```
====================================================================== Linear
                                                                       Linear
     PROGRAM LINEAR                                                    Linear
     VERSION 74-1 (MAY 1974)                                           Linear
     VERSION 75-1 (APRIL 1975)                                         Linear
     VERSION 76-2 (OCTOBER 1976)                                       Linear
     VERSION 77-1 (JANUARY 1977)                                       Linear
     VERSION 78-1 (JULY 1978)                                          Linear
     VERSION 79-1 (JULY 1979) CDC-7600 AND CRAY-1 VERSION.             Linear
     VERSION 80-1 (MAY 1980) IBM, CDC AND CRAY VERSION.                Linear
     VERSION 80-2 (DECEMBER 1980)                                      Linear
     VERSION 81-1 (MARCH 1981)                                         Linear
     VERSION 82-1 (JANUARY 1982) IMPROVED COMPUTER COMPATIBILITY.      Linear
     VERSION 83-1 (JANUARY 1983) *MAJOR RE-DESIGN.                     Linear
                                 *PAGE SIZE INCREASED - 1002 TO 3006.  Linear
                                 *ELIMINATED COMPUTER DEPENDENT CODING. Linear
                                 *NEW, MORE COMPATIBLE I/O UNIT NUMBER. Linear
                                 *ADDED OPTION TO KEEP ALL ORIGINAL    Linear
                                  ENERGY POINTS FROM EVALUATION.       Linear
                                 *ADDED STANDARD ALLOWABLE ERROR OPTION Linear
                                  (CURRENTLY 0.1 PER-CENT).            Linear
     VERSION 83-2 (OCTOBER 1983) IMPROVED BASED ON USER COMMENTS.      Linear
     VERSION 84-1 (APRIL 1984)   IMPROVED BASED ON USER COMMENTS.      Linear
     VERSION 84-2 (JUNE 1984)   *UPDATED FOR ENDF/B-VI FORMATS.       Linear
                                *SPECIAL I/O ROUTINES TO GUARANTEE     Linear
                                 ACCURACY OF ENERGY.                   Linear
                                *DOUBLE PRECISION TREATMENT OF ENERGY  Linear
                                 (REQUIRED FOR NARROW RESONANCES).     Linear
     VERSION 85-1 (AUGUST 1985) *FORTRAN-77/H VERSION                  Linear
     VERSION 86-1 (JANUARY 1986)*ENDF/B-VI FORMAT                      Linear
     VERSION 87-1 (JANUARY 1987)*DOUBLE PRECISION TREATMENT OF CROSS   Linear
                                 SECTION                               Linear
     VERSION 88-1 (JULY 1988)   *OPTION...INTERNALLY DEFINE ALL I/O    Linear
                                 FILE NAMES (SEE, SUBROUTINE FILEIO    Linear
                                 FOR DETAILS).                         Linear
                                *IMPROVED BASED ON USER COMMENTS.      Linear
     VERSION 89-1 (JANUARY 1989)*PSYCHOANALYZED BY PROGRAM FREUD TO    Linear
                                 INSURE PROGRAM WILL NOT DO ANYTHING   Linear
                                 CRAZY.                                Linear
                                *UPDATED TO USE NEW PROGRAM CONVERT    Linear
                                 KEYWORDS.                             Linear
                                *ADDED LIVERMORE CIVIC COMPILER        Linear
                                 CONVENTIONS.                          Linear
     VERSION 90-1 (JUNE 1990)   *EXTENDED TO LINEARIZE PHOTON          Linear
                                 INTERACTION DATA, MF=23 AND 27        Linear
                                *ADDED FORTRAN SAVE OPTION             Linear
                                *UPDATED BASED ON USER COMMENTS.       Linear
                                *NEW MORE CONSISTENT ENERGY OUTPUT     Linear
                                 ROUTINE.                              Linear
                                *WARNING...INPUT PARAMETER FORMAT      Linear
                                 HAS BEEN CHANGED...SEE DESCRIPTION    Linear
                                 BELOW.                                Linear
     VERSION 91-1 (JULY 1991)   *ADDED INTERPOLATION LAW 6 - ONLY USED Linear
                                 FOR CHARGED PARTICLE CROSS SECTIONS   Linear
                                 FOR COULOMB PENETRABILITIES.          Linear
     VERSION 92-1 (JANUARY 1992)*ADDED NU-BAR (TOTAL, DELAYED, PROMPT) Linear
                                 POLYNOMIAL OR TABULATED ALL CONVERTED Linear
                                 TO LINEARLY INTERPOLABLE              Linear
                                *INCREASED PAGE SIZE FROM 3006 TO 5010 Linear
                                 POINTS.                               Linear
                                *ALL ENERGIES INTERNALLY ROUNDED PRIOR Linear
                                 TO CALCULATIONS.                      Linear
                                *COMPLETELY CONSISTENT I/O AND ROUNDING Linear
                                 ROUTINES - TO MINIMIZE COMPUTER       Linear
                                 DEPENDENCE.                           Linear
     VERSION 92-2 (JULY 1992)   *CORRECTED CONVERSION OF NU-BAR FROM   Linear
                                 POLYNOMIAL TO TABULATED - COPY        Linear
                                 SPONTANEOUS NU-BAR (BY DEFINITION     Linear
                                 THE SPONTANEOUS NU-BAR IS NOT AN      Linear
                                 ENERGY DEPENDENT QUANTITY).           Linear
     VERSION 93-1 (MARCH 1993)  *UPDATED FOR USE WITH LAHEY COMPILER   Linear
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                          ON IBM-PCS.                                Linear
                         *INCREASED PAGE SIZE FROM 5010 TO           Linear
                          30000 POINTS                               Linear
VERSION 94-1 (JANUARY 1994)*VARIABLE ENDF/B DATA FILENAMES           Linear
                          TO ALLOW ACCESS TO FILE STRUCTURES          Linear
                          (WARNING - INPUT PARAMETER FORMAT           Linear
                          HAS BEEN CHANGED)                          Linear
                         *CLOSE ALL FILES BEFORE TERMINATING         Linear
                          (SEE, SUBROUTINE ENDIT)                    Linear
VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                       Linear
                          *IMPROVED COMPUTER INDEPENDENCE            Linear
                          *ALL DOUBLE PRECISION                      Linear
                          *ON SCREEN OUTPUT                          Linear
                          *UNIFORM TREATMENT OF ENDF/B I/O           Linear
                          *IMPROVED OUTPUT PRECISION                 Linear
                          *DEFINED SCRATCH FILE NAMES                Linear
                          *ALWAYS INCLUDE THERMAL VALUE              Linear
                          *INCREASED PAGE SIZE FROM 30000 TO         Linear
                           60000 POINTS                              Linear
VERSION 99-1 (MARCH 1999)   *CORRECTED CHARACTER TO FLOATING         Linear
                           POINT READ FOR MORE DIGITS                Linear
                          *UPDATED TEST FOR ENDF/B FORMAT            Linear
                           VERSION BASED ON RECENT FORMAT CHANGE     Linear
                          *GENERAL IMPROVEMENTS BASED ON             Linear
                           USER FEEDBACK                             Linear
VERSION 99-2 (JUNE 1999)    *ASSUME ENDF/B-VI, NOT V, IF MISSING     Linear
                           MF=1, MT-451.                             Linear
VERS. 2000-1 (FEBRUARY 2000)*ADDED MF = 9 AND 10 LINEARIZATION       Linear
                          *GENERAL IMPROVEMENTS BASED ON             Linear
                           USER FEEDBACK                             Linear
VERS. 2002-1 (MAY 2002)     *OPTIONAL INPUT PARAMETERS               Linear
VERS. 2004-1 (JAN. 2004)    *GENERAL UPDATE BASED ON USER FEEDBACK   Linear
                                                                     Linear
OWNED, MAINTAINED AND DISTRIBUTED BY                                 Linear
-----------------------------------                                  Linear
THE NUCLEAR DATA SECTION                                             Linear
INTERNATIONAL ATOMIC ENERGY AGENCY                                   Linear
P.O. BOX 100                                                         Linear
A-1400, VIENNA, AUSTRIA                                              Linear
EUROPE                                                               Linear
                                                                     Linear
ORIGINALLY WRITTEN BY                                                Linear
---------------------------------                                    Linear
DERMOTT E. CULLEN                                                    Linear
UNIVERSITY OF CALIFORNIA                                             Linear
LAWRENCE LIVERMORE NATIONAL LABORATORY                               Linear
L-159                                                                Linear
P.O. BOX 808                                                         Linear
LIVERMORE, CA 94550                                                  Linear
U.S.A.                                                               Linear
TELEPHONE  925-423-7359                                              Linear
E. MAIL    CULLEN1@LLNL.GOV                                          Linear
WEBSITE    HTTP://WWW.LLNL.GOV/CULLEN1                               Linear
                                                                     Linear
AUTHORS MESSAGE                                                      Linear
---------------                                                      Linear
THE REPORT DESCRIBED ABOVE IS THE LATEST PUBLISHED DOCUMENTATION     Linear
FOR THIS PROGRAM. HOWEVER, THE COMMENTS BELOW SHOULD BE CONSIDERED   Linear
THE LATEST DOCUMENTATION INCLUDING ALL RECENT IMPROVEMENTS. PLEASE   Linear
READ ALL OF THESE COMMENTS BEFORE IMPLEMENTATION.                    Linear
                                                                     Linear
AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER   Linear
INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE       Linear
OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT   Linear
IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY         Linear
COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO    Linear
IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF      Linear
THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR           Linear
COMPUTER.                                                            Linear
                                                                     Linear
PURPOSE                                                              Linear
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-------                                                                 Linear
THIS PROGRAM IS DESIGNED TO CONVERT ENDF/B FILE 3, 23 AND 27 DATA       Linear
TO LINEAR-LINEAR INTERPOLABLE FORM. ANY SECTION THAT IS ALREADY         Linear
LINEAR-LINEAR INTERPOLABLE WILL BE THINNED.                             Linear
                                                                        Linear
IN THE FOLLOWING DISCUSSION FOR SIMPLICITY THE ENDF/B TERMINOLOGY       Linear
---ENDF/B TAPE---WILL BE USED. IN FACT THE ACTUAL MEDIUM MAY BE         Linear
TAPE, CARDS, DISK OR ANY OTHER MEDIUM.                                  Linear
                                                                        Linear
ENDF/B FORMAT                                                           Linear
-------------                                                           Linear
THIS PROGRAM ONLY USES THE ENDF/B BCD OR CARD IMAGE FORMAT (AS          Linear
OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION        Linear
OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II,III, IV, V OR VI FORMAT).      Linear
                                                                        Linear
IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B            Linear
FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS          Linear
ASSUMED THAT THE MAT, MF AND MT ON EACH LINE IS CORRECT. SEQUENCE       Linear
NUMBERS (COLUMNS 76-80) ARE IGNORED ON INPUT, BUT WILL BE               Linear
CORRECTLY OUTPUT ON ALL LINES. THE FORMAT OF SECTION MF=1, MT=451       Linear
AND ALL SECTIONS OF MF=3 MUST BE CORRECT. THE PROGRAM COPIES ALL        Linear
OTHER SECTION OF DATA AS HOLLERITH AND AS SUCH IS INSENSITIVE TO        Linear
THE CORRECTNESS OR INCORRECTNESS OF ALL OTHER SECTIONS.                  Linear
                                                                        Linear
OUTPUT FORMAT                                                           Linear
-------------                                                           Linear
IN THIS VERSION OF LINEAR ALL ENERGIES WILL BE OUTPUT IN                Linear
F (INSTEAD OF E) FORMAT IN ORDER TO ALLOW ENERGIES TO BE WRITTEN        Linear
WITH UP TO 9 DIGITS OF ACCURACY. IN PREVIOUS VERSIONS THIS WAS AN       Linear
OUTPUT OPTION. HOWEVER USE OF THIS OPTION TO COMPARE THE RESULTS        Linear
OF ENERGIES WRITTEN IN THE NORMAL ENDF/B CONVENTION OF 6 DIGITS         Linear
TO THE 9 DIGIT OUTPUT FROM THIS PROGRAM DEMONSTRATED THAT FAILURE       Linear
TO USE THE 9 DIGIT OUTPUT CAN LEAD TO LARGE ERRORS IN THE DATA          Linear
DUE TO TRUNCATION OF ENERGIES TO 6 DIGITS DURING OUTPUT.                Linear
                                                                        Linear
CONTENTS OF OUTPUT                                                      Linear
------------------                                                      Linear
ENTIRE EVALUATIONS ARE OUTPUT, NOT JUST THE LINEARIZED DATA             Linear
CROSS SECTIONS, E.G. ANGULAR AND ENERGY DISTRIBUTIONS ARE ALSO          Linear
INCLUDED.                                                               Linear
                                                                        Linear
DOCUMENTATION                                                           Linear
-------------                                                           Linear
THE FACT THAT THIS PROGRAM HAS OPERATED ON THE DATA IS DOCUMENTED       Linear
BY THE ADDITION OF 3 COMMENT LINES AT THE END OF EACH HOLLERITH         Linear
SECTION IN THE FORM                                                     Linear
                                                                        Linear
***************** PROGRAM LINEAR (2004-1) ***************             Linear
FOR ALL DATA GREATER THAN 1.00000-10 IN ABSOLUTE VALUE                  Linear
DATA LINEARIZED TO WITHIN AN ACCURACY OF  0.1  PER-CENT                 Linear
                                                                        Linear
THE ORDER OF SIMILAR COMMENTS (FROM RECENT, SIGMA1 AND GROUPIE)         Linear
REPRESENTS A COMPLETE HISTORY OF ALL OPERATIONS PERFORMED ON             Linear
THE DATA BY THESE PROGRAMS.                                             Linear
                                                                        Linear
THESE COMMENT LINES ARE ONLY ADDED TO EXISTING HOLLERITH SECTIONS,      Linear
I.E., THIS PROGRAM WILL NOT CREATE A HOLLERITH SECTION. THE FORMAT      Linear
OF THE HOLLERITH SECTION IN ENDF/B-V DIFFERS FROM THE THAT OF           Linear
EARLIER VERSIONS OF ENDF/B. BY READING AN EXISTING MF=1, MT=451         Linear
IT IS POSSIBLE FOR THIS PROGRAM TO DETERMINE WHICH VERSION OF           Linear
THE ENDF/B FORMAT THE DATA IS IN. WITHOUT HAVING A SECTION OF           Linear
MF=1, MT=451 PRESENT IT IS IMPOSSIBLE FOR THIS PROGRAM TO               Linear
DETERMINE WHICH VERSION OF THE ENDF/B FORMAT THE DATA IS IN, AND        Linear
AS SUCH IT IS IMPOSSIBLE FOR THE PROGRAM TO DETERMINE WHAT FORMAT       Linear
SHOULD BE USED TO CREATE A HOLLERITH SECTION.                           Linear
                                                                        Linear
REACTION INDEX                                                          Linear
--------------                                                          Linear
THIS PROGRAM DOES NOT USE THE REACTION INDEX WHICH IS GIVEN IN          Linear
SECTION MF=1, MT=451 OF EACH EVALUATION.                                Linear
                                                                        Linear
```

```
THIS PROGRAM DOES NOT UPDATE THE REACTION INDEX IN MF=1, MT=451.   Linear
THIS CONVENTION HAS BEEN ADOPTED BECAUSE MOST USERS DO NOT         Linear
REQUIRE A CORRECT REACTION INDEX FOR THEIR APPLICATIONS AND IT WAS Linear
NOT CONSIDERED WORTHWHILE TO INCLUDE THE OVERHEAD OF CONSTRUCTING  Linear
A CORRECT REACTION INDEX IN THIS PROGRAM. HOWEVER, IF YOU REQUIRE  Linear
A REACTION INDEX FOR YOUR APPLICATIONS, AFTER RUNNING THIS PROGRAM Linear
YOU MAY USE PROGRAM DICTIN TO CREATE A CORRECT REACTION INDEX.     Linear
                                                                   Linear
SECTION SIZE                                                       Linear
------------                                                       Linear
SINCE THIS PROGRAM USES A LOGICAL PAGING SYSTEM THERE IS NO LIMIT  Linear
TO THE NUMBER OF POINTS IN ANY SECTION, E.G., THE TOTAL CROSS      Linear
SECTION MAY BE REPRESENTED BY 200,000 DATA POINTS.                 Linear
                                                                   Linear
FOR ANY LINEARIZED SECTION THAT CONTAINS 60000 OR FEWER POINTS     Linear
THE ENTIRE OPERATION WILL BE PERFORMED IN CORE AND THE LINEARIZED  Linear
DATA WILL BE OUTPUT DIRECTLY TO THE ENDF/B FORMAT. FOR ANY SECTION Linear
THAT CONTAINS MORE POINTS THE DATA WILL BE LINEARIZED A PAGE AT A  Linear
TIME (1 PAGE = 60000 POINTS) AND OUTPUT TO SCRATCH. AFTER THE      Linear
ENTIRE SECTION HAS BEEN LINEARIZED THE DATA WILL BE READ BACK FROM Linear
SCRATCH AND OUTPUT TO THE ENDF/B FORMAT.                           Linear
                                                                   Linear
SELECTION OF DATA                                                  Linear
-----------------                                                  Linear
THE PROGRAM SELECTS DATA TO BE LINEARIZED BASED EITHER ON EITHER   Linear
MAT (ENDF/B MAT NO.) OR ZA AS WELL AS MF AND MT NUMBERS. THIS      Linear
PROGRAM ALLOWS UP TO 100 MAT/MF/MT OR ZA/MF/MT RANGES TO BE        Linear
SPECIFIED BY INPUT PARAMETERS. THE PROGRAM WILL ASSUME THAT THE    Linear
ENDF/B TAPE IS IN MAT ORDER, REGARDLESS OF THE CRITERIA USED       Linear
TO RETRIEVE MATERIALS. IF RETRIEVAL IS BY MAT RANGE THE PROGRAM    Linear
WILL TERMINATE WHEN A MAT IS FOUND THAT IS ABOVE ALL REQUESTED     Linear
MAT RANGES. IF RETRIEVAL IS BY ZA RANGE THE PROGRAM WILL SEARCH    Linear
THE ENTIRE ENDF/B TAPE.                                            Linear
                                                                   Linear
PROGRAM OPERATION                                                  Linear
-----------------                                                  Linear
EACH SECTION OF DATA IS CONSIDERED SEPARATELY. EACH SECTION OF     Linear
ENDF/B DATA TO LINEARIZE IS REPRESENTED BY A TABLE OF ENERGY       Linear
VS. CROSS SECTION AND ANY ONE OF FIVE ALLOWABLE INTERPOLATION LAWS Linear
BETWEEN ANY TWO TABULATED POINTS. THIS PROGRAM WILL REPLACE EACH   Linear
SECTION OF DATA CROSS SECTIONS BY A NEW TABLE OF ENERGY VS.        Linear
CROSS SECTION IN WHICH THE INTERPOLATION LAW IS ALWAYS LINEAR IN   Linear
ENERGY AND CROSS SECTION BETWEEN ANY TWO TABULATED POINTS.         Linear
                                                                   Linear
DATA IS READ AND LINEARIZED A PAGE AT A TIME (ONE PAGE CONTAINS    Linear
60000 DATA POINTS). IF THE FINAL LINEARIZED SECTION CONTAINS TWO   Linear
PAGES OR LESS, DATA POINTS IT WILL BE ENTIRELY CORE RESIDENT       Linear
AFTER IT HAS BEEN LINEARIZED AND WILL BE WRITTEN DIRECTLY FROM     Linear
CORE TO THE OUTPUT TAPE. IF THE LINEARIZED SECTION IS LARGER THAN  Linear
TWO PAGES, AFTER EACH PAGE IS LINEARIZED IT WILL BE WRITTEN TO     Linear
SCRATCH. AFTER THE ENTIRE SECTION HAS BEEN LINEARIZED IT WILL      Linear
BE READ BACK FROM SCRATCH, TWO PAGES AT A TIME, AND WRITTEN TO     Linear
THE OUTPUT TAPE.                                                   Linear
                                                                   Linear
KEEP EVALUATED DATA POINTS                                         Linear
--------------------------                                         Linear
SOMETIMES IT IS CONVENIENT TO KEEP ALL ENERGY POINTS WHICH WERE    Linear
PRESENT IN THE ORIGINAL EVALUATION AND TO MERELY SUPPLEMENT THESE  Linear
POINTS WITH ADDITIONAL ENERGY POINTS IN ORDER TO LINEARIZE THE     Linear
CROSS SECTIONS. FOR EXAMPLE, IT IS OFTEN CONVENIENT TO KEEP THE    Linear
THERMAL VALUE (AT 0.0253 EV) OR THE VALUE AT 14.1 MEV.             Linear
                                                                   Linear
THE CURRENT VERSION OF THIS PROGRAM WILL ALLOW THE USER TO KEEP    Linear
ALL ORIGINAL EVALUATED DATA POINTS BY SPECIFYING 1 IN COLUMNS      Linear
34-44 OF THE FIRST INPUT LINE. THIS WILL TURN OFF THE BACKWARD     Linear
THINNING (SEE UCRL-50400, VOL. 17, PART A FOR EXPLANATION) AND     Linear
RESULT IN ALL ORIGINAL ENERGY POINTS BEING KEPT. CAUTION SHOULD    Linear
BE EXERCISED IN USING THIS OPTION SINCE IT CAN RESULT IN A         Linear
CONSIDERABLE INCREASE IN THE NUMBER OF DATA POINTS OUTPUT BY       Linear
THIS CODE.                                                         Linear
                                                                   Linear
```

```
FOR ALL USERS WHO ARE NOT INTERESTED IN THIS OPTIONS NO CHANGES    Linear
ARE REQUIRED IN THE INPUT TO THIS PROGRAM, I. E. IF COLUMNS        Linear
34-44 ARE BLANK (AS FOR ALL PREVIOUS VERSIONS OF THIS CODE) THE    Linear
PROGRAM WILL OPERATE EXACTLY AS IT DID BEFORE.                     Linear
                                                                   Linear
ALLOWABLE ERROR                                                    Linear
--------------                                                     Linear
ALLOWABLE ERROR MUST ALWAYS BE SPECIFIED IN THE INPUT TO THIS      Linear
PROGRAM AS A FRACTION, NOT A PER-CENT. FOR EXAMPLE, INPUT THE      Linear
ALLOWABLE FRACTIONAL ERROR 0.001 IN ORDER TO OBTAIN DATA THAT IS   Linear
ACCURATE TO WITHIN 0.1 PER-CENT.                                   Linear
                                                                   Linear
THE CONVERSION OF THE DATA FROM THE GENERAL INTERPOLATION FORM TO  Linear
LINARLY INTERPOLABLE FORM CANNOT BE PERFORMED EXACTLY. HOWEVER, IT Linear
CAN BE PERFORMED TO VIRTUALLY ANY REQUIRED ACCURACY AND MOST       Linear
IMPORTANTLY CAN BE PERFORMED TO A TOLERANCE THAT IS SMALL COMPARED Linear
TO THE UNCERTAINTY IN THE CROSS SECTIONS THEMSELVES. AS SUCH THE   Linear
CONVERSION OF CROSS SECTIONS TO LINEARLY INTERPOLABLE FORM CAN BE  Linear
PERFORMED WITH ESSENTIALLY NO LOSE OF INFORMATION.                 Linear
                                                                   Linear
THE ALLOWABLE ERROR MAY BE ENERGY INDEPENDENT (CONSTANT) OR ENERGY Linear
DEPENDENT. THE ALLOWABLE ERROR IS DESCRIBED BY A TABULATED         Linear
FUNCTION OF UP TO 20 (ENERGY,ERROR) PAIRS AND LINEAR INTERPOLATION Linear
BETWEEN TABULATED POINTS. IF ONLY ONE TABULATED POINT IS GIVEN THE Linear
ERROR WILL BE CONSIDERED CONSTANT OVER THE ENTIRE ENERGY RANGE.    Linear
WITH THIS ENERGY DEPENDENT ERROR ONE MAY OPTIMIZE THE OUTPUT FOR   Linear
ANY GIVEN APPLICATION BY USING A SMALL ERROR IN THE ENERGY RANGE   Linear
OF INTEREST AND A LESS STRINGENT ERROR IN OTHER ENERGY RANGES.     Linear
                                                                   Linear
DEFAULT ALLOWABLE ERROR                                            Linear
----------------------                                             Linear
IN ORDER TO INSURE CONVERGENCE OF THE LINEARIZING ALGORITHM THE    Linear
ALLOWABLE ERROR MUST BE POSITIVE. IF THE USER INPUTS AN ERROR      Linear
THAT IS NOT POSITIVE IT WILL AUTOMATICALLY BE SET TO THE DEFAULT   Linear
VALUE (CURRENTLY 0.001, CORRESPONDING TO 0.1 PER-CENT) AND         Linear
INDICATED AS SUCH IN THE OUTPUT LISTING.                           Linear
                                                                   Linear
COULOMB PENETRABILITY (INTERPOLATION LAW = 6)                      Linear
-------------------------------------------                        Linear
INTRODUCED FOR ENDF/B-VI. THIS IS DEFINED AS,                      Linear
                                                                   Linear
SIG(E) = C1*EXP(-C2/SQRT(E - T))                                   Linear
                                                                   Linear
THIS PROGRAM ONLY CONSIDERS EXOTHERMIC REACTIONS - T = 0           Linear
                                                                   Linear
SIG(E) = C1*EXP(-C2/SQRT(E))                                       Linear
                                                                   Linear
WARNING...THIS INTERPOLATION LAW SHOULD ONLY BE USED FOR REACTIONS Linear
          WHICH HAVE A POSITIVE Q-VALUE (EXOTHERMIC REACTIONS),    Linear
          SINCE HERE WE ONLY CONSIDER T = 0.0 IN THE FORMALISM.    Linear
          IN ALL OTHER CASES A WARNING MESSAGE WILL BE PRINTED.    Linear
                                                                   Linear
INPUT FILES                                                        Linear
-----------                                                        Linear
UNIT  DESCRIPTION                                                  Linear
----  -----------                                                  Linear
   2  INPUT LINES (BCD - 80 CHARACTERS/RECORD)                     Linear
  10  ORIGINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)            Linear
                                                                   Linear
OUTPUT FILES                                                       Linear
------------                                                       Linear
UNIT  DESCRIPTION                                                  Linear
----  -----------                                                  Linear
   3  OUTPUT REPORT (BCD - 120 CHARACTERS/RECORD)                  Linear
  11  FINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)               Linear
                                                                   Linear
SCRATCH FILES                                                      Linear
-------------                                                      Linear
UNIT  DESCRIPTION                                                  Linear
----  -----------                                                  Linear
  12  SCRATCH FILE (BINARY - 180000 WORDS/RECORD                   Linear
```

```
                                                                      Linear
OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILEIO)                  Linear
-------------------------------------------------                     Linear
UNIT  FILE NAME                                                       Linear
----  ----------                                                      Linear
  2   LINEAR.INP                                                      Linear
  3   LINEAR.LST                                                      Linear
 10   ENDFB.IN                                                        Linear
 11   ENDFB.OUT                                                       Linear
 12   (SCRATCH)                                                       Linear
                                                                      Linear
                                                                      Linear
INPUT PARAMETERS                                                      Linear
---------------                                                       Linear
FOR VERSIONS EARLIER THAN 90-1 THIS PROGRAM ONLY ALLOWED THE USER     Linear
TO SPECIFY BY INPUT PARAMETERS WHICH MATERIALS (MAT) TO PROCESS.       Linear
FOR EACH REQUESTED MATERIAL NEUTRON INTERACTION CROSS SECTIONS        Linear
(MF=3) WOULD BE LINEARIZED AND THE REMAINDER OF THE MATERIAL          Linear
WOULD BE COPIED.                                                      Linear
                                                                      Linear
FOR VERSIONS 90-1 AND LATER THIS PROGRAM WILL ALLOW THE USER TO       Linear
TO SPECIFY BY INPUT PARAMETERS EXACTLY WHAT SECTIONS OF DATA           Linear
TO PROCESS. FOR EACH SECTION OF DATA, SPECIFIED BY MAT, MF, MT         Linear
RANGES, SECTIONS OF MF=3, 23 AND 27 WILL BE LINEARIZED AND ALL        Linear
OTHER REQUESTED SECTIONS WILL BE COPIED. ALL SECTIONS WHICH ARE       Linear
NOT EXPLICITLY REQUESTED WILL BE SKIPPED AND WILL NOT APPEAR ON       Linear
ENDF/B FILE OUTPUT BY THIS PROGRAM.                                   Linear
                                                                      Linear
WITH THIS NEW PROCEDURE YOU CAN MINIMIZE THE SIZE OF THE ENDF/B       Linear
FILE OUTPUT BY THIS PROGRAM, E.G., IF YOU ONLY WANT NEUTRON           Linear
CROSS SECTIONS FOR SUBSEQUENT PROCESSING YOU NEED ONLY REQUEST        Linear
ONLY MF=3 DATA.                                                       Linear
                                                                      Linear
HOWEVER, YOU MUST UNDERSTAND THAT ONLY THOSE SECTIONS WHICH YOU       Linear
EXPLICITLY REQUEST WILL APPEAR ON THE ENDF/B FILE OUTPUT BY           Linear
THIS PROGRAM. FOR EXAMPLE, IF YOU WISH TO DOCUMENT EXACTLY            Linear
HOW YOU LINEARIZED THE DATA BY INCLUDING COMMENTS IN MF=1, MT=451     Linear
THEN YOU MUST EXPLICITLY REQUEST THAT MF=1, MT=451 BE PROCESSED       Linear
FOR EACH MATERIAL THAT YOU REQUEST. SIMILAR IF YOU WANT THE           Linear
ENTIRE EVALUATION YOU MUST REQUEST ALL MF AND MT TO BE OUTPUT.        Linear
                                                                      Linear
LINE  COLS.  DESCRIPTION                                              Linear
----  -----  -----------                                             Linear
   1   1-11  SELECTION CRITERIA (0=MAT, 1=ZA)                         Linear
      12-22  MONITOR MODE SELECTOR                                    Linear
             = 0 - NORMAL OPERATION                                   Linear
             = 1 - MONITOR PROGRESS OF LINEARIZING OF THE DATA.       Linear
                   EACH TIME A PAGE OF DATA POINTS IS WRITTEN TO      Linear
                   THE SCRATCH FILE PRINT OUT THE TOTAL NUMBER OF     Linear
                   POINTS ON SCRATCH AND THE LOWER AND UPPER          Linear
                   ENERGY LIMITS OF THE PAGE (THIS OPTION MAY BE      Linear
                   USED IN ORDER TO MONITOR THE EXECUTION SPEED       Linear
                   OF LONG RUNNING JOBS).                             Linear
      23-33  MINIMUM CROSS SECTION OF INTEREST (BARNS).               Linear
             (IF 0.0 OR LESS IS INPUT THE PROGRAM WILL                Linear
             USE 1.0E-10). ENERGY INTERVALS WILL NOT BE               Linear
             SUB-DIVIDED IF THE ABSOLUTE VALUE OF THE CROSS           Linear
             SECTION WITHIN THE INTERVAL IS LESS THAN THIS VALUE.     Linear
             AN EXCEPTION TO THIS RULE IS NEAR THRESHOLDS ENERGY      Linear
             INTERVALS WILL BE SUB-DIVIDED UNTIL CONVERGENCE          Linear
             REGARDLESS OF THE MAGNITUDE OF THE CROSS SECTION.        Linear
      34-44  KEEP ORIGINAL EVALUATED DATA POINTS.                     Linear
             = 0 - NO.                                                Linear
             = 1 - YES - ADDITIONAL POINTS MAY BE ADDED IN ORDER      Linear
                         TO LINEARIZE DATA, BUT ALL ORIGINAL          Linear
                         DATA POINTS WILL BE INCLUDED IN THE          Linear
                         RESULTS.                                     Linear
   2   1-60  ENDF/B INPUT DATA FILENAME                               Linear
             (STANDARD OPTION = ENDFB.IN)                             Linear
   3   1-60  ENDF/B OUTPUT DATA FILENAME                              Linear
             (STANDARD OPTION = ENDFB.OUT)                            Linear
```

```
 4-N   1- 6  LOWER MAT OR ZA LIMIT                                  Linear
       7- 8  LOWER MF LIMIT                                         Linear
       9-11  LOWER MT LIMIT                                         Linear
      12-17  UPPER MAT OR ZA LIMIT                                  Linear
      18-19  UPPER MF LIMIT                                         Linear
      20-22  UPPER MT LIMIT                                         Linear
             UP TO 100 RANGES MAY BE SPECIFIED, ONLY ONE RANGE     Linear
             PER LINE. THE LIST OF RANGES IS TERMINATED BY A       Linear
             BLANK LINE. IF THE UPPER MAT LIMIT OF ANY REQUEST     Linear
             IS LESS THAN THE LOW LIMIT IT WILL BE SET EQUAL TO    Linear
             THE LOWER LIMIT. IF THE UPPER LIMIT IS STILL ZERO     Linear
             IT WILL BE SET EQUAL TO 999999. IF THE UPPER MF OR    Linear
             MT LIMIT IS ZERO IT WILL BE SET TO 99 OR 999          Linear
             RESPECTIVELY.                                         Linear
 VARY  1-11  ENERGY FOR ERROR LAW                                  Linear
      12-22  ALLOWABLE FRACTIONAL ERROR FOR ERROR LAW.              Linear
             THE ACCEPTABLE LINEARIZING ERROR MAY BE SPECIFIED TO  Linear
             BE EITHER ENERGY INDEPENDENT (DEFINED BY A SINGLE     Linear
             ERROR), OR ENERGY DEPENDENT (DEFINED BY UP TO 20      Linear
             ENERGY, ERROR PAIRS). FOR THE ENERGY DEPENDENT CASE   Linear
             LINEAR INTERPOLATION WILL BE USED TO DEFINE THE ERROR Linear
             AT ENERGIES BETWEEN THOSE AT WHICH IT IS TABULATED.   Linear
             IN ALL CASES THE ERROR LAW IS TERMINATED BY A BLANK   Linear
             LINE. IF ONLY ONE ENERGY, ERROR PAIR IS GIVEN THE     Linear
             THE LAW WILL BE CONSIDERED TO BE ENERGY INDEPENDENT.  Linear
             IF MORE THAN ONE PAIR IS GIVEN IT WILL BE CONSIDERED  Linear
             TO BE ENERGY DEPENDENT (NOTE, ENERGY INDEPENDENT      Linear
             FORM WILL RUN FASTER THAN THE EQUIVALENT ENERGY       Linear
             DEPENDENT FORM). FOR AN ENERGY DEPENDENT ERROR LAW    Linear
             ALL ENERGIES MUST BE ASCENDING ENERGY ORDER. FOR      Linear
             CONVERGENCE OF THE LINEARIZING ALGORITHM ALL ERRORS   Linear
             MUST BE POSITIVE. IF AN ALLOWABLE ERROR IS NOT        Linear
             POSITIVE IT WILL BE SET EQUAL TO THE STANDARD OPTION  Linear
             (CURRENTLY 0.001, CORRESPONDING TO 0.1 PER-CENT).     Linear
             IF THE FIRST ERROR LINE IS BLANK IT WILL TERMINATE    Linear
             THE ERROR LAW AND THE ERROR WILL BE TREATED AS        Linear
             ENERGY INDEPENDENT, EQUAL TO THE STANDARD OPTION      Linear
             (CURRENTLY 0.1 PER-CENT). (SEE EXAMPLE INPUT 4).      Linear
                                                                   Linear
    EXAMPLE INPUT NO. 1                                            Linear
    ------------------                                             Linear
    RETRIEVE DATA BY ZA IN ORDER TO FIND ALL URANIUM ISOTOPES AND  Linear
    THORIUM 232. RETRIEVE ALL NEUTRON INTERACTION CROSS SECTIONS   Linear
    (MF=3). ALL ENERGY INTERVALS IN WHICH THE CROSS SECTION IS     Linear
    AT LEAST 1 MICRO-BARN (1.0E-06 BARNS) WILL BE SUBDIVIDED.      Linear
    BACKWARD THINNING WILL BE PERFORMED. FROM 0 TO 100 EV LINEARIZE Linear
    TO WITHIN 0.1 PER-CENT ACCURACY. FROM 100 EV TO 1 KEV VARY     Linear
    ACCURACY BETWEEN 0.1 AND 1.0 PER-CENT. ABOVE 1 KEV USE 1       Linear
    PER-CENT ACCURACY.                                             Linear
                                                                   Linear
    EXPLICITLY SPECIFY THE STANDARD FILENAMES.                     Linear
                                                                   Linear
    IN THIS CASE THE FOLLOWING 11 INPUT LINES ARE REQUIRED         Linear
                                                                   Linear
        1          0 1.00000- 6          0                       Linear
ENDFB.IN                                                           Linear
ENDFB.OUT                                                          Linear
92000 3  0 92999 3999                                              Linear
90232 3  0     0 3  0    (UPPER LIMIT AUTOMATICALLY SET TO 90232 3999) Linear
                         (END OF REQUEST LIST)                     Linear
0.00000+ 0 1.00000-03                                              Linear
1.00000+ 2 1.00000-03                                              Linear
1.00000+ 3 1.00000-02                                              Linear
1.00000+ 9 1.00000-02                                              Linear
                         (END OF ERROR LAW)                        Linear
                                                                   Linear
    EXAMPLE INPUT NO. 2                                            Linear
    ------------------                                             Linear
    SAME AS THE ABOVE CASE, EXCEPT LINEARIZE ALL DATA TO WITHIN THE Linear
    STANDARD ACCURACY (CURRENTLY 0.1 PER-CENT). IN ORDER TO USE THE Linear
    STANDARD ACCURACY YOU NEED NOT SPECIFY ANY ERROR LAW AT ALL. IN Linear
```

```
    THIS CASE INCLUDE THE HOLLERITH SECTION, MF=1, MT=451, FOR EACH    Linear
    MATERIAL.                                                          Linear
                                                                       Linear
    LEAVE THE DEFINITION OF THE FILENAMES BLANK - THE PROGRAM WILL     Linear
    THEN USE STANDARD FILENAMES.                                       Linear
                                                                       Linear
    IN THIS CASE THE FOLLOWING 9 INPUT LINES ARE REQUIRED              Linear
                                                                       Linear
         1          0 1.00000- 6          0                          Linear
                        (USE DEFAULT FILENAME = ENDFB.IN)              Linear
                        (USE DEFAULT FILENAME = ENDFB.OUT)             Linear
 92000 1451 92999 1451                                                 Linear
 92000 3  0 92999 3999                                                 Linear
 90232 1451     0 1451                                                 Linear
 90232 3  0     0 3  0    (UPPER LIMIT AUTOMATICALLY SET TO 90232 3999) Linear
                        (END OF REQUEST LIST)                          Linear
                        (0.1 PER-CENT ERROR, END OF ERROR LAW)         Linear
                                                                       Linear
    EXAMPLE INPUT NO. 3                                                Linear
    ------------------                                                 Linear
    LINEARIZE ALL MATERIALS ON AN ENDF/B TAPE TO WITHIN AN ACCURACY    Linear
    OF 0.5 PER-CENT (0.005 AS A FRACTION). IN THIS CASE YOU NEED NOT   Linear
    SPECIFY THE MAT, MF, MT RANGES.                                    Linear
                                                                       Linear
    READ THE ENDF/B DATA FROM \ENDFB6\ZA092238 AND WRITE THE ENDF/B    Linear
    DATA TO \ENDFB6\LINEAR\ZA092238.                                   Linear
                                                                       Linear
    IN THIS CASE THE FOLLOWING 6 INPUT LINES ARE REQUIRED              Linear
                                                                       Linear
                                          (MAT, 1.0E-10 BARNS, THIN)   Linear
 \ENDFB6\ZA092238                                                      Linear
 \ENDFB6\LINEAR\ZA092238                                               Linear
                        (RETRIEVE ALL DATA, END REQUEST LIST)          Linear
           5.00000-03                                                  Linear
                        (END OF ERROR LAW)                             Linear
                                                                       Linear
    NOTE THAT IN THIS CASE IF THE INPUT HAD SPECIFIED AN EQUIVALENT    Linear
    ENERGY DEPENDENT ERROR LAW BY GIVING A NUMBER OF ENERGY POINTS     Linear
    AT EACH OF WHICH THE ERROR IS 0.5 PER-CENT THE PROGRAM WOULD TAKE  Linear
    LONGER TO RUN (I.E., ONLY USE AN ENERGY DEPENDENT ERROR LAW WHEN   Linear
    IT IS NECESSARY).                                                  Linear
                                                                       Linear
    EXAMPLE INPUT NO. 4                                                Linear
    ------------------                                                 Linear
    IN ORDER TO LINEARIZE ALL MATERIALS ON AN ENDF/B TAPE TO THE       Linear
    STANDARD OPTION OF 0.1 PER-CENT IT IS ADEQUATE TO INPUT A SET      Linear
    OF COMPLETELY BLANK LINES WHICH WILL AUTOMATICALLY INVOKE ALL      Linear
    OF THE STANDARD OPTIONS.                                           Linear
                                                                       Linear
    LEAVE THE DEFINITION OF THE FILENAMES BLANK - THE PROGRAM WILL     Linear
    THEN USE STANDARD FILENAMES.                                       Linear
                                                                       Linear
    IN THIS CASE THE FOLLOWING THREE INPUT LINES ARE REQUIRED          Linear
                                                                       Linear
                                          (MAT, 1.0E-10 BARNS, THIN)   Linear
                        (USE DEFAULT FILENAME = ENDFB.IN)              Linear
                        (USE DEFAULT FILENAME = ENDFB.OUT)             Linear
                        (RETRIEVE ALL DATA, END REQUEST LIST)          Linear
                        (0.1 PER-CENT ERROR, END OF ERROR LAW)         Linear
                                                                       Linear
======================================================================= Linear
```