```
C=====================================================================C Linear
C                                                                     C Linear
      PROGRAM LINEAR                                                  C Linear
C     VERSION 74-1 (MAY 1974)                                         C Linear
C     VERSION 75-1 (APRIL 1975)                                       C Linear
C     VERSION 76-2 (OCTOBER 1976)                                     C Linear
C     VERSION 77-1 (JANUARY 1977)                                     C Linear
C     VERSION 78-1 (JULY 1978)                                        C Linear
C     VERSION 79-1 (JULY 1979) CDC-7600 AND CRAY-1 VERSION.           C Linear
C     VERSION 80-1 (MAY 1980) IBM, CDC AND CRAY VERSION.              C Linear
C     VERSION 80-2 (DECEMBER 1980)                                    C Linear
C     VERSION 81-1 (MARCH 1981)                                       C Linear
C     VERSION 82-1 (JANUARY 1982) IMPROVED COMPUTER COMPATIBILITY.    C Linear
C     VERSION 83-1 (JANUARY 1983) *MAJOR RE-DESIGN.                   C Linear
C                                 *PAGE SIZE INCREASED - 1002 TO 3006.C Linear
C                                 *ELIMINATED COMPUTER DEPENDENT CODINGC Linear
C                                 *NEW, MORE COMPATIBLE I/O UNIT NUMBERC Linear
C                                 *ADDED OPTION TO KEEP ALL ORIGINAL  C Linear
C                                  ENERGY POINTS FROM EVALUATION.     C Linear
C                                 *ADDED STANDARD ALLOWABLE ERROR OPTIONC Linear
C                                  (CURRENTLY 0.1 PER-CENT).          C Linear
C     VERSION 83-2 (OCTOBER 1983) IMPROVED BASED ON USER COMMENTS.    C Linear
C     VERSION 84-1 (APRIL 1984)   IMPROVED BASED ON USER COMMENTS.    C Linear
C     VERSION 84-2 (JUNE 1984)   *UPDATED FOR ENDF/B-VI FORMATS.      C Linear
C                                *SPECIAL I/O ROUTINES TO GUARANTEE   C Linear
C                                 ACCURACY OF ENERGY.                 C Linear
C                                *DOUBLE PRECISION TREATMENT OF ENERGY C Linear
C                                 (REQUIRED FOR NARROW RESONANCES).   C Linear
C     VERSION 85-1 (AUGUST 1985) *FORTRAN-77/H VERSION                C Linear
C     VERSION 86-1 (JANUARY 1986)*ENDF/B-VI FORMAT                    C Linear
C     VERSION 87-1 (JANUARY 1987)*DOUBLE PRECISION TREATMENT OF CROSS C Linear
C                                 SECTION                             C Linear
C     VERSION 88-1 (JULY 1988)   *OPTION...INTERNALLY DEFINE ALL I/O  C Linear
C                                 FILE NAMES (SEE, SUBROUTINE FILEIO  C Linear
C                                 FOR DETAILS).                       C Linear
C                                *IMPROVED BASED ON USER COMMENTS.    C Linear
C     VERSION 89-1 (JANUARY 1989)*PSYCHOANALYZED BY PROGRAM FREUD TO  C Linear
C                                 INSURE PROGRAM WILL NOT DO ANYTHING C Linear
C                                 CRAZY.                              C Linear
C                                *UPDATED TO USE NEW PROGRAM CONVERT  C Linear
C                                 KEYWORDS.                           C Linear
C                                *ADDED LIVERMORE CIVIC COMPILER      C Linear
C                                 CONVENTIONS.                        C Linear
C     VERSION 90-1 (JUNE 1990)   *EXTENDED TO LINEARIZE PHOTON        C Linear
C                                 INTERACTION DATA, MF=23 AND 27      C Linear
C                                *ADDED FORTRAN SAVE OPTION           C Linear
C                                *UPDATED BASED ON USER COMMENTS.     C Linear
C                                *NEW MORE CONSISTENT ENERGY OUTPUT   C Linear
C                                 ROUTINE.                            C Linear
C                                *WARNING...INPUT PARAMETER FORMAT    C Linear
C                                 HAS BEEN CHANGED...SEE DESCRIPTION  C Linear
C                                 BELOW.                              C Linear
C     VERSION 91-1 (JULY 1991)   *ADDED INTERPOLATION LAW 6 - ONLY USEDC Linear
C                                 FOR CHARGED PARTICLE CROSS SECTIONS C Linear
C                                 FOR COULOMB PENETRABILITIES.        C Linear
C     VERSION 92-1 (JANUARY 1992)*ADDED NU-BAR (TOTAL, DELAYED, PROMPT)C Linear
C                                 POLYNOMIAL OR TABULATED ALL CONVERTEDC Linear
C                                 TO LINEARLY INTERPOLABLE            C Linear
C                                *INCREASED PAGE SIZE FROM 3006 TO 5010C Linear
C                                 POINTS.                             C Linear
C                                *ALL ENERGIES INTERNALLY ROUNDED PRIORC Linear
C                                 TO CALCULATIONS.                    C Linear
C                                *COMPLETELY CONSISTENT I/O AND ROUNDINGC 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
                                                                 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
U.S.A.
TELEPHONE 925-423-7359
E. MAIL   CULLEN1@LLNL.GOV
WEBSITE   HTTP://WWW.LLNL.GOV/CULLEN1

AUTHORS MESSAGE

THE REPORT DESCRIBED ABOVE IS THE LATEST PUBLISHED DOCUMENTATION FOR THIS PROGRAM. HOWEVER, THE COMMENTS BELOW SHOULD BE CONSIDERED THE LATEST DOCUMENTATION INCLUDING ALL RECENT IMPROVEMENTS. PLEASE READ ALL OF THESE COMMENTS BEFORE IMPLEMENTATION.

AT THE PRESENT TIME WE ARE ATTEMPTING TO DEVELOP A SET OF COMPUTER INDEPENDENT PROGRAMS THAT CAN EASILY BE IMPLEMENTED ON ANY ONE OF A WIDE VARIETY OF COMPUTERS. IN ORDER TO ASSIST IN THIS PROJECT IT WOULD BE APPECIATED IF YOU WOULD NOTIFY THE AUTHOR OF ANY COMPILER DIAGNOSTICS, OPERATING PROBLEMS OR SUGGESTIONS ON HOW TO IMPROVE THIS PROGRAM. HOPEFULLY, IN THIS WAY FUTURE VERSIONS OF THIS PROGRAM WILL BE COMPLETELY COMPATIBLE FOR USE ON YOUR COMPUTER.

PURPOSE

THIS PROGRAM IS DESIGNED TO CONVERT ENDF/B FILE 3, 23 AND 27 DATA TO LINEAR-LINEAR INTERPOLABLE FORM. ANY SECTION THAT IS ALREADY LINEAR-LINEAR INTERPOLABLE WILL BE THINNED.

IN THE FOLLOWING DISCUSSION FOR SIMPLICITY THE ENDF/B TERMINOLOGY ---ENDF/B TAPE---WILL BE USED. IN FACT THE ACTUAL MEDIUM MAY BE TAPE, CARDS, DISK OR ANY OTHER MEDIUM.

ENDF/B FORMAT

THIS PROGRAM ONLY USES THE ENDF/B BCD OR CARD IMAGE FORMAT (AS OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION 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 (2007-1) **********
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 THIS CODE.

FOR ALL USERS WHO ARE NOT INTERESTED IN THIS OPTIONS NO CHANGES ARE REQUIRED IN THE INPUT TO THIS PROGRAM, I. E. IF COLUMNS 34-44 ARE BLANK (AS FOR ALL PREVIOUS VERSIONS OF THIS CODE) THE PROGRAM WILL OPERATE EXACTLY AS IT DID BEFORE.

ALLOWABLE ERROR

ALLOWABLE ERROR MUST ALWAYS BE SPECIFIED IN THE INPUT TO THIS PROGRAM AS A FRACTION, NOT A PER-CENT. FOR EXAMPLE, INPUT THE ALLOWABLE FRACTIONAL ERROR 0.001 IN ORDER TO OBTAIN DATA THAT IS ACCURATE TO WITHIN 0.1 PER-CENT.

THE CONVERSION OF THE DATA FROM THE GENERAL INTERPOLATION FORM TO LINARLY INTERPOLABLE FORM CANNOT BE PERFORMED EXACTLY. HOWEVER, IT CAN BE PERFORMED TO VIRTUALLY ANY REQUIRED ACCURACY AND MOST IMPORTANTLY CAN BE PERFORMED TO A TOLERANCE THAT IS SMALL COMPARED TO THE UNCERTAINTY IN THE CROSS SECTIONS THEMSELVES. AS SUCH THE CONVERSION OF CROSS SECTIONS TO LINEARLY INTERPOLABLE FORM CAN BE PERFORMED WITH ESSENTIALLY NO LOSE OF INFORMATION.

THE ALLOWABLE ERROR MAY BE ENERGY INDEPENDENT (CONSTANT) OR ENERGY DEPENDENT. THE ALLOWABLE ERROR IS DESCRIBED BY A TABULATED FUNCTION OF UP TO 20 (ENERGY,ERROR) PAIRS AND LINEAR INTERPOLATION

```
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. FOR EACH REQUESTED MATERIAL NEUTRON INTERACTION CROSS SECTIONS (MF=3) WOULD BE LINEARIZED AND THE REMAINDER OF THE MATERIAL WOULD BE COPIED.

FOR VERSIONS 90-1 AND LATER THIS PROGRAM WILL ALLOW THE USER TO TO SPECIFY BY INPUT PARAMETERS EXACTLY WHAT SECTIONS OF DATA TO PROCESS. FOR EACH SECTION OF DATA, SPECIFIED BY MAT, MF, MT RANGES, SECTIONS OF MF=3, 23 AND 27 WILL BE LINEARIZED AND ALL OTHER REQUESTED SECTIONS WILL BE COPIED. ALL SECTIONS WHICH ARE NOT EXPLICITLY REQUESTED WILL BE SKIPPED AND WILL NOT APPEAR ON ENDF/B FILE OUTPUT BY THIS PROGRAM.

WITH THIS NEW PROCEDURE YOU CAN MINIMIZE THE SIZE OF THE ENDF/B FILE OUTPUT BY THIS PROGRAM, E.G., IF YOU ONLY WANT NEUTRON CROSS SECTIONS FOR SUBSEQUENT PROCESSING YOU NEED ONLY REQUEST ONLY MF=3 DATA.

HOWEVER, YOU MUST UNDERSTAND THAT ONLY THOSE SECTIONS WHICH YOU EXPLICITLY REQUEST WILL APPEAR ON THE ENDF/B FILE OUTPUT BY THIS PROGRAM. FOR EXAMPLE, IF YOU WISH TO DOCUMENT EXACTLY HOW YOU LINEARIZED THE DATA BY INCLUDING COMMENTS IN MF=1, MT=451 THEN YOU MUST EXPLICITLY REQUEST THAT MF=1, MT=451 BE PROCESSED FOR EACH MATERIAL THAT YOU REQUEST. SIMILAR IF YOU WANT THE ENTIRE EVALUATION YOU MUST REQUEST ALL MF AND MT TO BE OUTPUT.

LINE	COLS.	DESCRIPTION
1	1-11	SELECTION CRITERIA (0=MAT, 1=ZA)
	12-22	MONITOR MODE SELECTOR = 0 - NORMAL OPERATION = 1 - MONITOR PROGRESS OF LINEARIZING OF THE DATA. EACH TIME A PAGE OF DATA POINTS IS WRITTEN TO THE SCRATCH FILE PRINT OUT THE TOTAL NUMBER OF POINTS ON SCRATCH AND THE LOWER AND UPPER ENERGY LIMITS OF THE PAGE (THIS OPTION MAY BE USED IN ORDER TO MONITOR THE EXECUTION SPEED OF LONG RUNNING JOBS).
	23-33	MINIMUM CROSS SECTION OF INTEREST (BARNS). (IF 0.0 OR LESS IS INPUT THE PROGRAM WILL USE 1.0E-10). ENERGY INTERVALS WILL NOT BE SUB-DIVIDED IF THE ABSOLUTE VALUE OF THE CROSS SECTION WITHIN THE INTERVAL IS LESS THAN THIS VALUE. AN EXCEPTION TO THIS RULE IS NEAR THRESHOLDS ENERGY INTERVALS WILL BE SUB-DIVIDED UNTIL CONVERGENCE REGARDLESS OF THE MAGNITUDE OF THE CROSS SECTION.
	34-44	KEEP ORIGINAL EVALUATED DATA POINTS. = 0 - NO. = 1 - YES - ADDITIONAL POINTS MAY BE ADDED IN ORDER TO LINEARIZE DATA, BUT ALL ORIGINAL DATA POINTS WILL BE INCLUDED IN THE RESULTS.
2	1-60	ENDF/B INPUT DATA FILENAME (STANDARD OPTION = ENDFB.IN)
3	1-60	ENDF/B OUTPUT DATA FILENAME (STANDARD OPTION = ENDFB.OUT)
4-N	1- 6	LOWER MAT OR ZA LIMIT
	7- 8	LOWER MF LIMIT
	9-11	LOWER MT LIMIT
	12-17	UPPER MAT OR ZA LIMIT
	18-19	UPPER MF LIMIT
	20-22	UPPER MT LIMIT UP TO 100 RANGES MAY BE SPECIFIED, ONLY ONE RANGE

```
                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
```