```
==================================================================== Linear
                                                                     Linear
      PROGRAM LINEAR                                                 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
	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
VERS. 2005-1 (JAN. 2005)	*ALWAYS KEEP ORIGINAL TABULATED	Linear
	NU-BAR POINTS.	Linear
VERS. 2006-1 (FEB. 2006)	*CORRECTED INT=6 NEAR THRESHOLD	Linear
	*NO SUBDIVIDE BELOW MINIMUM XCMIN	Linear
VERS. 2007-1 (JAN. 2007)	*CHECKED AGAINST ALL ENDF/B-VII.	Linear
	*INCREASED PAGE SIZE FROM 60,000 TO	Linear
	600,000 POINTS	Linear
VERS. 2007-2 (DEC. 2007)	*72 CHARACTER FILE NAMES.	Linear
VERS. 2010-1 (Apr. 2010)	*Skipped leading cross section = 0	Linear
	up to effective start, unless keeping	Linear
	ALL original energy points.	Linear
	*Replaced ETHRES by ESTART - it is	Linear
	not a threshold - just a minimum	Linear
	energy - if a section starts above	Linear
	this energy with a positive cross	Linear
	section, an additional point will	Linear
	inserted with cross section = 0.	Linear
VERS. 2012-1 (Aug. 2012)	*Minor Updates based on User Feedback.	Linear
	*Added CODENAME	Linear
	*32 and 64 bit Compatible	Linear
	*Added ERROR stops.	Linear
VERS. 2012-2 (Nov. 2012)	*Never thin nu-bar.	Linear

```
VERS. 2013-1 (Nov. 2013)    *Extended OUT9.                      Linear
VERS. 2015-1 (Jan. 2015)    *Allow Imaginary Anomolous Scattering Linear
                             Factor to be Negative (MF/MT=27/506). Linear
                            *Replaced ALL 3 way IF Statements.    Linear
VERS. 2016-1 (June 2016)    *Cosmetic changes based on FREUD      Linear
                             psychoanalysis.                      Linear
VERS. 2017-1 (May  2017)    *Updated based on user feedback.      Linear
                            *Inceased page size to 3,000,000.     Linear
                            *All floating input parameters changed Linear
                             to character input + IN9 conversion. 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
                                                                  Linear
PRESENT CONTACT INFORMATION                                       Linear
---------------------------                                      Linear
Dermott E. Cullen                                                 Linear
1466 Hudson Way                                                   Linear
Livermore, CA 94550                                               Linear
U.S.A.                                                            Linear
Telephone  925-443-1911                                           Linear
E. Mail    RedCullen1@Comcast.net                                 Linear
Website    RedCullen1.net/HOMEPAGE.NEW                            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
-------                                                          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).

IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B
FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS
ASSUMED THAT THE MAT, MF AND MT ON EACH LINE IS CORRECT. SEQUENCE
NUMBERS (COLUMNS 76-80) ARE IGNORED ON INPUT, BUT WILL BE
CORRECTLY OUTPUT ON ALL LINES. THE FORMAT OF SECTION MF=1, MT=451
AND ALL SECTIONS OF MF=3 MUST BE CORRECT. THE PROGRAM COPIES ALL
OTHER SECTION OF DATA AS HOLLERITH AND AS SUCH IS INSENSITIVE TO
THE CORRECTNESS OR INCORRECTNESS OF ALL OTHER SECTIONS.

OUTPUT FORMAT

IN THIS VERSION OF LINEAR ALL ENERGIES WILL BE OUTPUT IN
F (INSTEAD OF E) FORMAT IN ORDER TO ALLOW ENERGIES TO BE WRITTEN
WITH UP TO 9 DIGITS OF ACCURACY. IN PREVIOUS VERSIONS THIS WAS AN
OUTPUT OPTION. HOWEVER USE OF THIS OPTION TO COMPARE THE RESULTS
OF ENERGIES WRITTEN IN THE NORMAL ENDF/B CONVENTION OF 6 DIGITS
TO THE 9 DIGIT OUTPUT FROM THIS PROGRAM DEMONSTRATED THAT FAILURE
TO USE THE 9 DIGIT OUTPUT CAN LEAD TO LARGE ERRORS IN THE DATA
DUE TO TRUNCATION OF ENERGIES TO 6 DIGITS DURING OUTPUT.

CONTENTS OF OUTPUT

ENTIRE EVALUATIONS ARE OUTPUT, NOT JUST THE LINEARIZED DATA
CROSS SECTIONS, E.G. ANGULAR AND ENERGY DISTRIBUTIONS ARE ALSO
INCLUDED.

DOCUMENTATION

THE FACT THAT THIS PROGRAM HAS OPERATED ON THE DATA IS DOCUMENTED
BY THE ADDITION OF 3 COMMENT LINES AT THE END OF EACH HOLLERITH
SECTION IN THE FORM

***************** PROGRAM LINEAR (2017-1) ****************
FOR ALL DATA GREATER THAN 1.00000-10 IN ABSOLUTE VALUE
DATA LINEARIZED TO WITHIN AN ACCURACY OF 0.1 PER-CENT

THE ORDER OF SIMILAR COMMENTS (FROM RECENT, SIGMA1 AND GROUPIE)
REPRESENTS A COMPLETE HISTORY OF ALL OPERATIONS PERFORMED ON
THE DATA BY THESE PROGRAMS.

THESE COMMENT LINES ARE ONLY ADDED TO EXISTING HOLLERITH SECTIONS,
I.E., THIS PROGRAM WILL NOT CREATE A HOLLERITH SECTION. THE FORMAT
OF THE HOLLERITH SECTION IN ENDF/B-V DIFFERS FROM THE THAT OF
EARLIER VERSIONS OF ENDF/B. BY READING AN EXISTING MF=1, MT=451
IT IS POSSIBLE FOR THIS PROGRAM TO DETERMINE WHICH VERSION OF
THE ENDF/B FORMAT THE DATA IS IN. WITHOUT HAVING A SECTION OF
MF=1, MT=451 PRESENT IT IS IMPOSSIBLE FOR THIS PROGRAM TO
DETERMINE WHICH VERSION OF THE ENDF/B FORMAT THE DATA IS IN, AND
AS SUCH IT IS IMPOSSIBLE FOR THE PROGRAM TO DETERMINE WHAT FORMAT
SHOULD BE USED TO CREATE A HOLLERITH SECTION.

REACTION INDEX

THIS PROGRAM DOES NOT USE THE REACTION INDEX WHICH IS GIVEN IN
SECTION MF=1, MT=451 OF EACH EVALUATION.

THIS PROGRAM DOES NOT UPDATE THE REACTION INDEX IN MF=1, MT=451.
THIS CONVENTION HAS BEEN ADOPTED BECAUSE MOST USERS DO NOT
REQUIRE A CORRECT REACTION INDEX FOR THEIR APPLICATIONS AND IT WAS
NOT CONSIDERED WORTHWHILE TO INCLUDE THE OVERHEAD OF CONSTRUCTING
A CORRECT REACTION INDEX IN THIS PROGRAM. HOWEVER, IF YOU REQUIRE

A REACTION INDEX FOR YOUR APPLICATIONS, AFTER RUNNING THIS PROGRAM
YOU MAY USE PROGRAM DICTIN TO CREATE A CORRECT REACTION INDEX.

SECTION SIZE

SINCE THIS PROGRAM USES A LOGICAL PAGING SYSTEM THERE IS NO LIMIT
TO THE NUMBER OF POINTS IN ANY SECTION, E.G., THE TOTAL CROSS
SECTION MAY BE REPRESENTED BY 200,000 DATA POINTS.

FOR ANY LINEARIZED SECTION THAT CONTAINS 60000 OR FEWER POINTS
THE ENTIRE OPERATION WILL BE PERFORMED IN CORE AND THE LINEARIZED
DATA WILL BE OUTPUT DIRECTLY TO THE ENDF/B FORMAT. FOR ANY SECTION
THAT CONTAINS MORE POINTS THE DATA WILL BE LINEARIZED A PAGE AT A
TIME (1 PAGE = 60000 POINTS) AND OUTPUT TO SCRATCH. AFTER THE
ENTIRE SECTION HAS BEEN LINEARIZED THE DATA WILL BE READ BACK FROM
SCRATCH AND OUTPUT TO THE ENDF/B FORMAT.

SELECTION OF DATA

THE PROGRAM SELECTS DATA TO BE LINEARIZED BASED EITHER ON EITHER
MAT (ENDF/B MAT NO.) OR ZA AS WELL AS MF AND MT NUMBERS. THIS
PROGRAM ALLOWS UP TO 100 MAT/MF/MT OR ZA/MF/MT RANGES TO BE
SPECIFIED BY INPUT PARAMETERS. THE PROGRAM WILL ASSUME THAT THE
ENDF/B TAPE IS IN MAT ORDER, REGARDLESS OF THE CRITERIA USED
TO RETRIEVE MATERIALS. IF RETRIEVAL IS BY MAT RANGE THE PROGRAM
WILL TERMINATE WHEN A MAT IS FOUND THAT IS ABOVE ALL REQUESTED
MAT RANGES. IF RETRIEVAL IS BY ZA RANGE THE PROGRAM WILL SEARCH
THE ENTIRE ENDF/B TAPE.

PROGRAM OPERATION

EACH SECTION OF DATA IS CONSIDERED SEPARATELY. EACH SECTION OF
ENDF/B DATA TO LINEARIZE IS REPRESENTED BY A TABLE OF ENERGY
VS. CROSS SECTION AND ANY ONE OF FIVE ALLOWABLE INTERPOLATION LAWS
BETWEEN ANY TWO TABULATED POINTS. THIS PROGRAM WILL REPLACE EACH
SECTION OF DATA CROSS SECTIONS BY A NEW TABLE OF ENERGY VS.
CROSS SECTION IN WHICH THE INTERPOLATION LAW IS ALWAYS LINEAR IN
ENERGY AND CROSS SECTION BETWEEN ANY TWO TABULATED POINTS.

DATA IS READ AND LINEARIZED A PAGE AT A TIME (ONE PAGE CONTAINS
60000 DATA POINTS). IF THE FINAL LINEARIZED SECTION CONTAINS TWO
PAGES OR LESS, DATA POINTS IT WILL BE ENTIRELY CORE RESIDENT
AFTER IT HAS BEEN LINEARIZED AND WILL BE WRITTEN DIRECTLY FROM
CORE TO THE OUTPUT TAPE. IF THE LINEARIZED SECTION IS LARGER THAN
TWO PAGES, AFTER EACH PAGE IS LINEARIZED IT WILL BE WRITTEN TO
SCRATCH. AFTER THE ENTIRE SECTION HAS BEEN LINEARIZED IT WILL
BE READ BACK FROM SCRATCH, TWO PAGES AT A TIME, AND WRITTEN TO
THE OUTPUT TAPE.

KEEP EVALUATED DATA POINTS

SOMETIMES IT IS CONVENIENT TO KEEP ALL ENERGY POINTS WHICH WERE
PRESENT IN THE ORIGINAL EVALUATION AND TO MERELY SUPPLEMENT THESE
POINTS WITH ADDITIONAL ENERGY POINTS IN ORDER TO LINEARIZE THE
CROSS SECTIONS. FOR EXAMPLE, IT IS OFTEN CONVENIENT TO KEEP THE
THERMAL VALUE (AT 0.0253 EV) OR THE VALUE AT 14.1 MEV.

THE CURRENT VERSION OF THIS PROGRAM WILL ALLOW THE USER TO KEEP
ALL ORIGINAL EVALUATED DATA POINTS BY SPECIFYING 1 IN COLUMNS
34-44 OF THE FIRST INPUT LINE. THIS WILL TURN OFF THE BACKWARD
THINNING (SEE UCRL-50400, VOL. 17, PART A FOR EXPLANATION) AND
RESULT IN ALL ORIGINAL ENERGY POINTS BEING KEPT. CAUTION SHOULD
BE EXERCISED IN USING THIS OPTION SINCE IT CAN RESULT IN A

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  1-72   ENDF/B INPUT DATA FILENAME                           Linear
            (STANDARD OPTION = ENDFB.IN)                         Linear
  3  1-72   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
```

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         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
```