```
======================================================================= Sixpak
                                                                        Sixpak
     PROGRAM SIXPAK                                                     Sixpak
     ==============                                                     Sixpak
     VERSION 92-1 (JANUARY 1992)                                        Sixpak
     VERSION 92-2 (FEBRUARY 1992)*INCREASED CORE ALLOCATION TO          Sixpak
                                  ACCOMMODATE JEF AND EFF EVALUATIONS.  Sixpak
     VERSION 92-3 (APRIL 1992)   *ADDED ADDITIONAL DATA TESTS.          Sixpak
     VERSION 92-4 (SEPT. 1992)   *CORRECTED KALBACH-MANN CALCULATIONS.  Sixpak
                                 *FOR PHOTON PRODUCTION OUTPUT MF=12    Sixpak
                                  (MULTIPLICITY), MF=14 (ISOTROPIC      Sixpak
                                  ANGULAR DISTRIBUTIONS) AND MF=15      Sixpak
                                  (SPECTRA) - PREVIOUSLY ONLY MF=15.    Sixpak
                                 *FIRST ORDER CORRECTIONS TRANSFORMING  Sixpak
                                  CENTER-OF-MASS SPECTRA TO LAB SYSTEM  Sixpak
                                  FOR OUTPUT IN MF=5                    Sixpak
                                 *CORRECTED ISOTROPIC ANGULAR           Sixpak
                                  DISTRIBUTION FLAG (LI)                Sixpak
     VERSION 94-1 (JANUARY 1994) *VARIABLE ENDF/B INPUT DATA FILENAME   Sixpak
                                  TO ALLOW ACCESS TO FILE STRUCTURES     Sixpak
                                  (WARNING - INPUT PARAMETER FORMAT      Sixpak
                                  HAS BEEN CHANGED)                     Sixpak
                                 *CLOSE ALL FILES BEFORE TERMINATING    Sixpak
                                  (SEE, SUBROUTINE ENDIT)               Sixpak
                                 *INCREASED MAXIMUM TABLE SIZE FROM     Sixpak
                                  2000 TO 6000.                         Sixpak
     VERSION 96-1 (JANUARY 1996) *COMPLETE RE-WRITE                     Sixpak
                                 *IMPROVED COMPUTER INDEPENDENCE        Sixpak
                                 *ALL DOUBLE PRECISION                  Sixpak
                                 *ON SCREEN OUTPUT                      Sixpak
                                 *UNIFORM TREATMENT OF ENDF/B I/O       Sixpak
                                 *IMPROVED OUTPUT PRECISION             Sixpak
     VERSION 99-1 (MARCH 1999)   *CORRECTED CHARACTER TO FLOATING       Sixpak
                                  POINT READ FOR MORE DIGITS            Sixpak
                                 *UPDATED TEST FOR ENDF/B FORMAT        Sixpak
                                  VERSION BASED ON RECENT FORMAT CHANGE Sixpak
                                 *GENERAL IMPROVEMENTS BASED ON         Sixpak
                                  USER FEEDBACK                         Sixpak
     VERSION 99-2 (JUNE 1999)    *ASSUME ENDF/B-VI, NOT V, IF MISSING   Sixpak
                                  MF=1, MT-451.                         Sixpak
     VERS. 2000-1 (FEBRUARY 2000)*GENERAL IMPROVEMENTS BASED ON         Sixpak
                                  USER FEEDBACK                         Sixpak
     VERS. 2002-1 (JANUARY 2002) *CORRECTED ANGULAR DISTRIBUTION (MF=4) Sixpak
                                  OUTPUT TO INSURE USED FIELDS ARE 0    Sixpak
                  (MAY 2002)     *OPTIONAL INPUT PARAMETERS             Sixpak
                  (NOV. 2002)    *EXTENDED TO ALLOW CHARGED PARTICLE    Sixpak
                                  ANGULAR DISTRIBUTION IN MF=4 -        Sixpak
                                  WARNING - STRICTLY SPEAKING THIS IS   Sixpak
                                  NOT LEGAL, SINCE MF=4 IS SUPPOSED TO  Sixpak
                                  BE USED ONLY FOR NEUTRON ANGULAR      Sixpak
                                  DISTRIBUTIONS - BUT WHERE MT MAKES    Sixpak
                                  IT OBVIOUS THAT THE OUTGOING PARTICLE Sixpak
                                  IS NOT A NEUTRON HOPEFULLY IT WILL    Sixpak
                                  NOT CAUSE A PROBLEM IF MF=4 IS USED   Sixpak
                                  FOR CHARGED PARTICLES.                Sixpak
     VERS. 2004-1 (MARCH 2004)   *ADDED INCLUDE FOR COMMON             Sixpak
                                 *INCREASED MAXIMUM TABLE SIZE FROM     Sixpak
                                  6,000 TO 12,000.                      Sixpak
                                 *ADDED DUMMY A FOR ELEMENTS            Sixpak
                                 *CORRECTED OUTPUT INTERPOLATON LAWS    Sixpak
     VERS. 2007-1 (JAN.  2007)   *CHECKED AGAINST ALL ENDF/B-VII.       Sixpak
                                 *INCREASED MAXIMUM TABLE SIZE FROM     Sixpak
                                  12,000 TO 120,000.                    Sixpak
     VERS. 2007-2 (DEC.  2007)   *72 CHARACTER FILE NAMES.             Sixpak
     VERS. 2010-1 (Apr.  2010)   *General update based on user feedback Sixpak
     VERS. 2011-1 (May   2011)   *Added MF/MT=9/5 yield output starting Sixpak
                                  from  MF/MT=6/5 distributions.        Sixpak
                                 *Increased maximum Legendre order from Sixpak
                                  30 to 1,000 - WARNING - using more    Sixpak
                                  than 30 results in NONSENSE = NOISE!! Sixpak
     VERS. 2012-1 (Oct.  2012)   *Increased max. point count to 500,000 Sixpak
```

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                          *Added CODENAME                          Sixpak
                          *32 and 64 bit Compatible                Sixpak
                          *Added ERROR stop                        Sixpak
                          *For photons, combine discrete and       Sixpak
                           continuum into tabulated increasing     Sixpak
                           energy order.                           Sixpak
                          *Check energy output order increasing.   Sixpak
                           Print WARNING if not increasing - do    Sixpak
                           not STOP- stopping would prevent ALL    Sixpak
                           output - the user may not be at all     Sixpak
                           interested in the BAD data, but may     Sixpak
                           be interested in other output data      Sixpak
                           that is o.k.                            Sixpak
VERS. 2015-1 (Jan.  2015)  *Extended OUT9.                          Sixpak
                          *Replaced ALL 3 way IF Statements.       Sixpak
                          *Deleted unused coding.                  Sixpak
VERS. 2017-1 (May   2017)  *Increased max. point to 600,000         Sixpak
                          *Updated based on user feedback          Sixpak
VERS. 2017-2 (Oct.  2017)  *Updated for new P(nu) formats =         Sixpak
                           Recognized and ignored = no MF=5        Sixpak
                           equivalent.                             Sixpak
VERS. 2018-1 (Jan.  2018)  *Updated to skip Nu-Bar Data = there     Sixpak
                           is no double-differential data to       Sixpak
                           process.                                Sixpak
                          *On-linr report for ALL ENDERROR         Sixpak
VERS. 2019-1 (June  2019)  *Additional Interpolation Law Tests      Sixpak
                          *Checked Maximum Tabulated Energy to     Sixpak
                           insure it is the same for all MTs -     Sixpak
                           if not, print WARNING messages.         Sixpak
                          *WARNING MT=5 - not allowed in MF=4/5    Sixpak
                           see ENDF102 - but will translate here   Sixpak
                           to allow diagnostic use ONLY.           Sixpak
                          *Corrected END Histogram - guarantee     Sixpak
                           it ends with zero cross section,e.g.,   Sixpak
                           (E,Y) only defines upper energy of      Sixpak
                           the last group - Y has no meaning,      Sixpak
                           by ENDF convention it should be Y = 0   Sixpak
                                                                   Sixpak
OWNED, MAINTAINED AND DISTRIBUTED BY                               Sixpak
-----------------------------------                                Sixpak
THE NUCLEAR DATA SECTION                                           Sixpak
INTERNATIONAL ATOMIC ENERGY AGENCY                                 Sixpak
P.O. BOX 100                                                       Sixpak
A-1400, VIENNA, AUSTRIA                                            Sixpak
EUROPE                                                             Sixpak
                                                                   Sixpak
ORIGINALLY WRITTEN BY                                              Sixpak
-------------------------------------                              Sixpak
Dermott E. Cullen                                                  Sixpak
                                                                   Sixpak
PRESENT CONTACT INFORMATION                                        Sixpak
---------------------------                                        Sixpak
Dermott E. Cullen                                                  Sixpak
1466 Hudson Way                                                    Sixpak
Livermore, CA 94550                                                Sixpak
U.S.A.                                                             Sixpak
Telephone  925-443-1911                                            Sixpak
E. Mail    RedCullen1@Comcast.net                                  Sixpak
Website    RedCullen1.net/HOMEPAGE.NEW                             Sixpak
                                                                   Sixpak
COLLABORATION                                                      Sixpak
================================================================== Sixpak
DEVELOPED IN COLLABORATION WITH,                                   Sixpak
                                                                   Sixpak
*THE NATIONAL NUCLEAR DATA CENTER, BROOKHAVEN NATIONAL LAB         Sixpak
                                                                   Sixpak
*THE NUCLEAR DATA SECTION, IAEA, VIENNA, AUSTRIA                   Sixpak
                                                                   Sixpak
*CENTRO TECNICO AEROSPACIAL, SAO JOSE DOS CAMPOS, BRAZIL           Sixpak
                                                                   Sixpak
AS A PART OF AN INTERNATIONAL PROJECT ON THE EXCHANGE OF           Sixpak
```

NUCLEAR DATA Sixpak

ACKNOWLEDGEMENT (VERSION 92-1)
THE AUTHOR THANKS SOL PEARLSTEIN (BROOKHAVEN NATIONAL LAB) FOR SIGNIFICANTLY CONTRIBUTING TOWARD IMPROVING THE ACCURACY AND COMPUTER INDEPENDENCE OF THIS CODE - THANKS, SOL

ACKNOWLEDGEMENT (VERSION 92-4)
THE AUTHOR THANKS BOB MACFARLANE (LOS ALAMOS) FOR SUGGESTING HOW TO PROPERLY OUTPUT THE PHOTON PRODUCTION DATA TO PUT IT INTO EXACTLY THE FORM NEEDED FOR USE IN PROCESSING CODES.

THE AUTHOR THANKS CHRIS DEAN (WINFRITH) FOR POINTING OUT ERRORS IN THE EARLIER TREATMENT OF THE KALBACH-MANN FORMALISM AND IN THE DEFINITION OF THE ISOTROPIC ANGULAR DISTRIBUTION FLAG (LI).

AUTHORS MESSAGE
THE COMMENTS BELOW SHOULD BE CONSIDERED THE LATEST DOCUMENTATION INCLUDING ALL RECENT IMPROVEMENTS. PLEASE READ ALL OF THESE COMMENTS BEFORE IMPLEMENTING AND USING THESE CODES.

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
1) CHECK ALL DOUBLE-DIFFERENTIAL DATA (MF=6)

2) OUTPUT EQUIVALENT MF = 4, 5, 12, 14 AND 15 DATA.

DATA CHECKING
ALL OF THE ENDF/B-VI MF=6 DATA IS CHECKED - FOR DETAILS SEE BELOW.

THE MF=6 DATA IS NOT CORRECTED AND OUTPUT IN THE ENDF/B FORMAT. IT IS MERELY CHECKED. IF ERRORS ARE FOUND IT IS UP TO THE USER TO TAKE CORRECTIVE ACTION ON THE MF=6 DATA.

IN CONTRAST WHEN PROBLEMS ARE FOUND IN DATA WHICH WILL BE OUTPUT IN THE ENDF/B FORMAT (MF=4, 5, 12, 14 AND 15), WHENEVER POSSIBLE CORRECTIVE ACTION WILL BE TAKEN.

FURTHER CHECKS AND CORRECTIONS
ONCE THE DATA HAS BEEN OUTPUT IN MF = 4, 5, 12, 14 AND 15 FORMATS FURTHER CORRECTIVE ACTION CAN BE TAKEN AS FOLLOWS,

PROGRAM LEGEND
==========
CAN BE USED TO CORRECT ANGULAR DISTRIBUTIONS WHICH ARE NEGATIVE, TO CONVERT FROM LEGENDRE COEFFICIENTS TO TABULATED ANGULAR DISTRIBUTIONS AND GENERALLY PERFORM MORE EXTENSIVE TESTS OF ALL MF=4 DATA.

PROGRAM EVALPLOT
==========
VERSION 92-1 AND LATER VERSIONS CAN PLOT ALL OF THE MF=4, 5 AND 15 DATA OUTPUT BY THIS CODE. EARLIER VERSIONS CAN PLOT MF=4 AND 5. GRAPHICS IS AN EXCELLENT WAY TO CHECK THIS DATA.

PROGRAM PLOTTAB
==========

THIS IS A GENERAL PLOTTING PROGRAM AND THERE IS AN INTERFACE IN THIS CODE TO PRODUCE OUTPUT FOR ANY MF=6 DATA IN THE PLOTTAB INPUT FORMAT. THIS PROGRAM CAN BE USED TO CHECK ALL OF THE MF=6 DATA AS WELL AS THE EQUIVALENT MF=4, 5, 12, 14 AND 15 DATA - AS WELL AS COMPARING THE ORIGINAL MF=6 AND EQUIVALENT DATA. Sixpak

DATA OUTPUT Sixpak

THE ENDF/B MF=4, 5, 12, 14 AND 15 FORMATS ONLY ALLOW FOR NEUTRONS INCIDENTS Sixpak

THE ENDF/B MF=4 AND 5 FORMATS ONLY ALLOW FOR NEUTRONS OUTGOING. Sixpak

THE ENDF/B MF=12, 14 AND 15 ONLY ALLOWS FOR PHOTONS OUTGOING. Sixpak

THESE ARE THE ONLY COMBINATIONS OF DATA OUTPUT BY THIS CODE. Sixpak

ALL OTHER COMBINATIONS OF INCIDENT AND OUTGOING PARTICLES ARE CHECKED, BUT THE RESULTS CANNOT BE OUTPUT IN THE ENDF/B FORMAT. HOWEVER, USING THE PLOTTAB INTERFACE BUILT INTO THIS CODE THIS DATA CAN, AND HAS BEEN, OUTPUT AND CHECKED. Sixpak

THE NEUTRON DATA IN MF=4 CAN BE IN THE FORM OF EITHER TABULATED ANGULAR DISTRIBUTIONS OR LEGENDRE COEFFICIENTS. Sixpak

THE NEUTRON (MF=5) OR PHOTON (MF=15) SPECTRA ARE BOTH IN EXACTLY THE SAME FORMAT = ARBITRARY TABULATED FUNCTIONS - ENDF/B OPTION LF=1. Sixpak

ENDF/B DATA OUTPUT ORDER Sixpak

ENDF/B DATA IS OUTPUT IN ASCENDING MAT, MF, MT ORDER. IN ORDER TO ALLOW THIS PROGRAM TO PRODUCE ALL OUTPUT IN A SINGLE PASS THROUGH THE MF=6 DATA, OUTPUT FOR EACH (MAT, MT) IS OUTPUT TO SEPERATE FILES FOR MF=4, 5, 12, 14 AND 15. Sixpak

FOR SUBSEQUENT USE THE ENDF/B FORMATTED DATA OUTPUT BY THIS CODE CAN BE MERGED TOGETHER USING PROGRAM MERGER (CONTAIN THE AUTHOR OF THIS CODE FOR A COPY OF MERGER), E.G., MERGE MF=12, 14 AND 15 DATA IN ORDER TO THEN CALCULATE PHOTON PRODUCTION DATA OR MF=4 AND 5 CAN BE MERGED TOGETHER TO CALCULATE NEUTRON TRANSFER - OR ALL OF THEM CAN BE MERGED TOGETHER TO PERFORM NEUTRON AND PHOTON CALCULATIONS. Sixpak

CORRELATED (MF=6) VS. UNCORRELATED (MF=4 AND 5) DATA Sixpak

THE ENDF/B DOUBLE DIFFERENTAL = CORRELATED - DATA IN MF=6 REPRESENTS DATA IN THE FORM, Sixpak

$$F(E,EP,COS) = SIG(E)*Y(E)*G0(E,EP)*F(E,EP,COS)$$ Sixpak

SIG(E) = MF=3 CROSS SECTIONS Sixpak
Y(E) = YIELD (MULTIPLICITY) Sixpak
G0(E,EP) = ENERGY SPECTRUM Sixpak
F(E,EP,COS) = ANGULAR DISTRIBUTION Sixpak

IN A SITUATION WHERE YOU HAVE MONOENERGETIC AND MONODIRECTIONAL NEUTRONS INCIDENT YOU WILL BE ABLE TO OBSERVE CORRELATION EFFECTS IN THE NEUTRON SPECTRUM AND ANGULAR DISTRIBUTION. Sixpak

EVEN IN SITUATIONS WHERE YOU HAVE A NARROW SPECTRUM OF NEUTRONS THAT ARE HIGHLY DIRECTIONALLY ORIENTED YOU MAY BE ABLE TO OBSERVE THESE CORRELATION EFFECTS, E.G., A NARROW 14 MEV FUSION SOURCE INCIDENT ON THE FIRST WALL OF A CTR DEVICE. Sixpak

FOR SUCH SITUATIONS USE OF THE CORRELATED (MF=6) DATA IS REQUIRED IN CALCULATIONS. Sixpak

HOWEVER, IN MANY APPLICATIONS WHERE THERE IS A BROAD SPECTRUM OF NEUTRONS AND THE NEUTRON FLUX IS NOT HIGHLY DIRECTIONALLY ORIENTED, THE NEUTRON MULTIPLICATION, SPECTRUM AND ORIENTATION Sixpak

CAN BE FAIRLY ACCURATELY CALCULATED WITHOUT CONSIDERING Sixpak
CORRELATION EFFECTS. Sixpak
Sixpak
THE UNCORRELATED DATA PRODUCED BY THIS CODE REPLACES THE Sixpak
CORRELATED DATA, Sixpak
Sixpak
F(E,EP,COS) = SIG(E)*Y(E)*G0(E,EP)*F(E,EP,COS) Sixpak
Sixpak
BY THE UNCORRELATED DATA, Sixpak
Sixpak
F(E,EP,COS) = SIG(E)*Y(E)*G0(E,EP)*F0(E,COS) Sixpak
Sixpak
BY INTEGRATING G0(E,EP)*F(E,EP,COS) OVER SECONDARY ENERGY (EP) Sixpak
TO DEFINE AN AVERAGE ANGULAR DISTRIBUTION, F0(E,COS). Sixpak
Sixpak
WHAT IS LOST IN THIS PROCESS IS THE CORRELATION BETWEEN EP AND COS Sixpak
SO THAT IN A TRANSPORT CALCULATION ALL MOMENTS OF THE FLUX WILL Sixpak
HAVE THE SAME SPECTRUM, G0(E,EP) AND EACH WILL BE EFFECTED BY THE Sixpak
AVERAGE ANGULAR DISTRIBUTION. Sixpak
Sixpak
FOR APPLICATIONS TO HIGH ENERGY FUSION APPLICATIONS CORRELATED Sixpak
DATA SHOULD BE USED. HOWEVER, FOR LOWER ENERGY APPLICATIONS, Sixpak
SUCH AS FISSION REACTORS, IT SHOULD BE ADEQUATE TO USE THE Sixpak
UNCORRELATED DATA - IN THIS CASE THE MOST IMPORTANT EFFECT Sixpak
WILL BE THE OVERALL NEUTRON MULTIPLICATION AND SPECTRUM. Sixpak
Sixpak
AN IMPORTANT CONSIDERATION IN DESIGNING THIS PROGRAM IS THAT Sixpak
MANY COMPUTER CODES - DATA PROCESSING AND TRANSPORT CODES - Sixpak
CANNOT USE THE CORRELATED (MF=6) DATA - NOR ARE THEY INTENDED Sixpak
FOR HIGH ENERGY USE. FOR THESE CODES THE UNCORRELATED DATA Sixpak
PRODUCED BY THIS CODE SHOULD BE ADEQUATE TO MEET THEIR NEEDS. Sixpak
Sixpak
WARNING - IT CANNOT BE STRESSED ENOUGH THAT THE OUTPUT OF THIS Sixpak
CODE SHOULD ONLY BE USED FOR LOW ENERGY APPLICATIONS - FAILURE Sixpak
TO HEED THIS WARNING CAN LEAD TO COMPLETELY UNRELIABLE RESULTS. Sixpak
Sixpak
ENDF/B FORMAT Sixpak
========== Sixpak
THIS PROGRAM ONLY USES THE ENDF/B BCD OR CARD IMAGE FORMAT (AS Sixpak
OPPOSED TO THE BINARY FORMAT) AND CAN HANDLE DATA IN ANY VERSION Sixpak
OF THE ENDF/B FORMAT (I.E., ENDF/B-I, II,III, IV, V OR VI FORMAT). Sixpak
Sixpak
IT IS ASSUMED THAT THE DATA IS CORRECTLY CODED IN THE ENDF/B Sixpak
FORMAT AND NO ERROR CHECKING IS PERFORMED. IN PARTICULAR IT IS Sixpak
ASSUMED THAT THE MAT, MF AND MT ON EACH LINE IS CORRECT. SEQUENCE Sixpak
NUMBERS (COLUMNS 76-80) ARE IGNORED ON INPUT, BUT WILL BE Sixpak
CORRECTLY OUTPUT ON ALL LINES. THE FORMAT OF SECTION MF=1, MT=451 Sixpak
AND ALL SECTIONS OF MF=6 MUST BE CORRECT. THE PROGRAM SKIPS ALL Sixpak
OTHER SECTIONS OF DATA AND AS SUCH IS INSENSITIVE TO THE FORMAT Sixpak
OF ALL OTHER SECTIONS. Sixpak
Sixpak
CONTENTS OF OUTPUT Sixpak
========== Sixpak
5 ENDF/B FORMATTED OUTPUT FILES ARE PRODUCED FOR NEUTRON INCIDENT Sixpak
DATA, Sixpak
Sixpak
1) ENDFB.MF4 - ANGULAR DISTRIBUTIONS AND LEGENDRE COEFFICIENTS Sixpak
FOR NEUTRONS Sixpak
2) ENDFB.MF5 - TABULATED NEUTRON ENERGY SPECTRA Sixpak
3) ENDFB.M12 - PHOTON EMISSION MULTIPLICITY Sixpak
4) ENDFB.M14 - PHOTON EMISSION ANGULAR DISTRIBUTIONS (ALWAYS Sixpak
ISOTROPIC) Sixpak
5) ENDFB.M15 - TABULATED PHOTON EMISSION SPECTRA Sixpak
Sixpak
EMITTED PARTICLE YIELD Sixpak
========== Sixpak
NEUTRONS Sixpak
======== Sixpak
IN MF=6 THE YIELD FOR EACH REACTION IS THE ACTUAL MULTIPLICITY OF Sixpak
THE REACTION, E.G., (N,2N) = 2. IN USING MF=4 AND 5 DATA THE Sixpak
ENDF/B CONVENTION IS THAT THE MULTIPLICITY IS IMPLIED BY THE Sixpak

```
MT NUMBER, E.G., MT=16 = (N,2N) = 2.                                    Sixpak
                                                                        Sixpak
THE ONLY EXCEPT IN ENDF/B-VI IS MT=201 = TOTAL NEUTRON PRODUCTION       Sixpak
WHERE AN ACTUAL ENERGY DEPENDENT YIELD IS INCLUDED IN MF=6.             Sixpak
HOWEVER, IN THIS CASE THE MF=3 CROSS SECTION INCLUDES THE               Sixpak
MULTIPLICITY (S. PEARLSTEIN, PRIVATE COMMUNICATION, JAN. 1992),         Sixpak
SIG(MT=201) = 2*SIG(N,2N)+3*SIG(N,3N).....ETC.                          Sixpak
                                                                        Sixpak
SO THAT FOR ALL ENDF/B-VI DATA AS OF JANUARY 1992 THE MF=4 AND 5        Sixpak
DATA OUTPUT BY THIS CODE CAN BE USED IN CONJUNCTION WITH THE MF=3       Sixpak
CROSS SECTIONS - WITHOUT ANY REFERENCE TO THE MF=6 YIELD.               Sixpak
                                                                        Sixpak
PHOTONS                                                                 Sixpak
=======                                                                 Sixpak
UNLIKE THE NEUTRONS WHERE WITH ONLY ONE EXCEPTION (MT=201) THE          Sixpak
MF=6 YIELD IS ENERGY INDEPENDENT, IN THE CASE OF PHOTON EMISSION        Sixpak
ALMOST ALL OF THE PHOTONS HAVE AN ENERGY DEPENDENT YIELD.               Sixpak
                                                                        Sixpak
THIS PROGRAM WILL OUTPUT THE PHOTON MULTIPLICITY IN MF=12 AND           Sixpak
INDICATE THAT THERE IS A NORMALIZED DISTRIBUTION IN MF=15               Sixpak
(LF=1 IN MF=12).                                                        Sixpak
                                                                        Sixpak
THIS PROGRAM WILL OUTPUT THE NORMALIZED PHOTON SPECTRA IN MF=15.        Sixpak
CONTINUOUS ENERGY SPECTRA AND DISCRETE PHOTONS WILL ALL BE OUTPUT       Sixpak
AS NORMALIZED SPECTRA.                                                  Sixpak
                                                                        Sixpak
THIS PROGRAM WILL ALSO OUTPUT MF=14 PHOTON ANGULAR DISTRIBUTION         Sixpak
DATA, ALWAYS USING THE ISOTROPIC FLAG TO MINIMIZE OUTPUT.               Sixpak
                                                                        Sixpak
WARNING OF ENERGY DEPENDENT YIELD                                       Sixpak
=================================                                       Sixpak
THIS PROGRAM WILL PRINT A WARNING MESSAGE IF A SECTION OF DATA          Sixpak
BEING OUTPUT IN THE ENDF/B FORMAT HAS AN ENERGY DEPENDENT MF=6          Sixpak
YIELD AND THE EMITTED PARTICLE IS A NEUTRON - SINCE THE ENDF/B          Sixpak
CONVENTION IS THAT FOR EACH MT NUMBER THE MULTIPLICITY IS IMPLIED       Sixpak
WE DO NOT EXPECT AN ENERGY DEPENDENT MULTIPLICITY FOR NEUTRON           Sixpak
EMISSION.                                                               Sixpak
                                                                        Sixpak
USING THE OUTPUT                                                        Sixpak
================================================================        Sixpak
NOTE, THAT IN USING THIS DATA, STARTING FROM THE RELATIONSHIP,          Sixpak
                                                                        Sixpak
F(E,EP,COS) = SIG(E)*Y(E)*G0(E,EP)*F0(E,COS)                            Sixpak
                                                                        Sixpak
USING THE ENDF/B CONVENTION THAT THE MULTIPLICITY IS EITHER             Sixpak
IMPLIED BY THE MT NUMBER (E.G., MT=16 = N,2N - MULTIPLICITY = 2)        Sixpak
OR INCLUDED IN THE CROSS SECTION (E.G., MT=201 = TOTAL NEUTRON          Sixpak
PRODUCTION) ALL THE INFORMATION REQUIRED FOR A CALCULATION IS           Sixpak
AVAILABLE IN,                                                           Sixpak
                                                                        Sixpak
MF=3       - SIG(E)                                                     Sixpak
MF=4       - F0(E,COS) - FOR OUTGOING NEUTRONS                          Sixpak
MF=5       - G0(E,EP)  - FOR OUTGOING NEUTRONS                          Sixpak
MF=12      - Y(E)      - FOR OUTGOING PHOTONS                           Sixpak
MF=14      - F0(E,COS) - FOR OUTGOING PHOTONS (ALWAYS ISOTROPIC)        Sixpak
MF=15      - G0(E,EP)  - FOR OUTGOING PHOTONS                           Sixpak
                                                                        Sixpak
DOCUMENTATION                                                           Sixpak
================================================================        Sixpak
ONLY SECTIONS OF MF=4, 5, 12, 14, 15 ARE OUTPUT ON A ENDF/B FILE.       Sixpak
THE ONLY DOCUMENTATION IS THE ENDF/B TAPE LABEL (FIRST RECORD OF        Sixpak
EACH FILE) WHICH IDENTIFIES THE DATA AS SIXPAK OUTPUT.                  Sixpak
                                                                        Sixpak
REACTION INDEX                                                          Sixpak
================================================================        Sixpak
THIS PROGRAM DOES NOT USE THE REACTION INDEX WHICH IS GIVEN IN          Sixpak
SECTION MF=1, MT=451 OF EACH EVALUATION.                                Sixpak
                                                                        Sixpak
SECTION SIZE                                                            Sixpak
================================================================        Sixpak
ALL OF THE DATA IN ENDF/B-VI, MF=6 ARE QUITE SMALL TABLES. AS SUCH      Sixpak
```

```
THIS PROGRAM ONLY ALLOWS TABLES OF UP TO 12000 POINTS (12,000 X,   Sixpak
Y VALUES). THIS SIZE IS MORE THAN ADEQUATE TO HANDLE ALL OF THE    Sixpak
CURRENT ENDF/B-VI DATA, AND IT CAN BE EASILY INCREASED TO HANDLE   Sixpak
ANY NEWER DATA AS IT BECOMES AVAILABLE.                            Sixpak
                                                                   Sixpak
PLEASE CONTACT THE AUTHOR IF YOU HAVE AN EVALUATION WHICH EXCEEDS  Sixpak
THIS LIMIT.                                                        Sixpak
                                                                   Sixpak
SELECTION OF DATA                                                  Sixpak
================================================================== Sixpak
THE PROGRAM SELECTS DATA TO BE PROCESSED BASED ON MAT/MT RANGES    Sixpak
(MF=6 ASSUMED). THIS PROGRAM ALLOWS UP TO 100 MAT/MT RANGES TO BE  Sixpak
SPECIFIED BY INPUT PARAMETERS. THE PROGRAM WILL ASSUME THAT THE    Sixpak
ENDF/B TAPE IS IN MAT ORDER. THE PROGRAM WILL TERMINATE EXECUTION  Sixpak
WHEN A MAT IS FOUND THAT IS ABOVE ALL REQUESTED MAT RANGES.        Sixpak
                                                                   Sixpak
PROGRAM OPERATION                                                  Sixpak
================================================================== Sixpak
EACH SECTION (MT) OF MF=6 DATA IS SUBDIVIDED INTO SUBSECTIONS -    Sixpak
ONE SUBSECTION FOR EACH EMITTED PARTICLE.                          Sixpak
                                                                   Sixpak
EACH SUBSECTION OF DATA IS CONSIDERED SEPARATELY. EACH SUBSECTION  Sixpak
OF ENDF/B MF=6 DATA TO PROCESS IS IN THE FORM,                     Sixpak
                                                                   Sixpak
F(E,EP,COS) = SIG(E)*Y(E)*G0(E,EP)*F(E,EP,COS)                     Sixpak
                                                                   Sixpak
SIG(E)      = MF=3 CROSS SECTIONS                                  Sixpak
Y(E)        = YIELD (MULTIPLICITY)                                 Sixpak
G0(E,EP)    = ENERGY SPECTRUM                                      Sixpak
F(E,EP,COS) = ANGULAR DISTRIBUTION                                 Sixpak
                                                                   Sixpak
G0(E,EP) = 1 WHEN INTEGRATED OVER EP (SECONDARY ENERGY)            Sixpak
G0(E,EP)*F(E,EP,COS) = 1 WHEN INTEGRATED OVER EP AND COS           Sixpak
                                                                   Sixpak
THIS PROGRAM WILL DEFINE THE ZEROTH ORDER MOMENTS OF THE           Sixpak
ENERGY AND ANGULAR DISTRIBUTIONS,                                  Sixpak
                                                                   Sixpak
G0(E,EP)  = G0(E,EP)*F(E,EP,COS) INTEGRATED OVER COS               Sixpak
F0(E,COS) = G0(E,EP)*F(E,EP,COS) INTEGRATED OVER EP                Sixpak
                                                                   Sixpak
FOR NEUTRON INDUCED REACTIONS THE ENDF/B FORMATTED OUTPUT WILL BE  Sixpak
                                                                   Sixpak
F0(E,COS)- IN ENDFB.MF4 FOR NEUTRONS OUT OF A REACTION             Sixpak
G0(E,EP) - IN ENDFB.MF5 FOR NEUTRONS OUT OF A REACTION             Sixpak
         - IN ENDFB.M15 FOR PHOTONS OUT OF A REACTION              Sixpak
                                                                   Sixpak
FOR NEUTRONS INCIDENT AND NEUTRONS EMITTED THIS DATA WILL BE       Sixpak
OUTPUT IN MF=4 AND 5 FORMATS.                                      Sixpak
                                                                   Sixpak
FOR NEUTRONS INCIDENT AND PHOTONS EMITTED THIS DATA WILL BE        Sixpak
OUTPUT IN MF=15 FORMAT - THE SPECTRA ARE OUTPUT AND THE            Sixpak
ANGULAR DISTRIBUTION IS IGNORED.                                   Sixpak
                                                                   Sixpak
ALL PHOTON EMISSION IN THE ENDF/B-VI LIBRARY AS OF JANUARY 1992    Sixpak
IS ISOTROPIC AND AS SUCH NO DISTRIBUTION OF PHOTON ANGULAR         Sixpak
DISTRIBUTIONS NEED BE OUTPUT - IT IS ALWAYS ISOTROPIC.             Sixpak
                                                                   Sixpak
FOR ALL OTHER COMBINATIONS INCIDENT AND EMITTED PARTICLES          Sixpak
THERE WILL BE NO ENDF/B FORMATTED OUTPUT.                          Sixpak
                                                                   Sixpak
VARIATIONS FROM ENDF/B MANUAL                                      Sixpak
================================================================== Sixpak
LAW=1, LANG=2 = KALBACH-MANN                                       Sixpak
============================                                       Sixpak
FOR THE DISTRIBUTIONS,                                             Sixpak
                                                                   Sixpak
F(MU,E,EP) = G0(E,EP)*A*(COSH(MU*A)+R(E,EP)*SINH(MU*A))            Sixpak
                                                                   Sixpak
G0(E,EP) = 1 - WHEN INTEGRATED OVER EP.                            Sixpak
                                                                   Sixpak
A*(COSH(MU*A)+R(E,EP)*SINH(MU*A)) = 2 - WHEN INTEGRATD OVER MU     Sixpak
```

THIS MEANS AS DEFINED IN THE ENDF/B MANUAL THE DISTRIBUTIONS ARE NORMALIZED TO 2, INSTEAD OF 1. IN ORDER TO OBTAIN CORRECTLY NORMALIZED DISTRIBUTIONS THE DISTRIBUTION SHOULD BE DEFINED TO INCLUDE A FACTOR OF 1/2 MULTIPLYING THE ANGULAR PART OF THE DISTRIBUTION.

F(MU,E,EP) = G0(E,EP)*0.5*A*(COSH(MU*A)+R(E,EP)*SINH(MU*A))

THIS IS THE FORM USED IN THIS CODE

LAW=1, ND NOT 0 = DISCRETE SECONDARY ENERGY DISTRIBUTION
===

THE ENDF/B MANUAL SAYS THESE ARE FLAGGED WITH NEGATIVE ENERGIES. IN ENDF/B-VI ALL OF THESE HAVE POSITIVE ENERGY. THIS CODE DOES NOT CONSIDER THE ENDF/B-VI DATA TO BE IN ERROR.

WITH THE CONVENTION ACTUALLY USED IN ENDF/B-VI ALL SECONDARY ENERGIES SHOULD BE NON-NEGATIVE AND IN ASCENDING ENERGY ORDER FOR EACH INCIDENT ENERGY.

FROM THE ENDF/B MANUAL IT IS NOT OBVIOUS WHAT G0(E,EP) SHOULD BE FOR DISCRETE PHOTONS - PHYSICALLY THIS IS A DELTA FUNCTION. IN ENDF/B-VI IT IS ENTERED AS 1.0 = INTERPRETING IT AS INTEGRATED OVER SECONDARY ENERGY - IN WHICH CASE THE DELTA FUNCTION = 1.0.

LIMITATIONS
===========

CHECKING DATA
=============

THIS PROGRAM CHECKS ALL ENDF/B-VI MF=6 DATA. THE FOLLOWING CHECKS ARE PERFORMED.

PARAMETERS
==========

ALL PARAMETERS ARE CHECKED FOR CONSISTENCY. IF PARAMETERS ARE NOT CONSISTENT THE PROGRAM MAY NOT BE ABLE TO PERFORM THE FOLLOWING TESTS AND WILL MERELY SKIP A SECTION OF DATA.

INTERPOLATION LAWS
==================

ALL INTEGRATIONS ARE PERFORMED USING THE INTERPOLATION LAW GIVEN FOR SECONDARY ENERGY AND/OR COSINE. INTEGRATIONS ARE NOT PERFORMED OVER INCIDENT - ONLY INTEGRATION OVER SECONDARY ENERGY AND/OR COSINE ARE PERFORMED AT EACH INCIDENT ENERGY. THEREFORE THE INTERPOLATION LAW FOR INCIDENT ENERGY IS NOT USED BY THIS CODE.

ALL INTERPOLATION LAWS ARE CHECKED. ALL DATA ASSOCIATED WITH INTERPOLATION LAWS ARE CHECKED, E.G., NO NON-NEGATIVE VALUES REQUIRING LOG INTERPOLATION. IN ORDER TO PERFORM REQUIRED INTEGRALS OVER COS AND EP IT IS IMPERATIVE THAT THE INTERPOLATION LAWS BE COMPATIBLE WITH THE DATA.

ENDF/B-VI ALLOWS NEW INTERPOLATION LAWS FOR CORRESPONDING POINT AND UNIT BASE TRANSFORMATION INTERPOLATION. NONE OF THESE NEW INTERPOLATION LAWS ARE USED IN THE ENDF/B-VI LIBRARY AS OF JANUARY 1992 TO INTERPOLATE IN SECONDARY ENERGY OR COSINE. THEREFORE THIS PROGRAM CAN PERFORM ALL OF THE REQUIRED INTEGRALS OVER SECONDARY ENERGY AND/OR COSINE USING ONLY THE OLDER INTERPOLATION CODES. THIS PROGRAM ONLY PERFORMS INTEGRALS FOR EACH INCIDENT ENERGY, SO THAT INTERPOLATION IN INCIDENT ENERGY IS NOT PERFORMED BY THIS PROGRAM.

NEW INTERPOLATION SCHEMES ARE USED FOR INCIDENT ENERGY - FOR EXAMPLE, CORRESPONDING POINT INTERPOLATION IS SPECIFIED TO ALLOW INTERPOLATION IN G0(E,EP) TO SIMULATE CASES WHERE THE INPUT ENERGY LIMIT IS DEFINED BY E-EP = A DIAGONAL CURVE ACROSS (E,EP) SPACE. THIS INTERPOLATION CODE CANNOT BE SPECIFIED IN THE MF=5 OUTPUT OF THIS CODE - MF=5 ONLY ALLOWS THE OLDER INTERPOLATION LAWS INT=1 THROUGH 5. THEREFORE THIS PROGRAM WILL USE THE CLOSEST

CORRESPONDING INTERPOLATION CODE FOR OUTPUT TO MF=5. FOR USE WHERE THE OUTPUT OF THIS CODE = LOW ENERGY APPLICATIONS - THIS SHOULD HAVE LITTLE EFFECT ON RESULTS.

FOR CONSISTENCY WITH EARLIER VERSIONS OF ENDF/B IN CREATING THE ENDF/B OUTPUT, IF ANY INPUT INTERPOLATION LAW IS NOT IN THE RANGE 1-5, IT WILL FIRST BE TESTED TO SEE IF MOD(10) IT IS IN THIS RANGE, FINALLY IF EVEN THIS DOESN'T WORK IT IS SET EQUAL TO 2 (LINEARLY INTERPOLATION). THIS METHOD WILL EFFECTIVELY REPLACE CORRESPONDING POINT AND UNIT BASE TRANSFORMATION BY THE CLOSEST RELATED INTERPOLATION LAW 1 THROUGH 5 - AGAIN NOTE, AS OF JANUARY 1992 NONE OF THESE NEW LAWS ARE USED IN ENDF/B-VI. IF THIS MUST BE DONE FOR INTERPOLATION IN SECONDARY ENERGY OR COSINE AN ERROR MESSAGE WILL BE PRINTED - SINCE THIS WOULD EFFECT THE ACCURACY OF THE INTEGRALS PERFORMED BY THIS PROGRAM. IF THIS MUST BE DONE FOR INCIDENT ENERGY NO MESSAGE IS PRINTED - SINCE THIS WILL NOT EFFECT THE ACCURACY OF THE INTEGRALS PERFORMED BY THIS PROGRAM.

SPECTRA AND ANGULAR DISTRIBUTIONS

ALL SPECTRA AND ANGULAR DISTRIBUTIONS ARE CHECKED TO INSURE THEY ARE NORMALIZED AND DO NOT INCLUDE ANY NEGATIVE VALUES.

LEGENDRE COEFFICIENTS

THE NORMALIZATION, F0, CANNOT BE NEGATIVE.

LEGENDRE COEFFICIENTS IN NORMAL FORM ARE CHECKED TO INSURE THEY ARE IN THE RANGE -1 TO +1 = THE LEGENDRE EXPANSION OF A DELTA FUNCTION AT COS=+1 OR -1 - COEFFICIENTS SHOULD NOT EXCEED WHAT YOU GET FROM A DELTA FUNCTION.

ANGULAR DISTRIBUTIONS ARE CHECKED AT COS = -1, 0 AND +1.

CREATING ENDF/B OUTPUT

THIS PROGRAM CAN CREATE EQUIVALENT MF =4, 5, 12, 14, 15 DATA FOR ALL OF THE DATA INCLUDED IN ENDF/B-VI AS OF JANUARY 1992, EXCEPT FOR 1 SECTION OF LAW=6 DATA (SEE DETAILS BELOW).

THIS PROGRAM HAS NOT BEEN TESTED ON OTHER DATA LIBRARIES, E.G., JEF, JENDL, ETC.

THE PROGRAM HAS THE FOLLOWING LIMITATION AS FAR AS CREATING ENDF/B FORMATTED OUTPUT.

ISOTROPIC PHOTON EMISSION

FOR PHOTON EMISSION THE DISTRIBUTIONS ARE ASSUMED TO BE ISOTROPIC AND ONLY THE MULTIPLICITY IS OUTPUT IN MF=12, ISOTROPIC ANGULAR DISTRIBUTIONS IN MF=14 AND THE SPECTRA IN MF=15. ALL ENDF/B-VI MF=6 DATA AS OF JANUARY 1992 INCLUDE ONLY ISOTROPIC PHOTON EMISSION - SO THAT THIS IS NOT A LIMITATION ON TRANSLATING ENDF/B-VI DATA.

EITHER TABULATED OR LEGENDRE COEFFICIENTS

FOR LAW=2 THE REPRESENTATION, EITHER TABULATED OR LEGENDRE COEFFICIENTS, CAN BE SPECIFIED FOR EACH INCIDENT ENERGY.

IN ORDER TO OBTAIN CORRECT ENDF/B OUTPUT THE REPRESENTATION MUST BE THE SAME FOR ALL INCIDENT ENERGIES = MF=4 DATA CAN ONLY BE TABULATED OR LEGENDRE OVER THE ENTIRE ENERGY RANGE.

YIELD AND OUTPUT NORMALIZATION

THE YIELD INCLUDED WITH EACH SECTION OF DATA IS NOT USED FOR OUTPUT FOR NEUTRONS, BUT IS INCLUDED IN THE OUTPUT FOR PHOTONS. IN ALL CASES THE ANGULAR DISTRIBUTIONS AND SPECTRA OUTPUT ARE NORMALIZED TO UNITY.

```
                                                                      Sixpak
LAW=0                                                                 Sixpak
=====                                                                 Sixpak
NO OUTPUT - INCIDENT NEUTRON - EMITTED PHOTON OR NEUTRON              Sixpak
            REACTIONS ARE NOT EXPECTED.                               Sixpak
                                                                      Sixpak
LAW=1                                                                 Sixpak
=====                                                                 Sixpak
FOR EACH INCIDENT ENERGY DISCRETE AND CONTINUOUS EMISSION SPECTRA     Sixpak
CANNOT BE MIXED TOGETHER - THEY MUST BE ALL EITHER DISCRETE OR        Sixpak
CONTINUOUS. IF DISCRETE EMISSION IS GIVEN ONLY 1 SECONDARY            Sixpak
ENERGY (NEP=1) MAY BE GIVEN = A NORMALIZED DISTRIBUTION FOR A         Sixpak
SINGLE DISCRETE EMISSION ENERGY. ALL OF THE ENDF/B-VI DATA AS         Sixpak
OF JANUARY 1992 CONFORM TO THESE LIMITATIONS.                         Sixpak
                                                                      Sixpak
SINCE THE FLAG NA, TO INDICATE ISOTROPIC DISTRIBUTIONS, IS ONLY       Sixpak
GIVEN FOR EACH SECONDARY ENERGY (EP) THE PROGRAM CANNOT DECIDE        Sixpak
IN ADVANCE WHETHER OR NOT THE DISTRIBUTION WILL BE ISOTROPIC          Sixpak
AT ALL INCIDENT ENERGIES. THEREFORE ISOTROPIC DISTRIBUTIONS           Sixpak
WILL BE OUTPUT EITHER: LANG = 1 - AS 1 LEGENDRE COEFFICIENT = 0.0     Sixpak
OR LANG = NOT 1 - AS A 2 POINT ANGULAR DISTRIBUTION AT COS = -1.0     Sixpak
AND +1.0 WITH BOTH VALUES EQUAL TO 0.5 (A NORMALIZED ISOTROPIC        Sixpak
DISTRIBUTION).                                                        Sixpak
                                                                      Sixpak
DISCRETE PHOTONS ARE OUTPUT IN MF=15 AS 3 POINT DISTRIBUTIONS         Sixpak
WITH SECONDARY ENERGY POINTS AT EP-DEP, EP, EP+DEP, WHERE             Sixpak
DEP=0.001*EP. THE VALUES AT EP-DEP AND EP+DEP ARE 0.0, AND            Sixpak
AT EP THE VALUE IS 1000.0/EP TO NORMALIZE THE DISTRIBUTION.           Sixpak
                                                                      Sixpak
LAW=2                                                                 Sixpak
=====                                                                 Sixpak
NO LIMITATION ON REPRESENTATIONS.                                     Sixpak
                                                                      Sixpak
LAW=3                                                                 Sixpak
=====                                                                 Sixpak
NO LIMITATION ON REPRESENTATIONS.                                     Sixpak
                                                                      Sixpak
LAW=4                                                                 Sixpak
=====                                                                 Sixpak
NO OUTPUT - INCIDENT NEUTRON - EMITTED PHOTON OR NEUTRON              Sixpak
            REACTIONS ARE NOT EXPECTED.                               Sixpak
                                                                      Sixpak
LAW=5                                                                 Sixpak
=====                                                                 Sixpak
NO OUTPUT - INCIDENT NEUTRON - EMITTED PHOTON OR NEUTRON              Sixpak
            REACTIONS ARE NOT EXPECTED.                               Sixpak
                                                                      Sixpak
LAW=6                                                                 Sixpak
=====                                                                 Sixpak
NO OUTPUT - ENDF/B-VI ONLY INCLUDES 1 SECTION OF THIS TYPE OF DATA    Sixpak
            FOR (N,D) 2N,P.                                           Sixpak
                                                                      Sixpak
LAW=7                                                                 Sixpak
=====                                                                 Sixpak
FOR EACH INCIDENT ENERGY THE REPRESENTATION MUST BE EITHER,           Sixpak
                                                                      Sixpak
1) SQUARE = FOR EACH INCIDENT COSINE EXACTLY THE SAME SECONDARY       Sixpak
            ENERGIES.                                                 Sixpak
                                                                      Sixpak
2) LINEAR = FOR EACH INCIDENT COSINE THE INTERPOLATION LAW            Sixpak
            BETWEEN SECONDARY ENERGIES MUST BE LINEAR.                Sixpak
                                                                      Sixpak
THESE 2 PRESENTATIONS ARE THE ONLY ONES PRESENTED IN ENDF/B-VI        Sixpak
AS OF JANUARY 1992 - SO THIS PROGRAM CAN TRANSLATED ALL LAW=7         Sixpak
DATA FOR ENDF/B-VI.                                                   Sixpak
                                                                      Sixpak
LABORATORY VS. CENTER-OF-MASS SYSTEM                                  Sixpak
======================================================================Sixpak
IN MANY CASES PEOPLE ASSUME THAT FOR HEAVY (HIGH ATOMIC WEIGHT)       Sixpak
MATERIALS THE CENTER-OF-MASS AND LAB SYSTEMS ARE ALMOST IDENTICAL,    Sixpak
SINCE IN THIS CASE THE CENTER-OF-MASS ENERGY WILL BE MUCH SMALLER     Sixpak
```

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THAN THE INCIDENT ENERGY. FOR A PROCESS SUCH AS ELASTIC SCATTERING Sixpak
WHERE FOR HEAVY MATERIALS THE SECONDARY ENERGY, EP, WILL ALWAYS    Sixpak
BE A LARGE FRACTION OF THE INCIDENT ENERGY, THIS ASSUMPTION IS     Sixpak
VALID. HOWEVER, FOR THE TYPICAL REACTIONS INCLUDED IN MF=6 THIS    Sixpak
IS NOT ALWAYS TRUE - IN MANY OF THESE CASES THE SECONDARY ENERGY   Sixpak
CAN EXTEND ALL THE WAY DOWN TO ZERO, AND IN PARTICULAR IT CAN      Sixpak
BE SMALL COMPARED TO THE CENTER-OF-MASS ENERGY - WHICH MAKES THE   Sixpak
TRANSFORMATION FROM CENTER-OF-MASS TO LAB IMPORTANT. THEREFORE     Sixpak
GENERALLY TO TREAT MF=6 DATA WE MUST CONSIDER THIS TRANSFORMATION. Sixpak
                                                                   Sixpak
THE FOLLOWING DISCUSSING ONLY APPLIES TO SPECTRA THAT MAY BE       Sixpak
OUTPUT IN MF=5 = ONLY DATA FOR NEUTRONS INCIDENT AND EMITTED -     Sixpak
IN PARTICULAR THE FOLLOWING DEFINITIONS ARE NOT GENERAL - THEY     Sixpak
ARE ONLY VALID FOR INCIDENT AND EMITTED NEUTRONS.                  Sixpak
                                                                   Sixpak
DOUBLE DIFFERENTIAL DATA IN MF=6 MAY BE GIVEN IN EITHER THE LAB    Sixpak
OR C.M. SYSTEM. SIMILARLY ANGULAR DISTRIBUTIONS IN MF=4 MAY BE     Sixpak
GIVEN IN EITHER THE LAB OR C.M. SYSTEM. IN CONTRAST ENERGY         Sixpak
SPECTRA IN MF=5 CAN ONLY BE GIVEN IN THE LABORATORY SYSTEM.        Sixpak
                                                                   Sixpak
THE ANGULAR DISTRIBUTIONS OUTPUT BY THIS CODE IN MF=4 ARE IN THE   Sixpak
SAME SYSTEM IN WHICH THEY ARE GIVEN IN MF=6 - EITHER LAB OR        Sixpak
CENTER-OF-MASS SYSTEM.                                             Sixpak
                                                                   Sixpak
THE ENERGY SPECTRA OUTPUT BY THIS CODE IN MF=5 MUST BE IN THE LAB  Sixpak
SYSTEM - THIS IS THE ONLY ALLOWED FORM FOR MF=5 DATA.              Sixpak
                                                                   Sixpak
FOR MF=6 SPECTRA GIVEN IN THE LAB SYSTEM THIS MERELY REQUIRES      Sixpak
COPYING THE GIVEN SPECTRA TO MF=5 OUTPUT.                          Sixpak
                                                                   Sixpak
FOR MF=6 SPECTRA GIVEN IN THE CENTER-OF-MASS SYSTEM ONLY FIRST     Sixpak
ORDER CORRECTIONS IN THE SPECTRA AND USED AND THEY ARE THEN        Sixpak
OUTPUT IN MF=5 AS IN THE LAB SYSTEM - THE FIRST ORDER CORRECTIONS  Sixpak
ARE DESCRIBED BELOW.                                               Sixpak
                                                                   Sixpak
DEFINING,                                                          Sixpak
MM      = CENTER OF MASS MOTION                                    Sixpak
CM      = OUTGOING (EMITTED) PARTICLE IN CENTER OF MASS            Sixpak
LAB     = OUTGOING (EMITTED) PARTICLE IN LAB                       Sixpak
THETA   = CM SCATTERING ANGLE RELATIVE TO INCIDENT DIRECTION       Sixpak
COS(CM) = COSINE OF THE CM SCATTERING ANGLE                        Sixpak
                                                                   Sixpak
FOR NEUTRONS INCIDENT WITH AN ENERGY, E, AND THEREFORE A SPEED,    Sixpak
                                                                   Sixpak
VN(E) = 2*SQRT(E)/MASS(IN)                                         Sixpak
                                                                   Sixpak
THE CENTER-OF-MASS SPEED IS GIVEN BY,                              Sixpak
                                                                   Sixpak
V(MM) = VN(E)/(1 + A)                                              Sixpak
                                                                   Sixpak
AND THE CENTER OF MASS ENERGY BY,                                  Sixpak
                                                                   Sixpak
E(MM) = 1/2*MASS(IN)*V(MM)**2                                      Sixpak
      = 1/2*MASS(IN)*VN(E)**2/(1 + A)**2                           Sixpak
      = E/(1 + A)**2                                               Sixpak
                                                                   Sixpak
FOR DISTRIBUTIONS GIVEN IN MF=6 IN THE CM, THE SPEED, V(CM),       Sixpak
SHOULD BE VECTORIALLY ADDED TO THAT OF OUTGOING PARTICLES TO       Sixpak
DEFINE THE OUTGOING PARTICLES LAB VELOCITY, AND IN TURN IT'S       Sixpak
ENERGY,                                                            Sixpak
                                                                   Sixpak
V(LAB)*COS(LAB) = V(MM) + V(CM)*COS(CM)                            Sixpak
V(LAB)*SIN(LAB) =         V(CM)*SIN(CM)                            Sixpak
                                                                   Sixpak
V(LAB)**2 = V(MM)**2 + V(CM)**2 + 2*COS(CM)*V(MM)*V(CM)            Sixpak
                                                                   Sixpak
EP(LAB)   = 0.5*MASS(OUT)*V(LAB)**2                                Sixpak
                                                                   Sixpak
          = E(MM) + EP(CM) + 2*COS(CM)*SQRT(E(MM)*EP(CM))          Sixpak
                                                                   Sixpak
WE CAN ALSO DEFINE THE REVERSE TRANSFORMATION USING,               Sixpak
```

```
                                                                      Sixpak
V(CM)*COS(CM) = V(LAB)*COS(LAB) - V(MM)                               Sixpak
V(CM)*SIN(CM) = V(LAB)*SIN(LAB)                                       Sixpak
                                                                      Sixpak
V(CM)**2 = V(MM)**2 + V(LAB)**2 - 2*COS(LAB)*V(MM)*V(LAB)             Sixpak
                                                                      Sixpak
EP(CM)   = 0.5*MASS(OUT)*V(CM)**2                                     Sixpak
                                                                      Sixpak
          = E(MM) + EP(LAB) - 2*COS(LAB)*SQRT(E(MM)*EP(LAB))          Sixpak
                                                                      Sixpak
WE CAN DEFINE COS(LAB) FROM THE RELATIONSHIP,                         Sixpak
                                                                      Sixpak
V(LAB)*COS(LAB) = V(MM) + V(CM)*COS(CM)                               Sixpak
                                                                      Sixpak
COS(LAB)        =[V(MM) + V(CM)*COS(CM)]/V(LAB)                       Sixpak
                                                                      Sixpak
                 [V(MM) + V(CM)*COS(CM)]                              Sixpak
COS(LAB)        =-------------------------------------------         Sixpak
                 SQRT[V(MM)**2+V(CM)**2+2*COS(CM)*V(MM)*V(CM)]        Sixpak
                                                                      Sixpak
OR COS(CM) FROM THE RELATIONSHIP,                                     Sixpak
                                                                      Sixpak
V(CM)*COS(CM)  = V(LAB)*COS(LAB) - V(MM)                              Sixpak
                                                                      Sixpak
COS(CM)         =[V(LAB)*COS(LAB) - V(MM)]/V(CM)                      Sixpak
                                                                      Sixpak
                 [V(LAB)*COS(LAB) - V(MM)]                            Sixpak
COS(CM)         =-------------------------------------------         Sixpak
                 SQRT[V(LAB)**2+V(CM)**2-2*COS(LAB)*V(LAB)*V(MM)]     Sixpak
                                                                      Sixpak
THE JACOBIAN CAN BE DEFINED FROM,                                     Sixpak
                                                                      Sixpak
V(LAB)*COS(LAB) = V(MM) + V(CM)*COS(CM)                               Sixpak
                                                                      Sixpak
J = D[COS(CM)]/D[COS(LAB)] = V(LAB)/V(CM)                             Sixpak
                           = SQRT[EP(LAB)/EP(CM)]                     Sixpak
                                                                      Sixpak
WITH THESE DEFINITIONS OF EP(LAB) AND COS(LAB) IN TERMS OF E(MM),     Sixpak
EP(CM) AND COS(CM) IT IS POSSIBLE TO PERFORM A POINT-BY-POINT         Sixpak
TRANSFORMATION OF DISTRIBUTIONS FROM THE CM TO LAB SYSTEM USING       Sixpak
THESE DEFINITIONS - OR IF WE WISHED WE COULD PERFORM THE REVERSE      Sixpak
TRANSFORMATION USING THE ABOVE RELATIONSHIPS AND THE IDENTITY,        Sixpak
                                                                      Sixpak
F(E,EP(LAB),COS(LAB))*D(COS(LAB))=F(E,EP(CM),COS(CM))*D(COS(CM))      Sixpak
                                                                      Sixpak
THIS IS NOT WHAT WILL BE DONE HERE, SINCE WE WILL ONLY BE             Sixpak
INTERESTED IN THE ZEROTH ORDER MOMENTS OF THESE DISTRIBUTIONS,        Sixpak
BUT WE WILL BE INTERESTED IN DEFINING THOSE MOMENTS IN THE            Sixpak
LAB SYSTEM IN TERMS OF MF=6 SPECTRA GIVEN IN THE CM SYSTEM USING,     Sixpak
                                                                      Sixpak
F(E,EP(LAB),COS(LAB)) = F(E,EP(CM),COS(CM))*J                         Sixpak
                                                                      Sixpak
THE LIMITS OF EP(LAB) ARE DEFINED BY SETTING COS(CM) = +1 OR -1,      Sixpak
                                                                      Sixpak
EP(LAB)   = (SQRT(EP(CM)) + SQRT(E(MM)))**2  FOR COS(CM) = +1         Sixpak
          = (SQRT(EP(CM)) - SQRT(E(MM)))**2  FOR COS(CM) = -1         Sixpak
                                                                      Sixpak
IN THIS FORM WE CAN SEE THAT AS LONG AS THE SECONDARY ENERGY IN       Sixpak
THE CENTER-OF-MASS SYSTEM, EP(CM), IS MUCH LARGER THAN THE            Sixpak
ENERGY OF THE CENTER-OF-MASS, E(MM), THE CENTER-OF-MASS AND LAB       Sixpak
ENERGIES WILL BE ALMOST EQUAL - SIMILARLY FOR THE COSINE, IN          Sixpak
THIS CASE COS(LAB) AND COS(CM) WILL BE ALMOST EQUAL - HOWEVER,        Sixpak
FOR THE MF=6 DATA WE CANNOT ASSUME THAT THIS IS TRUE.                 Sixpak
                                                                      Sixpak
TO FIRST ORDER THE ANGULAR DEPENDENCE CAN BE IGNORED,                 Sixpak
                                                                      Sixpak
EP(LAB)   = E(MM) + EP(CM)                                            Sixpak
                                                                      Sixpak
ALL THIS SAYS IS THAT TO FIRST ORDER THE EFFECT OF TRANSFORMING       Sixpak
FROM THE CM TO LAB SYSTEM IS TO INCREASE THE ENERGY OF THE            Sixpak
EMITTED PARTICLE IN THE CENTER-OF-MASS SYSTEM BY THE ENERGY OF        Sixpak
```

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THE CENTER-OF-MASS TO DEFINE THE LAB ENERGY.                              Sixpak
                                                                          Sixpak
NOT ONLY THE ENERGY, BUT ALSO THE SPECTRA MUST BE TRANSFORMED.            Sixpak
STARTING FROM THE DOUBLE DIFFERENTIAL DATA IN THE LAB SYSTEM,             Sixpak
F(E,EP,COS(LAB)), WE CAN DEFINE THE LAB SCALAR SPECTRUM AS,               Sixpak
                                                                          Sixpak
G0(E,EP) = INTEGRAL F(E,EP,COS(LAB))*D(COS(LAB))                          Sixpak
                                                                          Sixpak
THIS IS THE NORMAL CALCULATION DEFINED ABOVE AND USED FOR DATA            Sixpak
GIVEN IN THE LAB SYSTEM.                                                  Sixpak
                                                                          Sixpak
STARTING FROM DATA IN THE CENTER OF MASS SYSTEM F(E,EP,COS(CM)),          Sixpak
WE CAN USE THE RELATIONSHIP,                                              Sixpak
                                                                          Sixpak
F(E,EP,COS(LAB))*D(COS(LAB)) = F(E,EP,COS(CM))*J*D(COS(LAB))              Sixpak
                                                                          Sixpak
J         = SQRT(EP(LAB)/EP(CM)) - THE JACOBIAN                           Sixpak
                                                                          Sixpak
          = E(MM)/EP(CM) + 1 + 2*COS(CM)*SQRT(E(MM)/EP(CM))               Sixpak
                                                                          Sixpak
AS IN THE CASE OF THE ENERGY, IN THIS FORM WE CAN SEE THAT AS             Sixpak
LONG AS THE SECONDARY ENERGY IN THE CENTER-OF-MASS SYSTEM,                Sixpak
EP(CM), IS LARGE COMPARED TO THE CENTER-OF-MASS ENERGY, E(MM),            Sixpak
THE JACOBIAN IS ESSENTIALLY UNITY AND THE CENTER-OF-MASS AND LAB          Sixpak
SPECTRA WILL BE VERY SIMILAR - AGAIN, GENERALLY WE CANNOT                 Sixpak
ASSUME THAT THIS IS TRUE FOR THE MF=6 SPECTRA.                            Sixpak
                                                                          Sixpak
THEREFORE WE CAN ALSO DEFINE THE LAB SCALAR SPECTRUM IN TERMS OF          Sixpak
THE CM SPECTRUM IN THE FORM,                                              Sixpak
                                                                          Sixpak
G0(E,EP) = INTEGRAL F(E,EP,COS(CM))*J*D(COS(LAB))                         Sixpak
                                                                          Sixpak
CONSISTENT WITH THE ABOVE ASSUMPTION THAT THE ANGULAR DEPENDENCE          Sixpak
OF EP(LAB) CAN BE IGNORED THE JACOBIAN WILL NOT BE USED IN                Sixpak
PERFORMING THESE INTEGRALS - IN WHICH CASE THE INTEGRAL REDUCES           Sixpak
TO EXACTLY THE SAME FORM AS IF THE DATA WERE IN THE LAB SYSTEM.           Sixpak
                                                                          Sixpak
IT SHOULD BE NOTED THAT SINCE IN THIS CASE THE MF=4 ANGULAR               Sixpak
DISTRIBUTIONS ARE GIVEN IN THE CM SYSTEM AND WHEN USED IN ANY             Sixpak
APPLICATION THEY WILL BE TRANSFORMED TO THE LAB SYSTEM - WHEN             Sixpak
THIS IS DONE THE JACOBIAN WILL BE APPLIED.                                Sixpak
                                                                          Sixpak
IN THIS CODE WHERE WE ARE MOSTLY CONCERNED WITH CONSERVING THE            Sixpak
NUMBER OF EMITTED PARTICLES AND AVERAGE ENERGIES THE NEUTRON              Sixpak
SPECTRA OUTPUT IN MF=5 WILL NOT BE COMPLETELY CONVERTED TO THE            Sixpak
LAB SYSTEM - ONLY FIRST ORDER CORRECTIONS WILL BE INCLUDED BY             Sixpak
INCREASING THE EMITTED PARTICLE ENERGY BY THE CENTER OF MASS              Sixpak
ENERGY, I.E., FOR A CENTER OF MASS SPECTRUM TABULATED AT CENTER           Sixpak
OF MASS ENERGIES EP(CM) THESE WILL ALL BE UNIFORMLY INCREASED             Sixpak
BY E(MM) TO ACCOUNT FOR THE CENTER OF MASS MOTION - THE SPECTRA           Sixpak
WILL NOT BE MODIFIED BY THE JACOBIAN FACTOR SQRT(EP(LAB)/EP(CM))          Sixpak
SINCE THIS WOULD REQUIRE A DETAILED TRANSFORMATION IN ENERGY AND          Sixpak
COS(THETA) SPACE - WHICH IS JUDGED NOT TO BE WORTH PERFORMING             Sixpak
WITHIN THE LIMITS OF WHERE THE OUTPUT FROM THIS CODE IS INTENDED          Sixpak
TO BE USED.                                                               Sixpak
                                                                          Sixpak
SINCE THE ANGULAR DISTRIBUTION IS ALWAYS OUTPUT IN THE SAME               Sixpak
SYSTEM AS WHICH IT IS GIVEN IN MF=6, NO TRANSFORMATION IS                 Sixpak
REQUIRED FOR THE MF=4 OUTPUT.                                             Sixpak
                                                                          Sixpak
WHEN USED IN LOW ENERGY APPLICATIONS (E.G., FISSION REACTORS) THE         Sixpak
HIGH ENERGY SPECTRA PRESENTED IN MF=6 WILL BE MOSTLY IMPORTANT            Sixpak
SIMPLY IN CONSERVING PARTICLES, (E.G., AS IN (N,2N)) AND ENERGY           Sixpak
AND THE DETAILS OF THE CORRELATION AND GROSS ENERGY SPECTRA WILL          Sixpak
NOTE PLAY THAT IMPORTANT A ROLE. IN THIS CASE THE SPECTRA OUTPUT          Sixpak
BY THIS PROGRAM IN MF=5 SHOULD BE ADEQUATE.                               Sixpak
                                                                          Sixpak
PLOTTAB FORMATTED OUTPUT                                                  Sixpak
================================================================          Sixpak
THIS PROGRAM CONTAINS ROUTINES TO PRODUCE OUTPUT THAT CAN BE USED         Sixpak
AS INPUT TO THE PLOTTAB CODE TO OBTAIN GRAPHIC RESULTS.                   Sixpak
```

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                                                                      Sixpak
THESE ROUTINES ARE DESIGNED ONLY FOR USE BY THE AUTHOR TO CHECK       Sixpak
THIS CODE. USERS ARE ASKED NOT TO ACTIVATE OR TRY TO USE THESE        Sixpak
ROUTINES. UNLESS YOU COMPLETELY UNDERSTAND THIS CODE THE RESULTS      Sixpak
CAN BE UNRELIABLE IF YOU ACTIVATE THESE ROUTINES.                     Sixpak
                                                                      Sixpak
INPUT FILES                                                           Sixpak
===================================================================== Sixpak
UNIT  DESCRIPTION                                                     Sixpak
----  -----------                                                     Sixpak
   2  INPUT LINES (BCD - 80 CHARACTERS/RECORD)                        Sixpak
  10  ORIGINAL ENDF/B DATA (BCD - 80 CHARACTERS/RECORD)               Sixpak
                                                                      Sixpak
OUTPUT FILES                                                          Sixpak
===================================================================== Sixpak
UNIT  DESCRIPTION                                                     Sixpak
----  -----------                                                     Sixpak
   3  OUTPUT REPORT (BCD - 120 CHARACTERS/RECORD)                     Sixpak
  11  ENDF/B DATA MF=4 (BCD - 80 CHARACTERS/RECORD)                   Sixpak
  12  ENDF/B DATA MF=5 (BCD - 80 CHARACTERS/RECORD)                   Sixpak
  14  ENDF/B DATA MF=15 (BCD - 80 CHARACTERS/RECORD)                  Sixpak
  17  ENDF/B DATA MF=12 (BCD - 80 CHARACTERS/RECORD)                  Sixpak
  18  ENDF/B DATA MF=14 (BCD - 80 CHARACTERS/RECORD)                  Sixpak
  15  PLOTTAB INPUT PARAMETERS (BCD - 80 CHARACTERS/RECORD)           Sixpak
  16  PLOTTAB FORMATTED OUTPUT (BCD - 80 CHARACTERS/RECORD)           Sixpak
                                                                      Sixpak
SCRATCH FILES                                                         Sixpak
===================================================================== Sixpak
NONE                                                                  Sixpak
                                                                      Sixpak
OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILIO1 AND FILIO2)       Sixpak
===================================================================== Sixpak
UNIT  FILE NAME                                                       Sixpak
----  ----------                                                      Sixpak
  2   SIXPAK.INP                                                      Sixpak
  3   SIXPAK.LST                                                      Sixpak
 10   ENDFB.IN                                                        Sixpak
 11   ENDFB.MF4                                                       Sixpak
 12   ENDFB.MF5                                                       Sixpak
 14   ENDFB.M15                                                       Sixpak
 17   ENDFB.M12                                                       Sixpak
 18   ENDFB.M14                                                       Sixpak
 15   PLOTTAB.INP                                                     Sixpak
 16   PLOTTAB.CUR                                                     Sixpak
                                                                      Sixpak
                                                                      Sixpak
INPUT PARAMETERS                                                      Sixpak
===================================================================== Sixpak
LINE  COLS.  DESCRIPTION                                              Sixpak
----  -----  -----------                                              Sixpak
   1   1-72  ENDF/B INPUT DATA FILENAME                               Sixpak
             (STANDARD OPTION = ENDFB.IN)                             Sixpak
 2-N   1-6   MINIMUM MAT FOR REQUESTED RANGE                          Sixpak
       9-11  MINIMUM MT FOR REQUESTED RANGE                           Sixpak
      12-17  MAXIMUM MAT FOR REQUESTED RANGE                          Sixpak
      20-22  MAXIMUM MT FOR REQUESTED RANGE                          Sixpak
                                                                      Sixpak
LEAVE THE DEFINITION OF THE FILENAME BLANK - THE PROGRAM WILL         Sixpak
THEN USE THE STANDARD FILENAME (ENDFB.IN).                            Sixpak
                                                                      Sixpak
UP TO 100 MAT/MT RANGES MAY BE SPECIFIED. THE LIST OF RANGES IS       Sixpak
TERMINATED BY A BLANK LINE. IF THE FIRST INPUT LINE IS COMPLETELY     Sixpak
BLANK ALL DATA WILL BE PROCESSED.                                     Sixpak
                                                                      Sixpak
EXAMPLE INPUT NO. 1                                                   Sixpak
-------------------                                                   Sixpak
PROCESS ALL MF=6 DATA ON AN ENDF/B TAPE. USE THE STANDARD INPUT       Sixpak
DATA FILENAME ENDFB.IN IN THIS CASE THE USER CAN EITHER EXPLICITLY    Sixpak
SPECIFY THE FILENAME AND MAT/MT RANGE BY THE FOLLOWING  2 INPUT       Sixpak
LINES,                                                                Sixpak
                                                                      Sixpak
```

```
     ENDFB.IN                                                                Sixpak
          1    1  9999  999                                                 Sixpak
                              (BLANK LINE, TERMINATES REQUEST LIST)          Sixpak
                                                                             Sixpak
     OR BY INPUTTING 2 BLANK LINE = PROCESS EVERYTHING.                      Sixpak
                                                                             Sixpak
     EXAMPLE INPUT NO. 2                                                     Sixpak
     -------------------                                                     Sixpak
     PROCESS BE-9, MAT=425, MT=16. READ THE DATA FROM ENDFB6\BE9.            Sixpak
     IN THIS CASE THE FOLLOWING 3 INPUT LINES ARE REQUIRED,                  Sixpak
                                                                             Sixpak
     ENDFBB6\BE9                                                             Sixpak
        425   16   425   16                                                 Sixpak
                              (BLANK LINE, TERMINATES REQUEST LIST)          Sixpak
                                                                             Sixpak
     EXAMPLE INPUT NO. 3                                                     Sixpak
     -------------------                                                     Sixpak
     PROCESS ALL MT=16 (N,2N) DATA. THIS CAN BE DONE BY SPECIFYING THE       Sixpak
     MAXIMUM MAT RANGE = 1 TO 9999, AND MT=16 FOR THE MINIMUM AND            Sixpak
     MAXIMUM MT RANGE. READ THE DATA FROM ENDFB6\K300. IN THIS CASE          Sixpak
     CASE THE FOLLOWING 3 INPUT LINES ARE REQUIRED,                          Sixpak
                                                                             Sixpak
     ENDFB6\K300                                                             Sixpak
          1   16  9999   16                                                 Sixpak
                              (BLANK LINE, TERMINATES REQUEST LIST)          Sixpak
                                                                             Sixpak
=====================================================================        Sixpak
```