECT REACTION INDEX.     Recent
                                                                   Recent
OUTPUT FORMAT OF ENERGIES                                          Recent
-------------------------                                          Recent
IN THIS VERSION OF RECENT ALL FILE 3 ENERGIES WILL BE OUTPUT IN    Recent
F (INSTEAD OF E) FORMAT IN ORDER TO ALLOW ENERGIES TO BE WRITTEN   Recent
WITH UP TO 9 DIGITS OF ACCURACY. IN PREVIOUS VERSIONS THIS WAS AN  Recent
OUTPUT OPTION. HOWEVER USE OF THIS OPTION TO COMPARE THE RESULTS   Recent
OF ENERGIES WRITTEN IN THE NORMAL ENDF/B CONVENTION OF 6 DIGITS    Recent
TO THE 9 DIGIT OUTPUT FROM THIS PROGRAM DEMONSTRATED THAT FAILURE  Recent
TO USE THE 9 DIGIT OUTPUT CAN LEAD TO LARGE ERRORS IN THE DATA     Recent
JUST DUE TO TRANSLATION OF ENERGIES FROM THEIR INTERNAL (BINARY)   Recent
REPRESENTATION TO THE ENDF/B FORMAT.                               Recent
                                                                   Recent
ACCURACY OF ENERGY                                                 Recent
------------------                                                 Recent
IN ORDER TO ALLOW ENERGIES TO BE ACCURATELY OUTPUT TO 9 DIGITS     Recent
ON SHORT WORD LENGTH COMPUTERS (E.G. IBM) ALL ENERGIES AND         Recent
ENERGY DEPENDENT TERMS ARE READ AND TREATED IN DOUBLE PRECISION.   Recent
                                                                   Recent
OUTPUT OF RESONANCE PARAMETERS                                     Recent
------------------------------                                     Recent
A SPECIAL CONVENTION HAS BEEN INTRODUCED REGARDING RESONANCE       Recent
PARAMETERS. IN ORDER TO ALLOW THE USER TO DOPPLER BROADEN AND/OR   Recent
SELF-SHIELD CROSS SECTIONS THE RESONANCE PARAMETERS ARE ALSO       Recent
INCLUDED IN THE OUTPUT WITH THE EVALUATION. IN ORDER TO AVOID THE  Recent
POSSIBILITY OF ADDING THE RESONANCE CONTRIBUTION A SECOND TIME     Recent
TWO CONVENTIONS HAVE BEEN ADOPTED TO INDICATE THAT THE RESONANCE   Recent
CONTRIBUTION HAS ALREADY BEEN ADDED TO THE FILE 3 CROSS SECTIONS,  Recent
                                                                   Recent
(1) WHEN THE DATA IS PROCESSED BY THIS PROGRAM LRP (IN MF=1,       Recent
MT=451) IS SET EQUAL TO 2. THIS IS A CONVENTION WHICH HAS BEEN     Recent
ADOPTED AS A STANDARD CONVENTION IN ENDF/B-VI, BUT IS ONLY TO BE   Recent
USED FOR PROCESSED DATA, AS OPPOSED TO THE ORIGINAL EVALUATIONS.   Recent
IN EVALUATIONS WHICH CONTAIN MF=1, MT=451 LRP CAN BE USED TO       Recent
DETERMINE IF THE MATERIAL HAS BEEN PROCESSED.                      Recent
                                                                   Recent
(2) THE LRU FLAG IN EACH SECTION OF FILE 2 DATA IS CHANGED TO      Recent
LRU=LRU+3. FOR EXAMPLE WHEN READING AN ENDF/B EVALUATION LRU=0     Recent
(NO RESONANCES), =1 (RESOLVED) OR =2 (UNRESOLVED) INDICATES THAT   Recent
THE DATA IS IN THE ORIGINAL ENDF/B FORM. LRU=3 (NO RESONANCES),    Recent
=4 (RESOLVED) OR =5 (UNRESOLVED) INDICATES THAT THE RESONANCE      Recent
CONTRIBUTION HAS ALREADY BEEN ADDED TO THE FILE 3 DATA. THIS       Recent
SECOND CONVENTION HAS BEEN ADOPTED AS INSURANCE THAT THE RESONANCE Recent
CONTRIBUTION WILL NOT BE ADDED TWICE, EVEN FOR EVALUATIONS WHICH   Recent
DO NOT CONTAIN MF=1, MT=451 (EVALUATIONS WHICH CONTAIN MF=1,       Recent
MT=451 ARE COVERED BY CONVENTION (1), DESCRIBED ABOVE).            Recent
                                                                   Recent
UNIFORM TREATMENT OF RESONANCE FORMALISMS                          Recent
================================================================== Recent
NORMALIZATION                                                      Recent
=============                                                      Recent
ALL OF THE RESONANCE FORMALISMS INCLUDE A FACTOR OF,               Recent
                                                                   Recent
PI*(FRACTIONAL ABUNDANCE)/(K**2)                                   Recent
                                                                   Recent
THIS FACTOR HAS BEEN REMOVED FROM THE CALCULATION OF EACH TYPE     Recent
OF RESONANCE FORMALISM AND IS APPLIED AS A FINAL NORMALIZATION     Recent
AFTER THE CALCULATION, ONLY ONE PLACE IN THIS PROGRAM.             Recent
                                                                   Recent
FOR SIMPLICITY THIS TERM IS NOT INCLUDED IN THE FOLLOWING          Recent
DERIVATIONS - IN ALL CASES THE ACTUAL CROSS SECTION IS A PRODUCT   Recent
OF THE ABOVE FACTOR TIMES THE RESULTS PRESENTED BELOW.             Recent
                                                                   Recent
SIMILARITIES                                                       Recent
```

```
============                                                        Recent
FOR THE RESOLVED RESONANCE REGION, EXCEPT FOR SINGLE LEVEL BREIT    Recent
WIGNER, PARAMETERS ALL OF THE FORMALISMS DEFINE THE CROSS SECTIONS  Recent
IN AN EQUIVALENT FORM,                                              Recent
                                                                    Recent
TOTAL    = 2*GJ*REAL(1 - U)                                         Recent
         = 2*GJ*(1 - REAL(U))                                       Recent
ELASTIC  =   GJ*(1 - U)**2                                          Recent
         =   GJ*((1 - 2*REAL(U)) + (REAL(U)**2 + IM(U)**2))         Recent
         = 2*GJ*(1 - REAL(U)) - GJ*(1 - (REAL(U)**2 + IM(U)**2))    Recent
                                                                    Recent
SINCE THE FIRST TERM IS THE TOTAL, THE SECOND TERM MUST BE          Recent
ABSORPTION. SO WE FIND,                                             Recent
                                                                    Recent
ABSORPTION = GJ*(1 - (REAL(U)**2 + IM(U)**2))                       Recent
                                                                    Recent
IN ALL CASES U IS DEFINED IN THE FORM,                              Recent
                                                                    Recent
U        = EXP(-I*2*PS)*((1-X) - I*Y)                               Recent
                                                                    Recent
WHERE (X) AND (Y) ARE RELATED TO THE SYMMETRIC AND ANTI-SYMMETRIC   Recent
CONTRIBUTIONS OF THE RESONANCES, RESPECTIVELY. ONLY THE DEFINITION  Recent
OF (X) AND (Y) WILL BE DIFFERENT FOR EACH RESONANCE FORMALISM.      Recent
BELOW WE WILL SHOW THAT WHAT MIGHT APPEAR TO BE A STRANGE CHOICE    Recent
OF DEFINITION OF THE SIGN OF (X) AND(Y) HAS BEEN SELECTED SO THAT   Recent
FOR BREIT-WIGNER PARAMETERS (X) AND (Y) CORRESPOND EXACTLY TO THE   Recent
SYMMETRIC AND ANTI-SYMMETRIC CONTRIBUTION OF THE RESONANCES.        Recent
                                                                    Recent
U        = (COS(2*PS) - I*SIN(2*PS))*((1-X) - I*Y)                  Recent
         =   ((1-X)*COS(2*PS) - Y*SIN(2*PS))                        Recent
         =-I*((1-X)*SIN(2*PS) + Y*COS(2*PS))                        Recent
                                                                    Recent
REAL(U)  = ((1-X)*COS(2*PS) - Y*SIN(2*PS))                          Recent
IM(U)    =-((1-X)*SIN(2*PS) + Y*COS(2*PS))                          Recent
                                                                    Recent
R(U)**2  =((1-X)*COS(2*PS))**2 + (Y*SIN(2*PS))**2                   Recent
          -2*(1-X)*Y*COS(2*PS)*SIN(2*PS)                            Recent
I(U)**2  =((1-X)*SIN(2*PS))**2 + (Y*COS(2*PS))**2                   Recent
          +2*(1-X)*Y*COS(2*PS)*SIN(2*PS)                            Recent
                                                                    Recent
THE TERMS 2*(1-X)*Y*COS(2*PS)*SIN(2*PS) CANCEL AND UPON USING       Recent
THE IDENTITY COS(2*PS)**2 + SIN(2*PS)**2 = 1,                       Recent
                                                                    Recent
SUM      = (1-X)**2 + (Y)**2                                        Recent
                                                                    Recent
WE NOW HAVE ALL THE QUANTITIES THAT WE NEED TO DEFINE THE CROSS     Recent
SECTIONS,                                                           Recent
                                                                    Recent
ELASTIC                                                             Recent
=======                                                             Recent
ELASTIC  =GJ*(1 - 2*REAL(U) + (REAL(U)**2 + IM(U)**2))              Recent
         =GJ*(1 - 2*((1-X)*COS(2*PS)-Y*SIN(2*PS))+(1-X)**2+(Y)**2)  Recent
                                                                    Recent
THIS CAN BE WRITTEN AS A SUM OF 2 SQUARES,                          Recent
                                                                    Recent
ELASTIC  =GJ*(COS(2*PS) - (1-X))**2 + (SIN(2*PS) + Y)**2            Recent
                                                                    Recent
         =GJ*((COS(2*PS))**2 - 2*(1-X)*COS(2*PS) + (1-X)**2) +      Recent
              (SIN(2*PS))**2 + 2*Y*SIN(2*PS)    + (Y)**2)           Recent
                                                                    Recent
AGAIN USING THE IDENTITY COS(2*PS)**2 + SIN(2*PS)**2 = 1, WE CAN    Recent
SEE THAT THE DEFINITION AS THE SUM OF 2 SQUARES IS IDENTICAL TO     Recent
THE PRECEDING DEFINITION OF THE ELASTIC.                            Recent
                                                                    Recent
ELASTIC  =GJ*(COS(2*PS) - (1-X))**2 + (SIN(2*PS) + Y)**2            Recent
         =GJ*((COS(2*PS)-1) + X)**2 + (SIN(2*PS) + Y)**2            Recent
                                                                    Recent
USING THE IDENTITY (1 - COS(2*PS))) = 2*SIN(PS)**2, WE OBTAIN       Recent
THE FINAL FORM FOR THE ELASTIC,                                     Recent
                                                                    Recent
ELASTIC =GJ*(2*SIN(PS)**2 - X)**2 + (SIN(2*PS) + Y)**2              Recent
```

```
                                                                      Recent
ABSORPTION                                                            Recent
==========                                                            Recent
ABSORPTION = GJ*(1 - (REAL(U)**2 + IM(U)**2))                         Recent
           = GJ*(1 - ((1-X)**2   + (Y)**2)                            Recent
           = GJ*(1 - (1 - 2*X + (X)**2 + (Y)**2)                      Recent
           = GJ*(2*X - (X)**2 + (Y)**2)                               Recent
                                                                      Recent
SINCE PHYSICALLY THE ABSORPTION CANNOT BE NEGATIVE WE CAN SEE         Recent
THAT (X) MUST BE POSITIVE AND 2*X MUST BE GREATER THAN                Recent
(X)**2 + (Y)**2, FOR ALL OF THE FORMALISMS.                           Recent
                                                                      Recent
TOTAL                                                                 Recent
=====                                                                 Recent
IN THIS PROGRAM THE TOTAL CROSS SECTION IS ALWAYS DEFINED TO BE       Recent
THE SUM OF ITS PARTS - SO THE ABOVE DEFINITION IS NEVER EXPLICITLY    Recent
USED. HOWEVER, WE CAN LEARN SOMETHING BY EXAMINING THE DEFINITION,    Recent
                                                                      Recent
TOTAL    = 2*GJ*REAL(1 - U)                                           Recent
         = 2*GJ*(1 - (((1-X)*COS(2*PS) - Y*SIN(2*PS)))                Recent
         = 2*GJ*((1 - COS(2*PS))*(1-X) - (1-X) + Y*SIN(2*PS))         Recent
         = 2*GJ*(2*SIN(PS)**2*(1-X)    - (1-X) + Y*SIN(2*PS))         Recent
                                                                      Recent
         = 4*GJ*SIN(PS)**2 +                                          Recent
           2*GJ*((X-1) - 2*X*SIN(PS)**2 +  Y*SIN(2*PS))               Recent
                                                                      Recent
THE IMPORTANT POINT TO NOTE IS THAT THE DEFINITION OF THE TOTAL       Recent
DOES NOT EXPLICITLY CONTAIN ANY DEPENDENCE ON X**2 AND Y**2 -         Recent
THE LEVEL-LEVEL INTERFERENCE TERMS.                                   Recent
                                                                      Recent
THIS IMPLIES THAT IF A GIVEN SET OF RESONANCE PARAMETERS ARE USED     Recent
WITH THIS DEFINITION THEY WILL PRODUCE EXACTLY THE SAME TOTAL         Recent
CROSS SECTION - WHETHER WE CLAIM THE PARAMETERS HAVE BEEN             Recent
PRODUCED USING A SINGLE OR MULTI-LEVEL FIT. THIS RESULT COULD         Recent
BE VERY MISLEADING, IF THIS RESULT FOR THE TOTAL IS IMPLIED TO        Recent
MEAN THAT ONE INTERPRETATION OR THE OTHER WILL NOT HAVE ANY           Recent
EFFECT ON THE INDIVIDUAL CROSS SECTIONS.                              Recent
                                                                      Recent
STARTING FROM EXACTLY THE SAME RESONANCE PARAMETERS, RELATIVE TO      Recent
THE RESULTS OBTAINED USING THE SINGLE LEVEL FORMULA, MULTI-LEVEL      Recent
RESULTS WILL TEND TO ALWAYS DECREASE THE ABSORPTION AND INCREASE      Recent
THE ELASTIC. THIS CAN BE IMMEDIATELY SEEN FROM OUR GENERAL            Recent
MULTI-LEVEL DEFINITION OF ABSORPTION,                                 Recent
                                                                      Recent
ABSORPTION =GJ*(2*X - ((X)**2 + (Y)**2))                              Recent
                                                                      Recent
THE SINGLE LEVEL ABSORPTION IS,                                       Recent
                                                                      Recent
ABSORPTION =GJ*(2*X)                                                  Recent
                                                                      Recent
THE DIFFERENCE BETWEEN THE TWO IS -2*GJ*(X**2 + Y**2), SO THAT        Recent
REGARDLESS OF HOW WE DEFINE (X) AND (Y) THE INCLUSION OF THIS         Recent
TERM WILL ALWAYS DECREASE ABSORPTION. SINCE THE TOTAL CROSS           Recent
SECTION IS THE SAME IN BOTH CASE, THIS MEANS THAT THE ELASTIC         Recent
HAS BEEN INCREASED BY THIS AMOUNT.                                    Recent
                                                                      Recent
AGAIN, THESE RESULTS ARE BASED ON STARTING FROM EXACTLY THE SAME      Recent
PARAMETERS - IN ANY ACTUAL CASE THE PARAMETERS BASED ON A SINGLE      Recent
OR MULTI-LEVEL FIT WILL BE QUITE DIFFERENT - THE POINT THAT WE        Recent
WANT TO STRESS HERE IS THAT YOU SHOULD NEVER USE PARAMETERS           Recent
WHICH HAVE BEEN DEFINED BY A FIT USING ONE FORMALISM - IN THE         Recent
EQUATIONS FOR A DIFFERENT FORMALISM - AND ASSUME THAT THE RESULTS     Recent
WILL BE CONSISTENT - AND NEVER USE THE TOTAL CROSS SECTION TO         Recent
SEE WHETHER OR NOT A SET OF SINGLE LEVEL PARAMETERS CAN BE USED       Recent
WITH A MULTI-LEVEL FORMALISM.                                         Recent
                                                                      Recent
POTENTIAL CROSS SECTION                                               Recent
=======================                                               Recent
FAR FROM RESONANCES (X) AND (Y) WILL BE SMALL AND THE ELASTIC         Recent
CROSS SECTION REDUCES TO,                                             Recent
                                                                      Recent
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ELASTIC =GJ*(2*SIN(PS)**2)**2     + (SIN(2*PS))**2                Recent
        =GJ*4*(SIN(PS)**4         + SIN(2*PS)**2                  Recent
                                                                  Recent
USING THE IDENTITY SIN(2*PS) = 2*SIN(PS)*COS(PS)                  Recent
                                                                  Recent
        =4*GJ*(SIN(PS)**4         + (SIN(PS)*COS(PS))**2)         Recent
        =4*GJ*SIN(PS)**2*(SIN(PS)**2 + COS(PS)**2)                Recent
        =4*GJ*SIN(PS)**2                                          Recent
                                                                  Recent
WHICH IS THE POTENTIAL CROSS SECTION. NOTE THAT THIS RESULT IS    Recent
INDEPENDENT OF THE FORMALISM USED, AS IT MUST PHYSICALLY BE,      Recent
AND AS SUCH ALTHOUGH AS YET WE HAVE NOT DEFINED IT, WE CAN        Recent
NOW SEE THAT IN ALL CASES (PS) MUST BE THE PHASE SHIFT AND FOR    Recent
CONSISTENCY IT MUST BE DEFINED USING EXACTLY THE SAME DEFINITION  Recent
IN ALL CASES.                                                     Recent
                                                                  Recent
IN ADDITION SINCE PHYSICALLY FOR EACH L VALUE WE EXPECT TO OBTAIN Recent
A POTENTIAL CROSS SECTION,                                        Recent
                                                                  Recent
4*(2*L+1)*SIN(PS)**2                                              Recent
                                                                  Recent
OBVIOUSLY FOR CONSISTENCY WE MUST HAVE,                           Recent
                                                                  Recent
(2*L+1) = (SUM OVER J) GJ                                         Recent
                                                                  Recent
ONLY IN THIS CASE WILL THE RESULTS BE CONSISTENT - THIS POINT WILL Recent
BE DISCUSSED IN DETAIL BELOW.                                     Recent
                                                                  Recent
WHAT ARE THIS TERMS (X) AND (Y)                                   Recent
==============================                                    Recent
(X) AND (Y) CAN BE EASILY IDENTIFIED BY CONSIDERING THE SINGLE    Recent
AND MULTI-LEVEL BREIT WIGNER FORMALISMS. IN THESE CASES WE WILL   Recent
FIND THAT,                                                        Recent
                                                                  Recent
X       = GAM(N)*GAM(T)/2/DEN                                     Recent
Y       = GAM(N)*(E-ER)/DEN                                       Recent
DEN     = ((E-ER)**2 + (GAM(T)/2)**2)                             Recent
                                                                  Recent
EXTREME CARE HAS TO BE USED TO PROPERLY DEFINE (Y) SUCH THAT IT   Recent
IS NEGATIVE FOR E LESS THAN ER AND POSITIVE FOR E GREATER THAN     Recent
ER. I WILL MERELY MENTION THAT THE EQUATIONS FOR ALL FORMALISMS   Recent
IN ENDF-102 DO NOT CONSISTENTLY USE (E - ER) - IN SOME CASES      Recent
THIS IS WRITTEN AS (ER - E), WHICH CAN LEAD TO AN INCORRECT       Recent
SIGN IN THE DEFINITION OF THE (Y) THAT WE REQUIRE.                Recent
                                                                  Recent
THE INTERFERENCE TERMS CAN BE WRITTEN IN TERMS OF,                Recent
1) LEVEL-SELF INTERFERENCE  = THE CONTRIBUTION OF EACH LEVEL      Recent
                              INTERFERRING WITH ITSELF            Recent
2) LEVEL-LEVEL INTERFERENCE = THE CONTRIBUTION OF EACH LEVEL      Recent
                              INTERFERRRING WITH ALL OTHER LEVELS Recent
                                                                  Recent
WE WILL REFER TO THESE TWO AS (L-S) AND (L-L),                    Recent
                                                                  Recent
X**2    = (GAM(N)*(GAM(T)/2)**2/(DEN)**2      + (L-L)             Recent
        = (GAM(N)**2*((GAM(T)/2)**2)/(DEN)**2 + (L-L)             Recent
Y**2    = (GAM(N))**2*((E-ER))**2/(DEN)**2    + (L-L)             Recent
                                                                  Recent
X**2+Y**2= GAM(N)**2*DEN/(DEN)**2 = GAM(N)**2/DEN + (L-L)         Recent
                                                                  Recent
TO SEE THE EFFECT OF INCLUDING MULTI-LEVEL INTERFERENCE WE CAN    Recent
CONSIDER OUR GENERAL EXPRESSION FOR ABSORPTION,                   Recent
                                                                  Recent
ABSORPTION =GJ*(2*X - ((X)**2 + (Y)**2))                          Recent
                                                                  Recent
AND NOTE THAT FOR BOTH SINGLE AND MULTI-LEVEL BREIT WIGNER THE    Recent
ENDF-102 SAYS TO TREAT ABSORPTION IN A SINGLE LEVEL APPROXIMATION Recent
I.E., IGNORE LEVEL-LEVEL INTERFERENCE. IF ALL INTERFERENCE IS     Recent
IGNORED THIS IS EQUIVALENT TO COMPLETELY IGNORING X**2 + Y**2 AND Recent
DEFINING,                                                         Recent
                                                                  Recent
ABSORPTION =GJ*2*X                                                Recent
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          =2*GJ*GAM(N)*GAM(T)/DEN                                    Recent
                                                                     Recent
WHICH IS INCORRECT - SINCE THIS SEEMS TO INDICATE EVERYTHING IS      Recent
ABSORBED. IN ORDER TO OBTAIN THE CORRECT EXPRESSION WE CANNOT        Recent
COMPLETELY IGNORE INTERFERENCE - WE CAN IGNORE LEVEL-LEVEL           Recent
INTERFERENCE, BUT WE MUST INCLUDE LEVEL-SELF INTERFERENCE,           Recent
                                                                     Recent
X**2+Y**2= GAM(N)**2/DEN                                             Recent
                                                                     Recent
ABSORPTION =GJ*(2*X - ((X)**2 + (Y)**2))                             Recent
           =GJ*GAM(N)*(GAM(T)-GAM(N))/DEN                            Recent
           =GJ*GAM(N)*GAM(A)/DEN                                     Recent
                                                                     Recent
SUMMARY                                                              Recent
=======                                                              Recent
AN IMPORTANT POINT TO NOTE IS THE DEFINITION OF (X) AND (Y)          Recent
WHICH IN ALL CASES WILL CORRESPOND TO THE SYMMETRIC AND              Recent
ANTI-SYMMETRIC CONTRIBUTION OF THE RESONANCES. IN PARTICULAR         Recent
DEFINING (U) IN TERMS OF (1-X) INSTEAD OF (X) IS EXTREMELY           Recent
IMPORTANT. NOTE, THAT THE DEFINITION OF THE ELASTIC AND              Recent
ABSORPTION ONLY INVOLVE (X), NOT (1-X). FAR FROM RESONANCES          Recent
(X) CAN BE EXTREMELY SMALL, THEREFORE (1-X) WILL BE VERY CLOSE       Recent
TO (1). IF THE CALCULATION PROCEEDS BY FIRST CALCULATING (1-X)       Recent
AND THEN DEFINING (X) BY SUBTRACTING (1), EXTREME ROUND-OFF          Recent
PROBLEMS CAN RESULT. THESE PROBLEMS CAN BE AVOIDED BY IN ALL         Recent
CASES DEFINING (X) DIRECTLY, WITHOUT ANY DIFFERENCES.                Recent
                                                                     Recent
IN EACH FORMALISM THE DEFINITION OF (X) AND (Y) MAY BE DIFFERENT     Recent
BUT ONCE WE HAVE DEFINED (X) AND (Y) WE CAN IMMEDIATELY WRITE        Recent
THE CROSS SECTIONS USING A UNIFORM DEFINITION,                       Recent
                                                                     Recent
ELASTIC =GJ*(2*SIN(PS)**2 - X)**2 + (SIN(2*PS) + Y)**2)              Recent
                                                                     Recent
ABSORPTION =-GJ*(2*X + (X)**2 + (Y)**2)                              Recent
                                                                     Recent
AND DEFINE THE TOTAL AS THE SUM OF THESE 2 PARTS.                    Recent
                                                                     Recent
RELATIONSHIP TO SINGLE LEVEL                                         Recent
===========================                                          Recent
HOW DO THE SINGLE AND MULTI-LEVEL FORMALISMS COMPARE. TO SEE,        Recent
STARTING FROM OUR GENERAL DEFINITION OF THE ELASTIC IN THE FORM,     Recent
                                                                     Recent
ELASTIC =GJ*(2*SIN(PS)**2 + X)**2 + (SIN(2*PS) + Y)**2)              Recent
        =GJ*(4*SIN(PS)**4 - 4*X*SIN(PS)**2 + X**2                    Recent
           + SIN(2*PS)**2 + 2*Y*SIN(2*PS)  + Y**2)                   Recent
                                                                     Recent
        =4*GJ*SIN(PS)**2 +                                           Recent
           GJ*(X**2 + Y**2                                           Recent
              -4*X*SIN(PS)**2                                        Recent
              +2*Y*SIN(2*PS))                                        Recent
                                                                     Recent
AND OUR SPECIFIC DEFINITIONS OF (X) AND (Y) FOR MULTI-LEVEL BREIT-   Recent
WIGNER PARAMETERS,                                                   Recent
                                                                     Recent
X        = GAM(N)*GAM(T)/2/DEN                                       Recent
Y        = GAM(N)*(E-ER)/DEN                                         Recent
DEN      = ((E-ER)**2 + (GAM(T)/2)**2)                               Recent
                                                                     Recent
X**2+Y**2= GAM(N)**2/DEN + (L-L)                                     Recent
                                                                     Recent
WE CAN RECOGNIZE X**2 AND Y**2 AS THE INTERFERENCE - (L-S) + (L-L)   Recent
TERMS IN THE MULTI-LEVEL FORMALISM. IN ORDER TO OBTAIN THE SINGLE    Recent
LEVEL EQUATION WE CAN ASSUME THAT EACH LEVEL DOES NOT INTERFERE      Recent
WITH ANY OTHER LEVEL - THEREFORE THE (L-L) CONTRIBUTION IS ZERO.     Recent
                                                                     Recent
ELASTIC =4*GJ*SIN(PS)**2 +                                           Recent
           GJ*GAM(N)*(GAM(N)                                         Recent
                     -2*GAM(T)*SIN(PS)**2                            Recent
                     +2*(E-ER)*SIN(2*PS))/DEN                        Recent
                                                                     Recent
WHICH IS THE FORM THAT IT APPEARS IN ENDF-102, EXCEPT FOR TWO        Recent
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TYPOGRAPHICAL ERRORS IN THE SECOND TERM,                                 Recent
                                                                         Recent
-2*GAM(T)*SIN(PS)**2                                                     Recent
                                                                         Recent
WHICH IN ENDF-102 IS WRITTEN,                                            Recent
                                                                         Recent
-2*(GAM(T)-GAM(N))*SIN(2*PS)**2                                          Recent
                                                                         Recent
PROGRAM CONVENTIONS                                                      Recent
================================================================         Recent
MINIMUM INPUT DATA                                                       Recent
------------------                                                       Recent
FOR EACH MATERIAL TO BE PROCESSED THE MINIMUM INPUT DATA ARE THE         Recent
RESONANCE PARAMETERS IN FILE 2. IF THERE ARE NO FILE 2 PARAMETERS        Recent
IN A GIVEN MATERIAL THE ENTIRE MATERIAL WILL SIMPLY BE COPIED.           Recent
NEITHER THE HOLLERITH SECTION (MF=1, MT=451) NOR THE BACKGROUND          Recent
CROSS SECTION (SECTIONS OF MF=3) NEED BE PRESENT FOR THIS PROGRAM        Recent
TO EXECUTE PROPERLY. HOWEVER, SINCE THE CONVENTIONS USED IN              Recent
INTERPRETING THE RESONANCE PARAMETERS DEPENDS ON ENDF/B VERSION          Recent
USERS ARE STRONGLY RECOMMENDED TO INSURE THAT MF=1, MT=451 IS            Recent
PRESENT IN EACH MATERIAL TO ALLOW THE PROGRAM TO DETERMINE THE           Recent
ENDF/B FORMAT VERSION.                                                   Recent
                                                                         Recent
RESONANCE PARAMETERS                                                     Recent
--------------------                                                     Recent
RESONANCE PARAMETERS MAY BE REPRESENTED USING ANY COMBINATION            Recent
OF THE REPRESENTATIONS ALLOWED IN ENDF/B,                                Recent
(1) RESOLVED DATA                                                        Recent
    (A) SINGLE LEVEL BREIT-WIGNER                                        Recent
    (B) MULTI-LEVEL BREIT-WIGNER                                         Recent
    (C) ADLER-ADLER                                                      Recent
    (D) REICH-MOORE                                                      Recent
    (E) HYBRID R-FUNCTION                                                Recent
(2) UNRESOLVED DATA                                                      Recent
    (A) ALL PARAMETERS ENERGY INDEPENDENT                                Recent
    (B) FISSION PARAMETERS ENERGY DEPENDENT                              Recent
    (C) ALL PARAMETERS ENERGY DEPENDENT                                  Recent
                                                                         Recent
THE FOLLOWING RESOLVED DATA FORMALISMS ARE NOT TREATED BY THIS           Recent
VERSION OF THE CODE AND WILL ONLY BE IMPLEMENTED AFTER EVALUATIONS       Recent
USING THESE FORMALISMS ARE AVAILABLE TO THE AUTHOR OF THIS CODE          Recent
FOR TESTING IN ORDER TO INSURE THAT THEY CAN BE HANDLED PROPERLY         Recent
    (A) GENERAL R-MATRIX                                                 Recent
                                                                         Recent
CALCULATED CROSS SECTIONS                                                Recent
-------------------------                                                Recent
THIS PROGRAM WILL USE THE RESONANCE PARAMETERS TO CALCULATE THE          Recent
TOTAL, ELASTIC, CAPTURE AND POSSIBLY FISSION CROSS SECTIONS. THE         Recent
COMPETITIVE WIDTH WILL BE USED IN THESE CALCULATIONS, BUT THE            Recent
COMPETITIVE CROSS SECTION ITSELF WILL NOT BE CALCULATED. THE             Recent
ENDF/B CONVENTION IS THAT ALTHOUGH A COMPETITIVE WIDTH MAY BE            Recent
GIVEN, THE COMPETITIVE CROSS SECTION MUST BE SEPARATELY TABULATED        Recent
AS A SECTION OF FILE 3 DATA.                                             Recent
                                                                         Recent
RESOLVED REGION                                                          Recent
---------------                                                          Recent
IN THE RESOLVED REGION THE RESOLVED PARAMETERS ARE USED TO               Recent
CALCULATE COLD (0 KELVIN), LINEARLY INTERPOLABLE, ENERGY DEPENDENT       Recent
CROSS SECTIONS.                                                          Recent
                                                                         Recent
SCATTERING RADIUS                                                        Recent
-----------------                                                        Recent
FOR SINGLE OR MULTI LEVEL BREIT-WIGNER PARAMETERS THE SCATTERING         Recent
RADIUS MAY BE SPECIFIED IN EITHER ENERGY INDEPENDENT (CONSTANT)          Recent
OR ENERGY DEPENDENT FORM (A TABLE OF ENERGY VS. RADIUS AND AN            Recent
ASSOCIATED INTERPOLATION LAW). IN ALL OTHER CASE ONLY AN ENERGY          Recent
INDEPENDENT SCATTERING RADIUS IS ALLOWED.                                Recent
                                                                         Recent
FOR ANY ONE MATERIAL (I.E. MAT) IF ENERGY DEPENDENT SCATTERING           Recent
RADII ARE GIVEN THE TOTAL NUMBER OF INTERPOLATION REGIONS AND            Recent
TABULATED VALUES FOR THE ENTIRE MATERIAL CANNOT EXCEED,                  Recent
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200 - INTERPOLATION REGIONS                                          Recent
500 - TABULATED VALUES                                               Recent
IF THESE LIMITS ARE EXCEEDED THE PROGRAM WILL PRINT AN ERROR         Recent
MESSAGE AND TERMINATE.                                               Recent
                                                                     Recent
IF YOU REQUIRE A LARGER NUMBER OF INTERPOLATION REGION AND/OR        Recent
TABULATED VALUES,                                                    Recent
(1) INTERPOLATION REGIONS - INCREASE THE DIMENSION OF NBTRHO AND     Recent
INTRHO IN COMMON/TABRHO/ THROUGHOUT THE PROGRAM AND CHANGE MAXSEC    Recent
IN SUBROUTINE RDAP (MAXSEC = MAXIMUM NUMBER OF INTERPOLATION         Recent
REGIONS).                                                            Recent
(2) TABULATED VALUES - INCREASE THE DIMENSION OF ERHOTB, RHOTAB      Recent
AND APTAB IN COMMON/TABRHO/ THROUGHOUT THE PROGRAM AND CHANGE        Recent
MAXRHO IN SUBROUTINE RDAP (MAXRHO = MAXIMUM NUMBER OF TABULATED      Recent
VALUES).                                                             Recent
                                                                     Recent
RESOLVED REICH-MOORE AND MULTI-LEVEL BREIT-WIGNER PARAMETERS         Recent
-----------------------------------------------------------          Recent
CROSS SECTIONS FOR REICH-MOORE PARAMETERS ARE CALCULATED ACCORDING    Recent
TO THE EQUATION (1) - (8) OF SECTION D.1.3 OF ENDF-102. IN ORDER     Recent
TO CALCULATE CROSS SECTIONS FROM MULTI-LEVEL PARAMETERS IN A         Recent
REASONABLE AMOUNT OF TIME THIS PROGRAM EXPRESSES THE CROSS SECTION   Recent
IN TERMS OF A SINGLE SUM OVER RESONANCES (SEE, ENDF-102, SECTION     Recent
D.1.2, EQUATIONS 6-7), RATHER THAN AS A DOUBLE SUM (SEE, ENDF-102    Recent
SECTION D.1.2, EQUATION 1-2). IN ORDER FOR THE ENDF-102 EQUATIONS    Recent
TO BE CORRECT THE PARAMETERS MUST MEET THE FOLLOWING CONDITIONS,     Recent
                                                                     Recent
(1) FOR EACH L STATE ALL PHYSICALLY POSSIBLE J SEQUENCES MUST BE     Recent
    PRESENT. ONLY IN THIS CASE WILL THE CONTRIBUTIONS OF THE         Recent
    INDIVIDUAL J SEQUENCES ADD UP TO PRODUCE THE CORRECT POTENTIAL   Recent
    SCATTERING CONTRIBUTION FOR THE L STATE (SEE, ENDF-102,          Recent
    SECTION D.1.2, EQUATIONS 6-7). IF ANY J SEQUENCE IS MISSING      Recent
    THE PROGRAM WILL PRINT A WARNING AND ADD THE J SEQUENCE WITH     Recent
    NO RESONANCE PARAMETERS IN ORDER TO ALLOW THE POTENTIAL          Recent
    SCATTERING TO BE CALCULATED CORRECTLY (THIS IS EQUIVALENT TO     Recent
    ASSUMING THAT THE EVALUATOR REALIZES THAT ALL J SEQUENCES MUST   Recent
    BE AND ARE PRESENT AND THAT THE EVALUATION STATES THAT THERE     Recent
    ARE NO RESONANCES WITH CERTAIN PHYSICALLY POSSIBLE J VALUES...   Recent
    IN THIS CASE POTENTIAL CONTRIBUTION MUST STILL BE CONSIDERED).   Recent
                                                                     Recent
    EXAMPLE                                                          Recent
    =======                                                          Recent
    AN EXAMPLE OF WHERE THIS OCCURS AND IS IMPORTANT TO CONSIDER     Recent
    IS U-238 IN ENDF/B-IV AND V LIBRARIES WHERE FOR L=1 THERE IS     Recent
    ONLY A J=1/2 SEQUENCE. NOT INCLUDING THE J=3/2 SEQUENCE LEADS    Recent
    TO UNDERESTIMATING THE POTENTIAL SCATTERING AND PRODUCES          Recent
    MINIMA IN THE ELASTIC CROSS SECTION WHICH ARE AN ORDER OF        Recent
    MAGNITUDE LOWER THAN THE CROSS SECTIONS OBTAINED BE INCLUDING    Recent
    THE J=3/2 SEQUENCE.                                              Recent
                                                                     Recent
(2) FOR A GIVEN TARGET SPIN AND L VALUE THERE MAY BE 2 POSSIBLE      Recent
    MEANS OF OBTAINING THE SAME J VALUE. WHEN THIS OCCURS IN         Recent
    ORDER TO CALCULATE THE CORRECT POTENTIAL SCATTERING CROSS         Recent
    SECTION IT IS IMPORTANT TO INCLUDE THE EFFECT OF BOTH            Recent
    POSSIBLE J SEQUENCES, EVEN THOUGH FROM THE ENDF/B DATA IT IS     Recent
    NOT POSSIBLE TO DETERMINE WHICH OF THE 2 POSSIBLE SEQUENCES      Recent
    ANY GIVEN RESONANCE BELONGS TO. IN THIS CASE THIS PROGRAM        Recent
    TREAT ALL RESONANCES WITH THE SAME J VALUE AS BELONGING TO       Recent
    THE SAME J SEQUENCE (TO ALLOW INTERFERENCE) AND WILL ADD AN      Recent
    ADDITIONAL J SEQUENCE WITH NO RESONANCES IN ORDER TO ALLOW       Recent
    THE POTENTIAL CROSS SECTION TO BE CALCULATED CORRECTLY. WHEN     Recent
    THIS OCCURS A WARNING MESSAGE IS PRINTED, BUT BASED ON THE       Recent
    ENDF/B DATA THERE IS NOTHING WRONG WITH THE DATA AND THERE IS    Recent
    NOTHING THAT THE USER CAN DO TO CORRECT OR IN ANY WAY MODIFY     Recent
    THE DATA TO ELIMINATE THE PROBLEM.                               Recent
                                                                     Recent
    EXAMPLE                                                          Recent
    =======                                                          Recent
    FOR A TARGET SPIN =1 AND L=1 THE 2 RANGES OF PHYSICALLY          Recent
    POSSIBLE J ARE 1/2, 3/2, 5/2 AND 1/2, 3/2. BY CHECKING THE       Recent
    ENDF/B DATA IT IS POSSIBLE TO INSURE THAT THE 3 POSSIBLE         Recent
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    J VALUES (1/2, 3/2, 5/2) ARE PRESENT AND TO INCLUDE ALL 3      Recent
    J SEQUENCES IN THE CALCULATIONS. HOWEVER, UNLESS ALL 5         Recent
    POSSIBLE J SEQUENCES ARE INCLUDED THE STATISTICAL WEIGHTS      Recent
    OF THE J SEQUENCES WILL NOT SUM UP TO 2*L+1 AND THE            Recent
    POTENTIAL CROSS SECTION WILL BE UNDERESTIMATED. IN THIS        Recent
    EXAMPLE THE SUM OF THE 3 J SEQUENCES 1/2, 3/2, 5/2 IS 2,       Recent
    RATHER THAN 3 AS IT SHOULD BE FOR L=1, AND THE CONTRIBUTION    Recent
    OF THE L=1 RESONANCES TO THE POTENTIAL SCATTERING CROSS         Recent
    SECTION WILL ONLY BE 2/3 OF WHAT IT SHOULD BE, UNLESS THE      Recent
    OTHER 2 J SEQUENCES (WITH DUPLICATE J VALUES) ARE INCLUDED     Recent
    IN THE CALCULATION.                                            Recent
                                                                   Recent
(3) EACH RESONANCE MUST HAVE AN ASSIGNED, PHYSICALLY POSSIBLE      Recent
    J VALUE. PHYSICALLY IMPOSSIBLE OR AVERAGE J VALUES CANNOT BE   Recent
    UNIQUELY INTERPRETED USING THE EQUATIONS IN ENDF-102 AND        Recent
    THEIR USE WILL USUALLY RESULT IN PHYSICALLY UNRELIABLE CROSS   Recent
    SECTIONS. THIS PROGRAM WILL CHECK ALL J VALUES AND IF ANY ARE  Recent
    ARE FOUND TO BE PHYSICALLY IMPOSSIBLE (BASED ON TARGET SPIN    Recent
    AND L VALUE) AN ERROR MESSAGE WILL BE PRINTED TO INDICATE THAT Recent
    THE RECONSTRUCTED CROSS SECTIONS WILL BE UNRELIABLE AND THE    Recent
    PROGRAM WILL CONTINUE. IN AN ATTEMPT TO CALCULATE THE CORRECT  Recent
    POTENTIAL SCATTERING CROSS SECTION THIS PROGRAM WILL SUBTRACT   Recent
    THE POTENTIAL SCATTERING CONTRIBUTION DUE TO ALL FICTICIOUS J  Recent
    SEQUENCES AND ADD THE CONTRIBUTION OF ALL PHYSICALLY POSSIBLE  Recent
    J SEQUENCES (AS DESCRIBED ABOVE).                              Recent
                                                                   Recent
    WARNING (LET THE USER BEWARE)                                  Recent
    ============================                                   Recent
    (A) IT CANNOT BE STRESSED ENOUGH THAT CROSS SECTIONS OBTAINED  Recent
        USING PHYSICALLY IMPOSSIBLE J VALUES FOR REICH-MOORE AND   Recent
        MULTI-LEVEL BREIT-WIGNER RESONANCE PARAMETERS WILL RESULT  Recent
        IN UNRELIABLE CROSS SECTIONS. THE DECISION TO HAVE THIS    Recent
        PROGRAM CONTINUE TO PROCESS WHEN THIS CONDITION IS FOUND   Recent
        IS BASED ON AN ATTEMPT TO ALLOW THE USER TO AT LEAST HAVE  Recent
        SOME RESULTS (HOWEVER BAD THEY MAY BE) IF THERE IS NO      Recent
        OTHER EVALUATED DATA AVAILABLE.                            Recent
    (B) EVEN THOUGH THE REICH-MOORE AND MULTI-LEVEL EQUATIONS ARE  Recent
        DEFINED AS ABSOLUTE OR SQUARED CONTRIBUTIONS WHICH MUST    Recent
        ALL BE PHYSICALLY POSSIBLE, ATTEMPTING TO CORRECT THE      Recent
        POTENTIAL CROSS SECTION (AS DESCRIBED ABOVE) CAN LEAD TO   Recent
        NEGATIVE ELASTIC CROSS SECTIONS. THIS IS BECAUSE BASED ON  Recent
        THE INFORMATION AVAILABLE IN THE EVALUATION IT IS NOT      Recent
        NOT POSSIBLE TO CORRECTLY ACCOUNT FOR THE INTERFERENCE     Recent
        BETWEEN THE RESONANCE AND POTENTIAL CONTRIBUTIONS FOR EACH Recent
        J SEQUENCE.                                                Recent
                                                                   Recent
UNRESOLVED RESONANCE REGION                                        Recent
---------------------------                                        Recent
IN THE UNRESOLVED RESONANCE REGION THE UNRESOLVED PARAMETERS       Recent
ARE USED TO CALCULATE INFINITELY DILUTE AVERAGE CROSS SECTIONS.    Recent
NOTE, IT IS IMPORTANT TO UNDERSTAND THAT FROM THE DEFINITION OF    Recent
THE UNRESOLVED PARAMETERS IT IS NOT POSSIBLE TO UNIQUELY CALCULATE Recent
ENERGY DEPENDENT CROSS SECTIONS. ONLY AVERAGES OR DISTRIBUTIONS    Recent
MAY BE CALCULATED.                                                 Recent
                                                                   Recent
UNRESOLVED INTERPOLATION                                           Recent
------------------------                                           Recent
IN THE UNRESOLVED RESONANCE REGION CROSS SECTIONS AT EACH ENERGY   Recent
ARE CALCULATED BY INTERPOLATING PARAMETERS. THIS IS THE CONVENTION Recent
USED IN ENDF/B-IV AND EARLIER VERSIONS OF ENDF/B. THE ENDF/B-V     Recent
CONVENTION OF INTERPOLATING CROSS SECTIONS, NOT PARAMETERS, HAS    Recent
BEEN ABANDONED AS IMPRACTICAL SINCE IT CAN LEAD TO THE SITUATION   Recent
WHERE EXACTLY THE SAME PHYSICAL DATA CAN LEAD TO DIFFERENT RESULTS Recent
DEPENDING ON WHICH OF THE THREE ENDF/B UNRESOLVED PARAMTER FORMATS Recent
IS USED. FOR EXAMPLE, GIVEN A SET OF ENERGY INDEPENDENT UNRESOLVED Recent
PARAMETERS IT IS POSSIBLE TO CODE THESE PARAMETERS IN EACH OF THE  Recent
THREE ENDF/B UNRESOLVED PARAMETER FORMATS. SINCE PHYSICALLY WE     Recent
ONLY HAVE ONE SET OF PARAMETERS WE WOULD EXPECT THE RESULTS TO BE  Recent
INDEPENDENT OF HOW THEY ARE REPRESENTED IN ENDF/B. UNFORTUNATELY   Recent
USING THE ENDF/B-V CONVENTION TO INTERPOLATE CROSS SECTIONS CAN    Recent
LEAD TO THREE COMPLETELY DIFFERENT RESULTS. IN CONTRAST USING THE  Recent
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ENDF/B-IV AND EARLIER CONVENTION OF INTERPOLATING PARAMETERS LEADS Recent
TO COMPLETELY CONSISTENT RESULTS.                                 Recent
                                                                  Recent
INTERNAL REPRESENTATION OF UNRESOLVED PARAMETERS                  Recent
-----------------------------------------------                   Recent
ANY OF THE THREE POSSIBLE REPRESENTATIONS OF UNRESOLVED PARAMETERS Recent
CAN BE UNIQUELY REPRESENTED IN THE ALL PARAMETERS ENERGY DEPENDENT Recent
REPRESENTATIONS WITH THE APPROPRIATE (ENDF/B VERSION DEPENDENT)   Recent
INTERPOLATION LAW. THIS IS DONE BY THE PROGRAM WHILE READING THE  Recent
UNRESOLVED PARAMETERS AND ALL SUBSEQUENT CALCULATIONS NEED ONLY   Recent
CONSIDER THE ALL PARAMETERS ENERGY DEPENDENT REPRESENTATION.      Recent
                                                                  Recent
RESONANCE RECONSTRUCTION STARTING ENERGY GRID                     Recent
---------------------------------------------                     Recent
AS IN ANY ITERATIVE METHOD THE WAY TO SPEED CONVERGENCE IS TO TRY  Recent
TO START CLOSE TO THE ANSWER. THIS PROGRAM ATTEMPTS TO DO THIS BY  Recent
STARTING FROM AN ENERGY GRID WHICH IS A GOOD APPROXIMATION TO A    Recent
SIMPLE BREIT-WIGNER LINE SHAPE,                                   Recent
                                                                  Recent
SIGMA(X)=1.0/(1.0+X*X)                                            Recent
                                                                  Recent
WHERE X IS THE DISTANCE FROM THE PEAK IN HALF-WIDTHS              Recent
                                                                  Recent
SUBROUTINE SUBINT HAS A BUILT-IN TABLE OF NODES WHICH ARE THE      Recent
HALF-WIDTH MULTIPLES TO APPROXIMATE THE SIMPLE BREIT-LINE SHAPE    Recent
TO WITHIN 1 PER-CENT OVER THE ENTIRE INTERVAL 0 TO 500 HALF-WIDTHS Recent
                                                                  Recent
BETWEEN ANY TWO RESOLVED RESONANCES THE STARTING GRID IS BASED ON  Recent
THE HALF-WIDTHS OF THE TWO RESONANCES. FROM THE LOWER ENERGY       Recent
RESONANCE UP TO THE MID-POINT BETWEEN THE RESONANCES (MID-POINT    Recent
IS DEFINED HERE AS AN EQUAL NUMBER OF HALF-WIDTHS FROM EACH        Recent
RESONANCE) THE HALF-WIDTH OF THE LOWER ENERGY RESONANCE IS USED.   Recent
FROM THE MID-POINT UP TO THE HIGHER ENERGY RESONANCE THE HALF-     Recent
WIDTH OF THE UPPER ENERGY RESONANCE IS USED.                       Recent
                                                                  Recent
WITH THIS ALOGORITHM CLOSELY SPACED RESONANCES WILL HAVE ONLY      Recent
A FEW STARTING NODES PER RESONANCE (E.G. U-235). WIDELY SPACED     Recent
RESONANCES WILL HAVE MORE NODES PER RESONANCE (E.G. U-238). FOR    Recent
A MIX OF S, P, D ETC. RESONANCES THIS ALOGORITHM GUARANTEES AN     Recent
ADEQUTE DESCRIPTION OF THE PROFILE OF EVEN EXTREMELY NARROW        Recent
RESONANCES (WHICH MAY IMMEDIATELY CONVERGENCE TO THE ACCURACY      Recent
REQUESTED, THUS MINIMIZING ITERATION).                            Recent
                                                                  Recent
BACKGROUND CROSS SECTIONS                                         Recent
-------------------------                                         Recent
THE PROGRAM WILL SEARCH FOR BACKGROUND CROSS SECTIONS FOR TOTAL    Recent
(MT=1), ELASTIC (MT=2), FISSION (MT=18), FIRST CHANCE FISSION      Recent
(MT=19) AND CAPTURE (MT=102).                                     Recent
                                                                  Recent
(1) THE BACKGROUND CROSS SECTIONS (FILE 3) CAN BE PRESENT OR NOT   Recent
    PRESENT FOR EACH REACTION.                                    Recent
(2) IF FOR A GIVEN REACTION THE BACKGROUND CROSS SECTION IS        Recent
    PRESENT, IT WILL BE ADDED TO THE RESONANCE CONTRIBUTION AND    Recent
    THE RESULT WILL BE OUTPUT.                                    Recent
(3) IF FOR A GIVEN REACTION THE BACKGROUND IS NOT PRESENT THE      Recent
    PROGRAM WILL,                                                 Recent
    (A) IF THE INPUT TO THE PROGRAM SPECIFIES NO OUTPUT FOR        Recent
        REACTIONS WITH NO BACKGROUND THERE WILL BE NO OUTPUT.      Recent
    (B) IF THE INPUT TO THE PROGRAM SPECIFIES OUTPUT FOR REACTIONS Recent
        WITH NO BACKGROUND,                                       Recent
        (I) THE RESONANCE CONTRIBUTION TO TOTAL, ELASTIC OR        Recent
            CAPTURE WILL BE OUTPUT.                               Recent
        (II) IF ALL FISSION RESONANCE PARAMETERS ARE ZERO THE      Recent
             FISSION CROSS SECTION (MT=18) WILL NOT BE OUTPUT.     Recent
             OTHERWISE THE RESONANCE CONTRIBUTION OF THE FISSION   Recent
             (MT=18) WILL BE OUTPUT.                              Recent
        (III) THERE WILL BE NO OUTPUT FOR FIRST CHANCE FISSION     Recent
              (MT=19).                                            Recent
                                                                  Recent
COMBINING RESONANCES AND BACKGROUND CROSS SECTIONS                Recent
--------------------------------------------------                Recent
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IN ORDER TO BE COMBINED WITH THE RESONANCE CONTRIBUTION THE        Recent
BACKGROUND CROSS SECTIONS MUST BE GIVEN AT 0 KELVIN TEMPERATURE    Recent
AND MUST BE LINEARLY INTERPOLABLE. IF THESE CONDITIONS ARE MET     Recent
THE RESONANCE AND BACKGROUND CONTRIBUTIONS WILL BE ADDED TOGETHER  Recent
AND OUTPUT. IF THESE CONDITIONS ARE NOT MET THE BACKGROUND CROSS   Recent
SECTION WILL BE IGNORED AND ONLY THE RESONANCE CONTRIBUTION WILL   Recent
BE OUTPUT. IF THE BACKGROUND HAS NOT BEEN ADDED TO THE RESONANCE   Recent
CONTRIBUTION AFTER THIS PROGRAM FINISHES THE USER CAN MAKE THE     Recent
RESONANCE AND BACKGROUND CONTRIBUTIONS COMPATIBLE BY,              Recent
                                                                   Recent
(1) IF THE BACKGROUND IS NOT LINEARLY INTERPOABLE, LINEARIZE THE   Recent
    BACKGROUND (E.G., USE PROGRAM LINEAR).                         Recent
(2) IF THE BACKGROUND IS NOT GIVEN AT 0 KELVIN, DOPPLER BROADEN    Recent
    THE RESONANCE (NOT BACKGROUND) CONTRIBUTION TO THE SAME        Recent
    TEMPERATURE AS THE BACKGROUND (E.G., USE PROGRAM SIGMA1).      Recent
                                                                   Recent
ONCE THE RESONANCE AND BACKGROUND CONTRIBUTIONS HAVE BEEN MADE     Recent
COMPATIBLE THEY CAN BE ADDED TOGETHER (E.G., USE PROGRAM MIXER).   Recent
                                                                   Recent
THE RECONSTRUCTION OF THE RESONANCE CONTRIBUTION TO THE CROSS      Recent
SECTION CAN BE QUITE EXPENSIVE (IN TERMS OF COMPUTER TIME). SINCE  Recent
THE RECONSTRUCTION IS PERFORMED BEFORE THE BACKGROUND CROSS        Recent
SECTIONS ARE READ, THE ABOVE CONVENTIONS HAVE BEEN ADOPTED IN      Recent
ORDER TO AVOID LOSE OF COMPUTER TIME INVOLVED IN RECONSTRUCTING    Recent
THE RESONANCE CONTRIBUTION.                                        Recent
                                                                   Recent
COMMON ENERGY GRID                                                 Recent
------------------                                                 Recent
THIS PROGRAM WILL RECONSTRUCT THE RESONANCE CONTRIBUTION TO THE    Recent
TOTAL, ELASTIC, FISSION AND CAPTURE CROSS SECTIONS ALL ON THE      Recent
SAME ENERGY GRID. EACH REACTION WILL THEN BE COMBINED WITH ITS     Recent
BACKGROUND CROSS SECTION (IF ANY) AND OUTPUT WITHOUT ANY FURTHER   Recent
THINNING. IF THERE ARE NO BACKGROUND CROSS SECTIONS, OR IF THE     Recent
BACKGROUND CROSS SECTION FOR ALL FOUR REACTIONS ARE GIVEN ON A     Recent
COMMON ENERGY GRID, THE OUTPUT FROM THIS PROGRAM WILL BE ON A      Recent
COMMON ENERGY GRID FOR ALL FOUR REACTIONS.                         Recent
                                                                   Recent
THERMAL ENERGY                                                     Recent
--------------                                                     Recent
IF THE RESONANCE REGION SPANS THERMAL ENERGY (0.0253 EV) THIS      Recent
POINT IS ALWAYS INCLUDED IN THE COMMON ENERGY GRID USED FOR ALL    Recent
REACTIONS AND WILL ALWAYS APPEAR IN THE OUTPUT DATA.               Recent
                                                                   Recent
SECTION SIZE                                                       Recent
------------                                                       Recent
SINCE THIS PROGRAM USES A LOGICAL PAGING SYSTEM THERE IS NO LIMIT  Recent
TO THE NUMBER OF POINTS IN ANY SECTION, E.G., THE TOTAL CROSS      Recent
SECTION MAY BE REPRESENTED BY 200,000 DATA POINTS.                 Recent
                                                                   Recent
SELECTION OF DATA                                                  Recent
-----------------                                                  Recent
THE PROGRAM SELECTS MATERIALS TO BE PROCESSED BASED EITHER ON      Recent
MAT (ENDF/B MAT NO.) OR ZA. THE PROGRAM ALLOWS UP TO 100 MAT OR    Recent
ZA RANGES TO BE SPECIFIED. THE PROGRAM WILL ASSUME THAT THE        Recent
ENDF/B TAPE IS IN EITHER MAT OR ZA ORDER, WHICHEVER CRITERIA IS    Recent
USED TO SELECT MATERIALS, AND WILL TERMINATE WHEN A MAT OR ZA      Recent
IS FOUND THAT IS ABOVE THE RANGE OF ALL REQUESTS.                  Recent
                                                                   Recent
ALLOWABLE ERROR                                                    Recent
---------------                                                    Recent
THE RECONSTRUCTION OF LINEARLY INTERPOLABLE CROSS SECTIONS FROM    Recent
RESONANCE PARAMETERS CANNOT BE PERFORMED EXACTLY. HOWEVER IT CAN   Recent
BE PERFORMED TO VIRTUALLY ANY REQUIRED ACCURACY AND MOST           Recent
IMPORTANTLY CAN BE PERFORMED TO A TOLERANCE THAT IS SMALL COMPARED Recent
TO THE UNCERTAINTY IN THE CROSS SECTIONS THEMSELVES. AS SUCH THE   Recent
CONVERSION OF CROSS SECTIONS TO LINEARLY INTERPOLABLE FORM CAN BE  Recent
PERFORMED WITH ESSENTIALLY NO LOSS OF INFORMATION.                 Recent
                                                                   Recent
THE ALLOWABLE ERROR MAY BE ENERGY INDEPENDENT (CONSTANT) OR ENERGY Recent
DEPENDENT. THE ALLOWABLE ERROR IS DESCRIBED BY A TABULATED         Recent
FUNCTION OF UP TO 20 (ENERGY,ERROR) PAIRS AND LINEAR INTERPOLATION Recent
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BETWEEN TABULATED POINTS. IF ONLY ONE TABULATED POINT IS GIVEN THE Recent
ERROR WILL BE CONSIDERED CONSTANT OVER THE ENTIRE ENERGY RANGE.    Recent
WITH THIS ENERGY DEPENDENT ERROR ONE MAY OPTIMIZE THE OUTPUT FOR   Recent
ANY GIVEN APPLICATION BY USING A SMALL ERROR IN THE ENERGY RANGE   Recent
OF INTEREST AND A LESS STRINGENT ERROR IN OTHER ENERGY RANGES,     Recent
E.G., 0.1 PER-CENT FROM 0 UP TO THE LOW EV RANGE AND A LESS        Recent
STRINGENT TOLERANCE AT HIGHER ENERGIES.                            Recent
                                                                   Recent
DEFAULT ALLOWABLE ERROR                                            Recent
----------------------                                             Recent
IN ORDER TO INSURE CONVERENCE OF THE RESONANCE RECONSTRUCTION THE  Recent
ALLOWABLE ERROR MUST BE POSITIVE. IF THE USER INPUTS AN ERROR FOR  Recent
RESONANCE RECONSTRUCTION THAT IS NOT POSITIVE IT WILL BE SET TO    Recent
THE DEFAULT VALUE (CURRENTLY 0.1 PER-CENT) AND INDICATED AS SUCH   Recent
IN THE OUTPUT LISTING.                                             Recent
                                                                   Recent
INTERVAL HALVING ALGORITHM                                         Recent
------------------------                                           Recent
THIS PROGRAM WILL START BY CALCULATING THE CROSS SECTIONS AT THE   Recent
ENERGIES CORRESPONDING TO THE PEAK OF EACH RESONANCE, AS WELL AS   Recent
A FIXED NUMBER OF HALF-WIDTHS ON EACH SIDE OF EACH RESONANCE.      Recent
STARTING FROM THIS BASIC GRID OF POINTS THE PROGRAM WILL CONTINUE  Recent
TO HALF EACH INTERVAL UNTIL THE CROSS SECTIONS FOR ALL REACTIONS   Recent
AT THE CENTER OF THE INTERVAL CAN BE DEFINED BY LINEAR             Recent
INTERPOLATION FROM THE ENDS OF THE INTERVAL TO WITHIN THE USER     Recent
SPECIFIED ACCURACY CRITERIA.                                       Recent
                                                                   Recent
DISTANT RESONANCE TREATMENT                                        Recent
---------------------------                                        Recent
THE OPTION TO TREAT DISTANT RESONANCES, WHICH WAS AVAILABLE IN     Recent
EARLIER VERSIONS OF THIS PROGRAM, IS NO LONGER AVAILABLE, BECAUSE  Recent
IT WAS FOUND TO PRODUCE UNRELIABLE RESULTS. IN THIS VERSION OF     Recent
THE PROGRAM ALL RESONANCES ARE TREATED EXACTLY.                    Recent
                                                                   Recent
PROGRAM OPERATION                                                  Recent
================================================================== Recent
EDIT MODE                                                          Recent
---------                                                          Recent
IT IS SUGGESTED THAT BEFORE RUNNING THIS PROGRAM TO RECONSTRUCT    Recent
CROSS SECTIONS FROM RESONANCE PARAMETERS (WHICH CAN BE QUITE       Recent
EXPENSIVE) THE USER FIRST RUN THE PROGRAM IN THE EDIT MODE (SEE,   Recent
DESCRIPTION OF INPUT PARAMETERS BELOW). IN THE EDIT MODE THE       Recent
PROGRAM WILL READ, LIST AND EXTENSIVELY CHECK THE CONSISTENCY OF   Recent
ALL RESONANCE PARAMETERS AND ENDF/B DEFINED RESONANCE FLAGS. THIS  Recent
IS A VERY INEXPENSIVE MEANS OF CHECKING ALL DATA BEFORE INVESTING  Recent
A LARGE AMOUNT OF MONEY IN RECONSTRUCTING CROSS SECTIONS. ANY AND  Recent
ALL DIGNOSTICS RECEIVED FROM THE EDIT WILL SUGGEST HOW TO CORRECT  Recent
THE EVALUATED DATA TO MAKE IT CONSISTENT BEFORE RECONSTRUCTING     Recent
CROSS SECTIONS. IN ORDER TO OBTAIN MEANINGFUL RESULTS FROM THE     Recent
RECONSTRUCTION ALL SUGGESTED CHANGES TO THE EVALUATION SHOULD BE   Recent
PERFORMED BEFORE TRYING RECONSTRUCTION (OTHERWISE THE RESULT OF    Recent
RECONSTRUCTION WILL NOT BE RELIABLE).                              Recent
                                                                   Recent
RECONSTRUCTION MODE                                                Recent
-------------------                                                Recent
FOR EACH REQUESTED MATERIAL                                        Recent
---------------------------                                        Recent
IF SECTION MF=1, MT=451 IS PRESENT COMMENTS WILL BE ADD TO         Recent
DOCUMENT THAT THE MATERIAL HAS BEEN PROCESSED. MF=1, MT=451 WILL   Recent
ALSO BE USED TO DETERMINE THE VERSION OF THE ENDF/B FORMAT WHICH   Recent
WILL ALLOW THE PROGRAM TO USE THE APPROPRIATE CONVENTIONS.         Recent
                                                                   Recent
ALL OF THE FILE 2 RESONANCE PARAMETERS ARE FIRST READ AND THE      Recent
LINEARLY INTERPOLABLE CONTRIBUTION OF THE RESONANCE PARAMETERS     Recent
TO THE TOTAL, ELASTIC, CAPTURE AND FISSION CROSS SECTIONS IS       Recent
CALCULATED SIMULTANEOUSLY USING A COMMON ENERGY GRID FOR ALL       Recent
FOUR REACTIONS.                                                    Recent
                                                                   Recent
AFTER THE RESONANCE CONTRIBUTION HAS BEEN RECONSTRUCTED EACH OF    Recent
THE FIVE REACTIONS (MT=1, 2, 18, 19, 102) IS CONSIDERED SEPARATELY Recent
FOR COMBINATION WILL THE BACKGROUND CROSS SECTION, IF ANY, AS      Recent
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DESCRIBED ABOVE.                                                    Recent
                                                                    Recent
OUTPUT WILL INCLUDE THE ENTIRE EVALUATION, INCLUDING RESONANCES     Recent
PARAMETERS WITH LRU MODIFIED (AS DESCRIBED ABOVE) TO INDICATE       Recent
THAT THE RESONANCE CONTRIBUTION HAS ALREADY BEEN ADDED TO THE       Recent
FILE 3 CROSS SECTIONS.                                              Recent
                                                                    Recent
THE CYCLE OF RECONSTRUCTING THE RESONANCE CONTRIBUTION AND ADDING   Recent
THE BACKGROUND WILL BE REPEATED FOR EACH MATERIAL REQUESTED.        Recent
                                                                    Recent
PROCESS ONLY A PORTION OF RESONANCE REGION                          Recent
================================================================== Recent
MODERN EVALUATIONS MAY BE EXTREMELY LARGE AND IT MAY NOT BE         Recent
POSSIBLE TO PROCESS AN ENTIRE EVALUATION (I.E., ADD THE RESONANCE   Recent
CONTRIBUTION) DURING A SINGLE COMPUTER RUN.                         Recent
                                                                    Recent
ALSO IN THE CASE WHERE YOU ARE ONLY INTERESTED IN THE CROSS         Recent
SECTIONS OVER A SMALL ENERGY RANGE, YOU MAY NOT WANT TO PROCESS     Recent
AN ENTIRE EVALUATION, E.G., IF YOU ONLY WANT TO KNOW WHAT THE       Recent
CROSS SECTIONS ARE NEAR THERMAL ENERGY, 0.0253 EV.                  Recent
                                                                    Recent
IN ORDER TO ALLOW AN EVALUATION TO BE PROCESSED USING A NUMBER OF   Recent
SHORTER COMPUTER RUNS AN OPTION HAS BEEN ADDED TO THIS PROGRAM TO   Recent
ALLOW THE USER TO SPECIFY THE ENERGY RANGE TO BE PROCESSED.         Recent
                                                                    Recent
USING THIS OPTION YOU MAY START AT THE LOWEST ENERGY (ZERO UP TO    Recent
SOME ENERGY) AND USE THE RESULTS OF THIS RUN AS INPUT TO THE        Recent
NEXT RUN, WHERE YOU CAN SPECIFY THE NEXT ENERGY RANGE. THIS         Recent
CYCLE CAN BE REPEATED UNTIL YOU HAVE PROCESSED THE ENTIRE           Recent
EVALUATION.                                                         Recent
                                                                    Recent
WARNING - THIS OPTION SHOULD BE USED WITH EXTREME CARE - THIS       Recent
OPTION HAS BEEN RELUCTANTLY ADDED - RELUCTANTLY BECAUSE IT CAN      Recent
BE EXTREMELY DANGEROUS TO USE THIS OPTION UNLESS YOU CAREFULLY      Recent
CHECKED WHAT YOU ARE DOING.                                         Recent
                                                                    Recent
THE OPTION SHOULD ONLY BE USED AS FOLLOWS,                          Recent
1) YOU MUST PROCESS USING ENERGY RANGES STARTING AT LOW ENERGY      Recent
   AND WORKING YOUR WAY TOWARD HIGH ENERGY, E.G.,                   Recent
    0.0   TO  3.0+3                                                Recent
    3.0+3 TO 10.0+3                                                 Recent
   10.0+3 TO 80.0+3, ETC.                                           Recent
2) FOR THE LAST ENERGY RANGE THE LOWER ENERGY LIMIT MUST BE         Recent
   NON-ZERO (WHERE TO START) AND THE UPPER ENERGY LIMIT MUST        Recent
   BE ZERO (NO LIMIT)                                               Recent
   80.0+3 TO  0.0                                                   Recent
                                                                    Recent
IF YOU ARE ONLY INTERESTED IN THE CROSS SECTION OVER A NARROW       Recent
ENERGY INTERVAL AND DO NOT INTENT TO MAKE ANY OTHER USE OF THE      Recent
RESULTS, YOU CAN IGNORE THESE WARNINGS AND MERELY SPECIFY ANY       Recent
ENERGY INTERVAL OVER WHICH YOU WISH CALCULATIONS TO BE               Recent
PERFORMED.                                                          Recent
                                                                    Recent
NORMALLY WHEN THIS PROGRAM PROCESSES AN EVALUATION IT WILL SET      Recent
FLAGS IN THE EVALUATION TO PREVENT THE SAME RESONANCE               Recent
CONTRIBUTION FROM BEING ADDED TO THE CROSS SECTION MORE THAN        Recent
ONCE, SHOULD YOU USE THE OUTPUT FROM THIS PROGRAM AS INPUT TO       Recent
THE PROGRAM.                                                        Recent
                                                                    Recent
WHEN PROCESSING ONLY PORTIONS OF THE RESONANCE REGION THIS          Recent
PROGRAM CANNOT SET THESE FLAGS TO PROTECT AGAINST ADDING THE        Recent
RESONANCE CONTRIBUTION MORE THAN ONCE - WHICH MAKES USE OF          Recent
THIS OPTION EXTREMELY DANGEROUS.                                    Recent
                                                                    Recent
ONLY YOU CAN CHECK TO MAKE SURE THAT YOU HAVE CORRECTLY             Recent
INCLUDED EACH ENERGY RANGE ONLY ONCE - SEE THE COMMENT LINES        Recent
AT THE END OF SECTION, MF=1, MT=451, FOR A COMPLETE RECORD          Recent
OF EACH RUN USING THIS PROGRAM. THIS SECTION WILL CONTAIN            Recent
LINES OF THE FORM                                                   Recent
                                                                    Recent
***************** PROGRAM RECENT (VERSION 2004-1) *************     Recent
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ONLY PROCESS  0.00000+ 0 TO  3.00000+ 3 EV                          Recent
***************** PROGRAM RECENT (VERSION 2004-1) *************    Recent
ONLY PROCESS  3.00000+ 3 TO  1.00000+ 4 EV                          Recent
***************** PROGRAM RECENT (VERSION 2004-1) *************    Recent
ONLY PROCESS  1.00000+ 4 TO  8.00000+ 4 EV                          Recent
***************** PROGRAM RECENT (VERSION 2004-1) *************    Recent
ONLY PROCESS  8.00000+ 4 TO  2.00000+ 7 EV                          Recent
                                                                    Recent
YOU SHOULD CHECK TO INSURE THAT THERE ARE NO OVERLAPPING ENERGY      Recent
RANGES OR MISSING ENERGY RANGES.                                    Recent
                                                                    Recent
WHEN YOU INDICATE BY INPUT THAT YOU ARE ABOUT TO PROCESS THE        Recent
LAST ENERGY RANGE (SEE ABOVE, LOWER ENERGY LIMIT = NON-ZERO,        Recent
UPPER ENERGY LIMIT = ZERO), THIS PROGRAM WILL ASSUME THAT           Recent
YOU HAVE NOW COMPLETED ALL PROCESSING - AND ONLY THEN WILL          Recent
IT SET FLAGS IN THE EVALUATION TO PREVENT THE RESONANCE             Recent
CONTRIBUTION FROM BEING ADDED MORE THAN ONCE. FOR THIS REASON       Recent
YOU CANNOT PROCESS STARTING WITH ENERGY INTERVALS AT HIGH            Recent
ENERGY AND WORKING TOWARD LOW ENERGY - YOU MUST START AT LOW        Recent
ENERGY AND WORK TOWARD HIGH ENERGY.                                 Recent
                                                                    Recent
I/O FILES                                                           Recent
=================================================================== Recent
INPUT FILES                                                         Recent
-----------                                                         Recent
UNIT  DESCRIPTION                                                   Recent
----  -----------                                                   Recent
  2   INPUT LINE (BCD - 80 CHARACTERS/RECORD)                       Recent
 10   ORIGINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)             Recent
                                                                    Recent
OUTPUT FILES                                                        Recent
------------                                                        Recent
UNIT  DESCRIPTION                                                   Recent
----  -----------                                                   Recent
  3   OUTPUT REPORT (BCD - 120 CHARACTERS/RECORD)                   Recent
 11   FINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)                Recent
                                                                    Recent
SCRATCH FILES                                                       Recent
-------------                                                       Recent
UNIT  DESCRIPTION                                                   Recent
----  -----------                                                   Recent
 12   SCRATCH FILE FOR DATA RECONSTRUCTED FROM RESONANCE            Recent
      PARAMETERS (BINARY - 100200 WORDS/RECORD)                     Recent
 14   SCRATCH FILE FOR COMBINED FILE 2 AND 3 DATA                   Recent
      (BINARY - 40080 WORDS/RECORD)                                 Recent
                                                                    Recent
OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILEIO)                Recent
=================================================================== Recent
UNIT  FILE NAME                                                     Recent
----  ----------                                                    Recent
  2   RECENT.INP                                                    Recent
  3   RECENT.LST                                                    Recent
 10   ENDFB.IN                                                      Recent
 11   ENDFB.OUT                                                     Recent
 12   (SCRATCH)                                                     Recent
 14   (SCRATCH)                                                     Recent
                                                                    Recent
INPUT CARDS                                                         Recent
=================================================================== Recent
LINE  COLS.  FORMAT  DESCRIPTION                                    Recent
----  -----  ------  -----------                                    Recent
  1    1-11    I11   RETRIEVAL CRITERIA (0=MAT, 1=ZA)              Recent
                     THIS OPTION DEFINED WHETHER COLUMNS 1-22 OF    Recent
                     SUBSEQUENT INPUT CARDS SHOULD BE INTERPRETED   Recent
                     TO BE MAT OR ZA RANGES.                        Recent
      12-22   E11.4  FILE 2 MINIMUM ABSOLUTE CROSS SECTION          Recent
                     (IF 1.0E-10 OR LESS IS INPUT THE PROGRAM       Recent
                     WILL USE 1.0E-10)                              Recent
      23-33    I11   TREATMENT OF REACTIONS FOR WHICH BACKGROUND    Recent
                     CROSS SECTION IS NOT GIVEN.                    Recent
                     = 0 - IGNOR (I.E. NO OUTPUT)                   Recent
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                    = 1 - OUTPUT RESONANCE CONTRIBUTION.          Recent
                    THIS OPTION IS USEFUL WITH PARTIAL EVALUATION Recent
                    (E.G. ENDF/B-V DOSIMETRY LIBRARY) WHERE ONLY  Recent
                    ONE OR MORE OF THE REACTIONS ARE OF ACTUAL    Recent
                    INTEREST.                                     Recent
                    WARNING...THE USE OF THIS FIELD HAS BEEN      Recent
                    CHANGED. THIS FIELD WAS PREVIOUSLY USED TO    Recent
                    DEFINE THE PRECISION OF THE CALCULATION AND   Recent
                    OUTPUT. THE FORMER DEFINITION OF THIS FIELD   Recent
                    WAS...                                        Recent
                    MINIMUM ENERGY SPACING FLAG                   Recent
                    = 0 - 6 DIGIT MINIMUM ENERGY SPACING.         Recent
                          STANDARD 6 DIGIT E11.4 OUTPUT.          Recent
                    = 1 - 9 DIGIT MINIMUM ENERGY SPACING.         Recent
                          STANDARD 6 DIGIT E11.4 OUTPUT.          Recent
                    = 2 - 9 DIGIT MINIMUM ENERGY SPACING.         Recent
                          VARIABLE 9 DIGIT F FORMAT OUTPUT.       Recent
                    FROM EXPERIENCE IT HAS BEEN FOUND THAT        Recent
                    FAILURE TO SET THIS OPTION TO 2 CAN RESULT    Recent
                    IN LARGE ERRORS IN THE FINAL DATA. THEREFORE  Recent
                    INTERNALLY THIS OPTION IS SET TO 2.           Recent
          34-44     I11   OPERATING MODE                          Recent
                    = 0 - CACULATE. MINIMUM OUTPUT LISTING        Recent
                    = 1 - CACULATE. LIST ALL RESONANCE PARAMETERS Recent
                    = 2 - EDIT MODE. NO CALCULATION. LIST ALL     Recent
                          RESONANCE PARAMETERS.                   Recent
                    NOTE, THE EDIT MODE (=2) IS THE SUGGESTED     Recent
                    MODE TO FIRST TEST THE CONSISTENCY OF THE     Recent
                    EVALUATED DATA, BEFORE RECONSTRUCTING CROSS   Recent
                    SECTIONS (SEE, COMMENTS ABOVE).               Recent
          45-55     I11   THIS OPTION IS NO LONGER USED. THE PREVIOUS Recent
                    DEFINITION OF THIS OPTION WAS---DISTANT       Recent
                    RESONANCE TREATMENT.                          Recent
                    = 0 - EXACT                                   Recent
                    = 1 - LINEAR RATIO OVER SUBINTERVAL           Recent
                    = 2 - LINEAR RATIO OVER INTERVAL              Recent
                    ALL RESONANCES ARE TREATED EXACTLY IN THIS    Recent
                    VERSION OF THE CODE.                          Recent
          56-66     I11   MONITOR MODE SELECTOR                   Recent
                    = 0 - NORMAL OPERATION                        Recent
                    = 1 - MONITOR PROGRESS OF RECONSTRUCTION OF   Recent
                          FILE 2 DATA AND COMBINING FILE 2 AND    Recent
                          FILE 3 DATA. EACH TIME A PAGE OF DATA   Recent
                          POINTS IS WRITTEN TO A SCRATCH FILE     Recent
                          PRINT OUT THE TOTAL NUMBER OF POINTS    Recent
                          ON SCRATCH AND THE LOWER AND UPPER      Recent
                          ENERGY LIMITS OF THE PAGE (THIS OPTION  Recent
                          MAY BE USED IN ORDER TO MONITOR THE     Recent
                          EXECUTION SPEED OF LONG RUNNING JOBS).  Recent
     2     1-60     A60   ENDF/B INPUT DATA FILENAME              Recent
                          (STANDARD OPTION = ENDFB.IN)            Recent
     3     1-60     A60   ENDF/B OUTPUT DATA FILENAME             Recent
                          (STANDARD OPTION = ENDFB.OUT)           Recent
   4-N     1-11     I11   MINIMUM MAT OR ZA (SEE COLS. 1-11, LINE 1) Recent
          12-22     I11   MAXIMUM MAT OR ZA (SEE COLS. 1-11, LINE 1) Recent
                    UP TO 100 MAT OR ZA RANGES MAY BE SPECIFIED,  Recent
                    ONE RANGE PER LINE. THE LIST IS TERMINATED    Recent
                    BY A BLANK LINE. IF THE THE UPPER LIMIT OF    Recent
                    ANY REQUEST IS LESS THAN THE LOWER LIMIT THE  Recent
                    UPPER LIMIT WILL BE SET EQUAL TO THE LOWER    Recent
                    LIMIT. IF THE FIRST REQUEST LINE IS BLANK IT  Recent
                    WILL TERMINATE THE REQUEST LIST AND CAUSE ALL Recent
                    DATA TO BE RETRIEVED (SEE EXAMPLE INPUT).     Recent
          23-33   E11.4  LOWER ENERGY LIMIT FOR PROCESSING.       Recent
          34-44   E11.4  UPPER ENERGY LIMIT FOR PROCESSING.       Recent
                   *THE LOWER AND UPPER ENERGY LIMITS MUST BE     Recent
                    ZERO, OR BLANK, UNLESS YOU WISH TO ONLY       Recent
                    PROCESS A PORTION OF RESONANCE REGIONS.       Recent
                   *THESE ENERGY LIMITS ARE ONLY READ FROM THE    Recent
                    FIRST MAT/ZA REQUEST LINE                     Recent
                   *IF BOTH ARE ZERO (OR BLANK) THE ENTIRE        Recent
```

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                        RESONANCE REGION FOR EACH MATERIAL WILL BE    Recent
                        PROCESSED                                     Recent
                       *IF LIMITS ARE INPUT ONLY THAT PORTION OF THE  Recent
                        RESONANCE REGION FOR EACH MATERIAL WHICH      Recent
                        LIES BETWEEN THESE LIMITS WILL BE PROCESSED   Recent
                       *SEE INSTRUCTIONS ABOVE BEFORE USING THIS      Recent
                        OPTION.                                       Recent
    VARY   1-11   E11.4  ENERGY FOR FILE 2 ERROR LAW     (  SEE   )    Recent
          12-22   E11.4  ERROR FOR FILE 2 ERROR LAW      (COMMENTS)    Recent
                                                        ( BELOW  )    Recent
                                                                      Recent
    NOTE, THIS VERSION OF THE PROGRAM DOES NOT THIN THE COMBINED FILE  Recent
    FILE 2 + 3 DATA. AS SUCH THE ERROR LAW FOR COMBINING FILE 2 + 3    Recent
    WHICH WAS REQUIRED IN EARLIER VERSIONS OF THIS CODE ARE NO LONGER  Recent
    REQUIRED.                                                         Recent
                                                                      Recent
    THE FILE 2 ERROR LAW MAY BE ENERGY INDEPENDENT (DEFINED BY A       Recent
    SINGLE ERROR) OR ENERGY DEPENDENT (DEFINED BY UP TO 20 ENERGY,     Recent
    ERROR PAIRS). FOR THE ENERGY DEPENDENT CASE LINEAR INTERPOLATION   Recent
    WILL BE USED TO DEFINE THE ERROR AT ENERGIES BETWEEN THOSE AT      Recent
    WHICH THE ERROR IS TABULATED. THE ERROR LAW IS TERMINATED BY A     Recent
    BLANK LINE. IF ONLY ONE ENERGY, ERROR PAIR IS GIVEN THE LAW WILL   Recent
    BE CONSIDERED TO BE ENERGY INDEPENDENT. IF MORE THAN ONE PAIR      Recent
    IS GIVEN IT BE CONSIDERED TO BE ENERGY DEPENDENT (NOTE, THAT       Recent
    FOR A CONSTANT ERROR THE ENERGY INDEPENDENT FORM WILL RUN FASTER.  Recent
    HOWEVER, FOR SPECIFIC APPLICATIONS AN ENERGY DEPENDENT ERROR MAY   Recent
    BY USED TO MAKE THE PROGRAM RUN CONSIDERABLE FASTER).              Recent
                                                                      Recent
    ALL ENERGIES MUST BE IN ASCENDING ENERGY ORDER. FOR CONVERGENCE    Recent
    OF THE FILE 2 RECONSTRUCTION ALGORITHM ALL THE ERRORS MUST BE      Recent
    POSITIVE. IF ERROR IS NOT POSITIVE IT WILL BE SET EQUAL TO THE     Recent
    STANDARD OPTION (CURRENTLY 0.001, CORRRESPONDING TO 0.1 PER-CENT). Recent
    IF THE FIRST LINE OF THE ERROR LAW IS BLANK IT WILL TERMINATE THE   Recent
    ERROR LAW AND THE ERROR WILL BE TREATED AS ENERGY INDEPENDENT,      Recent
    EQUAL TO THE STANDARD OPTION (CURRENTLY, 0.1 PER-CENT). SEE,       Recent
    EXAMPLE INPUT 4.                                                  Recent
                                                                      Recent
    EXAMPLE INPUT NO. 1                                               Recent
    ------------------                                                Recent
    CONSIDER ALL URANIUM ISOTOPES AND TH-232. CONSIDER CROSS SECTIONS  Recent
    WHICH ARE LARGER THAN 1.0E-8 BARNS IN ABSOLUTE VALUE. ONLY OUTPUT  Recent
    REACTIONS FOR WHICH A BACKGROUND IS GIVEN. LIST ALL PARAMETERS AND Recent
    CALCULATE CROSS SECTIONS. MONITOR THE EXECUTION PROGRESS OF THE    Recent
    PROGRAM. BETWEEN 0 AND 100 EV USE 0.1 PER-CENT ACCURACY. BETWEEN   Recent
    100 EV AND 1 KEV VARY THE ACCURACY FROM 0.1 TO 1 PER-CENT. ABOVE   Recent
    1 KEV USE 1 PER-CENT ACCURACY.                                    Recent
                                                                      Recent
    EXPLICITLY SPECIFY THE STANDARD FILENAMES.                        Recent
                                                                      Recent
    THE FOLLOWING 11 INPUT CARDS ARE REQUIRED.                        Recent
                                                                      Recent
         1 1.00000-08          0          1          0         1      Recent
ENDFB.IN                                                              Recent
ENDFB.OUT                                                             Recent
     92000      92999                                                 Recent
     90232                  (UPPER LIMIT AUTOMATICALLY SET TO 90232)   Recent
                            (END REQUEST LIST)                        Recent
0.00000+ 0 1.00000-03                                                 Recent
1.00000+02 1.00000-03                                                 Recent
1.00000+03 1.00000-02                                                 Recent
1.00000+09 1.00000-02                                                 Recent
                            (END FILE 2 ERROR LAW)                    Recent
                                                                      Recent
    EXAMPLE INPUT NO. 2                                               Recent
    ------------------                                                Recent
    CONSIDER ALL URANIUM ISOTOPES AND TH-232. CONSIDER CROSS SECTIONS  Recent
    WHICH ARE LARGER THAN 1.0E-8 BARNS IN ABSOLUTE VALUE. ONLY OUTPUT  Recent
    REACTIONS FOR WHICH A BACKGROUND IS GIVEN. CROSS SECTIONS WILL BE  Recent
    CALCULATED, BUT PARAMETERS WILL NOT BE LISTED. THE PROGRESS OF THE Recent
    PROGRAM WILL NOT BE MONITORED. USE 0.1 PER-CENT ACCURACY FOR ALL   Recent
    ENERGIES. SINCE 0.1 PER-CENT IS THE STANDARD OPTION FOR THE ERROR  Recent
```

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    LAW THE FIRST ERROR LAW LINE MAY BE LEFT BLANK.                    Recent
                                                                       Recent
    LEAVE THE DEFINITION OF THE FILENAMES BLANK - THE PROGRAM WILL     Recent
    THEN USE THE STANDARD FILENAMES.                                   Recent
                                                                       Recent
    THE FOLLOWING 7 INPUT CARDS ARE REQUIRED.                          Recent
                                                                       Recent
         1 1.00000-08          0          0          0         0      Recent
                                                                       Recent
                                                                       Recent
     92000      92999                                                  Recent
     90232                  (UPPER LIMIT AUTOMATICALLY SET TO 90232)   Recent
                            (END REQUEST LIST)                         Recent
                            (USE STANDARD OPTION FOR ERROR LAW)        Recent
                                                                       Recent
    EXAMPLE INPUT NO. 3                                                Recent
    ------------------                                                 Recent
    THE SAME AS EXAMPLE INPUT NO. 2, ONLY IN THIS CASE ONLY CALCULATE  Recent
    CROSS SECTIONS OVER THE ENERGY RANGE 0.01 TO 0.1 EV - ACROSS THE   Recent
    THERMAL ENERGY RANGE. NOTE, THE ONLY DIFFERENCE BETWEEN THE INPUT  Recent
    PARAMETERS IN THIS CASE AND IN EXAMPLE NO. 2, IS THAT ON THE       Recent
    SECOND INPUT LINE WE HAVE ADDED THE ENERGY RANGE 0.01 TO 0.1 EV.   Recent
    USE \PREPRO94\LINEAR\ENDFB.OUT AS INPUT AND ENDFB.OUT AS OUTPUT -  Recent
    SINCE ENDFB.OUT IS THE STANDARD OUTPUT FILENAME THE NAME CAN BE    Recent
    EITHER INCLUDED IN THE INPUT OR LEFT BLANK.                        Recent
                                                                       Recent
    THE FOLLOWING 7 INPUT CARDS ARE REQUIRED.                          Recent
                                                                       Recent
         1 1.00000-08          0          0          0         0      Recent
\PREPRO94\LINEAR\ENDFB.OUT                                             Recent
ENDFB.OUT                                                              Recent
     92000      92999 1.00000- 2 1.00000- 1                            Recent
     90232                  (UPPER LIMIT AUTOMATICALLY SET TO 90232)   Recent
                            (END REQUEST LIST)                         Recent
                            (USE STANDARD OPTION FOR ERROR LAW)        Recent
                                                                       Recent
    EXAMPLE INPUT NO. 4                                                Recent
    ------------------                                                 Recent
    RECONSTRUCT ALL DATA. OUTPUT ALL REACTIONS, REGARDING OF WHETHER   Recent
    OR NOT THERE IS A BACKGROUND CROSS SECTION. DO NOT MONITOR THE     Recent
    PROGRESS OF THE PROGRAM. RECONSTRUCT CROSS SECTIONS TO 1 PER-CENT  Recent
    ACCURACY. USE \ENDFB6\LINEAR\ZA092238 AS INPUT AND                 Recent
    \ENDFB6\RECENT\ZA092238 AS OUTPUT.                                 Recent
                                                                       Recent
    THE FOLLOWING 6 INPUT CARDS ARE REQUIRED.                          Recent
                                                                       Recent
         0 0.0                 1          0          0         0      Recent
\ENDFB6\ZA092238                                                       Recent
\ENDFB6\RECENT\ZA092238                                                Recent
                   (RETRIEVE ALL DATA, END REQUEST LIST)               Recent
           1.00000- 2                                                  Recent
                   (END FILE 2 ERROR LAW)                              Recent
                                                                       Recent
    EXAMPLE INPUT NO. 5                                                Recent
    ------------------                                                 Recent
    RECONSTRUCT ALL DATA. ONLY OUTPUT REACTIONS FOR WHICH A BACKGROUND Recent
    CROSS SECTION IS GIVEN. DO NOT MONITOR THE PROGRESS OF THE PROGRAM Recent
    RECONSTRUCT CROSS SECTIONS TO 0.1 PER-CENT ACCURACY. USE ENDFB.IN  Recent
    AS INPUT AND ENDFB.OUT AS OUTPUT.                                  Recent
                                                                       Recent
    THIS CORRESPONDS TO USING ALL OF THE STANDARD OPTONS BUILT-IN TO   Recent
    THE PROGRAM AND ALL INPUT CARDS MAY BE BLANK.                      Recent
                                                                       Recent
    IN THIS CASE THE FOLLOWING 5 INPUT CARDS ARE REQUIRED.             Recent
    (ZEROES ARE INDICATED ON THE FIRST LINE, BELOW, ONLY TO INDICATE   Recent
    WHERE THE LINE IS. THE ACTUAL INPUT LINE CAN BE COMPLETELY BLANK). Recent
                                                                       Recent
         0 0.0                 0          0          0         0      Recent
                   (USE STANDARD INPUT FILENAME = ENDFB.IN)            Recent
                   (USE STANDARD OUTPUT FILENAME = ENDFB.OUT)          Recent
                   (RETRIEVE ALL DATA, END REQUEST LIST)               Recent
```

```
                    (0.1 ERROR, END FILE 2 ERROR LAW)               Recent
                                                                    Recent
====================================================================== Recent
```