ANEXO I

A continuación se adjunta la guía de usuario del programa **FASTRAN II**, en la que se revisan las principales variables utilizadas tanto en el archivo de entrada como durante la ejecución del programa.

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                    FASTRAN II User Guide -- Short Version

          (Refer to NASA TM-104159 for explanations of most parameters.
                   Additional parameters are described herein.
                      Free format unless otherwise noted.)

FASTRAN Input File:

    1. Problem Title

       READ  TITLE
       FORMAT (20A4)

    2. Spectrum Filename and Time Limit (seconds)

       READ  SPECTRA, TLIMIT
       FORMAT (A10,E10.3)

    3. Material Title

       READ  MAT
       FORMAT (20A4)

    4. Material Tensile Yielding Properties

       READ  SYIELD, SULT, E, ETA, ALP, NALP, NEP, BETA

    5. Fatigue-Crack Growth Rate Option

       READ  IRATE

       Repeat lines 6 to 7 IRATE times (J = 1 to IRATE).

    6. Fatigue-Crack Growth Rate Equation and Fracture Properties

       READ  C1(J), C2(J), C3(J), C4(J), C5(J), C6(J), KF, M

       (Note: C6 is power on the [1-(Kmax/C5)^C6] term in equation 15.)

    7. Fatigue-Crack Growth Rate Table (see ref. 5)

       (a) READ  NTAB, NDKTH

           (Set NDKTH = 0 for current code or see comments about NDKTH
            in comment section near the top of the fastran3x.f code or
            see the comment section repeated at the end of this file.)
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    If NTAB = 0, go to line 8, otherwise continue:

    (b) READ  DKETAB(I,J), CGRTAB(I,J)

    Repeat line 7(b) NTAB times.

 8. Crack Growth Rates at Transition (NALP = 1 option only)

    READ  RATE1, ALP1, BETA1, RATE2, ALP2, BETA2

 9. Date Output Options

    READ  NIPT, NPRT, LSTEP, NDKE, DCPR

10. Specimen Type and Loading

    READ  NTYP, LTYP, LFAST, NS, NFOPT, INVERT, KCONST

    (Note: NTYP = -13, -12, 7 and 8 are not described in NASA
           TM-104159, see comments at top of fastran3x.f code.
           NTYP = 99 and -99 are user input crack configurations.

11. Specimen and Crack Starter-Notch Dimensions

    READ  W, T, CI, AI, CN, AN, HN, RAD

12. Stress-Intensity Factor Table or Equation (NTYP = 99 & -99 only)

    (a) READ  KTAB

    If KTAB = 0, go to line 13, otherwise continue:

    (b) READ  CWTAB(I), FCTAB(I)

    Repeat line 12(b) KTAB times.

    (Note: KTAB = 0 is user input equation in Subroutine SIF99.
           KTAB > 0 is user input table in the form of c/w
                    against Fc (CWTAB(I) and FCTAB(I), respectively,
                    I = 1 to KTAB).  Maximum KTAB = 50.)

13. Final Crack Length Requested

    READ  CF

14. Special Input for Various Crack Configurations

    (a) If NTYP = 0 (with LTYP = 2) or NTYP = -10 then:

    READ  GAMMA

    (b) If NTYP = -7, -8 and -9 then:

    READ  XKT, NBCF

    (c) If NTYP = 5 then:
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       READ  RADIUS

       (Note: NTYP = -13, -12 and 7 require special input that is not
              described in current manual, see comments in fastran3x.f.)

   15. Input Constant-Amplitude Loading to Initiate Crack from Starter
Notch

       READ  SMAX, SMIN

   16. Special Input for Proof Test or Constant Crack-Opening Stress
Concept

       READ  NRC, DVALUE

   17. Input Primary Fatigue Loading

       (a) Constant- or Variable-Amplitude Loading (NFOPT = 0 or 1):

             Line 1: READ  MAXSEQ, MAXBLK, LPRINT, MAXLPR

                        LPRINT = MAXLPR = 0

             Line 2: READ  SCALE

             Line 3: READ  NBLK, NSL(I), NSQ(I)

             Line 4: READ  SMAXP(I,J), SMINP(I,J), NCYCP(I,J)

             Repeat lines 3 and 4, MAXBLK times.

       B. TWIST [14] or MINI-TWIST [15] Flight-Load Sequence
          (NFOPT = 2 or 3, respectively):

             Line 1: READ  MAXSEQ, MAXBLK, LPRINT, MAXLPR

                       MAXSEQ = 4000   MAXBLK = 10
                       LPRINT = 0, 1 or 2

             Line 2: READ  SMEAN

       C. FALSTAFF [16] Flight-Load Sequence (NFOPT = 4):

             Line 1: READ  MAXSEQ, MAXBLK, LPRINT, MAXLPR

                       MAXSEQ = MAXBLK = 200
                       LPRINT = 0, 1 or 2

             Line 2: READ  SPEAK

       D. Space Shuttle (STS/NLR) Load Sequence (NFOPT = 5):
          (SPECTRA = stsn)

             Line 1: READ  MAXSEQ, MAXBLK, LPRINT, MAXLPR

                       MAXSEQ = MAXBLK = MAXLPR = 2
                       LPRINT = 0 or 1
```

```
      Line 2: READ  SPEAK

   E. Gaussian Load Sequence [17] (NFOPT = 6):

      Line 1: READ  MAXSEQ, MAXBLK, LPRINT, MAXLPR

                MAXSEQ = MAXBLK = 839
                LPRINT = 0 or 1

      Line 2: READ  SPEAK, SMEAN

   F. Felix/28 [18] Helicopter Load Sequence (NFOPT = 7):

      Line 1: READ  MAXSEQ, MAXBLK, LPRINT, MAXLPR

                MAXSEQ = 140   MAXBLK = 12
                LPRINT = 0, 1 or 2

      Line 2: READ  SPEAK

   G. Spectrum Read from List of Stress Points (NFOPT = 8):

      Line 1: READ  MAXSEQ, MAXBLK, LPRINT, MAXLPR

                MAXSEQ = MAXBLK = NPOINTS/5000 + 1
                LPRINT = 0, 1 or 2

      Line 2: READ  SPEAK

   H. Spectrum Read from Flight-by-Flight Input (NFOPT = 9):

      Line 1: READ  MAXSEQ, MAXBLK, LPRINT, MAXLPR

                MAXSEQ = MAXBLK = NFLIGHTS
                LPRINT = 0, 1 or 2

      Line 2: READ  SPEAK

   I. Spectrum Read from Flight Schedule Input (NFOPT = 10):

      Line 1: READ  MAXSEQ, MAXBLK, LPRINT, MAXLPR

                MAXSEQ = Total number of flights in schedule
                MAXBLK = Number of different flights
                LPRINT = 0, 1 or 2
                MAXLPR = Number of flights to be printed out

      Line 2: READ  SPEAK

18. Input Variables for Load-Reduction Threshold Test

   READ  KTH, SMAXTH, RTH, CONST, PRT

   (New option added for KTH = 4 -- KMAX = constant
    and new parameter PRT added for KTH = 3 option,
    see comments about KMAX test in comment section
    near the top of the fastran3x.f code.)
```

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   19. Input HALT or next problem (lines 1 to 18).

-----------------------------------------------------------------------

Spectrum Input Files for NFOPT = 8, 9 and 10:

    1. List of Stress Points (NFOPT = 8)

          Line 1: READ  TITLE
                  FORMAT (20A4)

                    Any 80-character title describing the spectrum.

          Line 2: READ  NPOINTS, MAXST, MINST, INVERT, LFORMAT

                    NPOINTS = Number of stress points in total spectrum
                    MAXST = Highest stress point in total spectrum
                    MINST = Lowest stress point in total spectrum
                    INVERT = Value indicating order of stresses
                           = 0  Smax , Smin ,..., Smax , Smin
                           = 1  Smin , Smax ,..., Smin , Smax
                    LFORMAT = Specified format for stress values
                            = 1  FORMAT(20I4)
                            = 2  FORMAT(16I5)
                            = 3  FORMAT(10I8)

                      Note: Stress values must conform to the specified
                            format field.  Either 20, 16 or 10 stress
values
                            must be on all lines except the last line.
The
                            last line may have any number less than the
                            specified format field.

          Line 3: READ  (NSIG(I), I=1,NPOINTS)
                  FORMAT (20I4, 16I5 or 10I8)

                    NSIG(I) = stress expressed as an integer

          If INVERT = 1, the spectrum is read and the array NSIG is
          reordered to correspond to the INVERT = 0 option.  A new
spectrum
          file is generated named 'spectra8'.  FASTRAN must then be run
          using the new spectrum filename or a new filename given by the
          user with INVERT = 0.


    2. Flight-by-Flight Loading (NFOPT = 9)

          Line 1: READ  TITLE
                  FORMAT (20A4)

                    Any 80-character title describing the spectrum.

          Line 2: READ  NFLIGHT, MAXST, MINST, INVERT

                    NFLIGHT = Number of flights in total spectrum
                    MAXST = Highest stress point in total spectrum
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```
                    MINST = Lowest stress point in total spectrum
                    INVERT = Value indicating order of stresses in
flights
                           = 0  Smax , Smin ,..., Smax , Smin
                           = 1  Smin , Smax ,..., Smin , Smax

          Line 3: READ  JFLT(M), NUM, (NSIG(I), I=1,NUM)

                    JFLT(M) = Flight number for flight m
                    NUM = Number of stress points in flight m
                    NSIG(I) = stress expressed as an integer

          Repeat Line 3, NFLIGHT times.

          If INVERT = 1, the spectrum is read and the array NSIG is
          reordered to correspond to the INVERT = 0 option.  A new
spectrum
          file is generated named 'spectra9'.  FASTRAN must then be run
          using the new spectrum filename or a new filename given by the
          user with INVERT = 0.


    3. Flight Schedule Loading (NFOPT = 10)

          Line 1: READ  TITLE
                  FORMAT (20A4)

                    Any 80-character title describing the spectrum.

          Line 2: READ  MAXSEQ, MAXBLK, SPMAX

                    MAXSEQ = Total number of flights in spectrum schedule
                    MAXBLK = Number of different flights in spectrum
                    SPMAX = Highest stress value total spectrum

          Line 3: READ  NBLK, NSL(I)

                    NBLK = Flight number
                    NSL(I) = Number of maximum/minimum stress values

          Line 4: READ  SMAXP(I,J), SMINP(I,J)  (J = 1, NSL(I))

                    SMAXP(I,J) = Jth maximum stress for flight I
                    SMINP(I,J) = Jth minimum stress for flight I

          Repeat Line 3 and 4, MAXBLK times.
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------------------------------------------------------------------------
C  FASTRAN - II - CLOSURE MODEL LIFE PREDICTION CODE
************************************************************************
*  NASA FATIGUE CRACK GROWTH STRUCTURAL ANALYSIS - CLOSURE MODEL       *
************************************************************************
*   ********   ***       ****  ********   ***       ***     *     **   *
*   *******   *****     ***    ********   *****     *****    **    **   *
*   **        **   **  **         **     **   **   **   **   ***   **   *
*   **        **   **  **         **     **   **   **   **   ****  **   *
*   *****     *******   ***       **     ******    *******   ***** **   *
*   ****      *******     ***     **     *****     *******   ** *****   *
*   **        **   **       **    **     ** **     **   **   **  ****   *
*   **        **   **       **    **     **  **    **   **   **   ***   *
*   **        **   **     ***     **     **   **   **   **   **    **   *
*   **        **   **  ****       **     **    **  **   **   **     *   *
************************************************************************
C
C VERSION CREATED:  October 22, 1998
C
C NTYP = SPECIMEN TYPE ANALYZED
C    =-99 CRACK AT HOLE (OR NOTCH) CONFIGURATION INPUT BY USER, S
C
C    =-13 LAP-SPLICE JOINT WITH CORNER CRACKS AT OUTER HOLES UNDER RIVET
C           LOADING (RF1), BY-PASS LOADING (RF2), AND BENDING (GAMMA*S)
C    =-12 LAP-SPLICE JOINT WITH THROUGH CRACKS AT OUTER HOLES UNDER RIVET
C           LOADING (RF1), BY-PASS LOADING (RF2), AND BENDING (GAMMA*S)
C    =-11 PERIODIC ARRAY OF SYMMETRIC THROUGH CRACKS AT HOLES, S
C    =-10 PERIODIC ARRAY OF SYMMETRIC THROUGH CRACKS AT HOLES UNDER PIN
C           LOADING (P), REMOTE STRESS (S=P/(2wt)), AND MOMENT (GAMMA*S)
C    =-9 CORNER CRACK AT SEMI-CIRCULAR EDGE NOTCH, S
C    =-8 THROUGH CRACK AT SEMI-CIRCULAR EDGE NOTCH, S
C    =-7 SURFACE CRACK CENTER SEMI-CIRCULAR EDGE NOTCH, S         S
C    =-6 TWO SYMMETRIC SURFACE CRACKS (CENTER OF HOLE), S   |//////////|
C    =-5 ONE SURFACE CRACK AT CENTER OF HOLE, S             |          |
C    =-4 TWO SYMMETRIC THROUGH CRACKS AT A HOLE, S          |          |
C    =-3 ONE THROUGH CRACK AT A HOLE, S                     |          |
C    =-2 TWO CORNER CRACKS AT A HOLE UNDER TENSION (S)      |          |
C           OR BENDING (Sb)                                 |   ----   |
C    =-1 ONE CORNER CRACK AT A HOLE UNDER TENSION (S)       |    2c    |
C           OR BENDING (Sb)                                 |          |
C    = 0 SURFACE CRACK UNDER TENSION (S) AND BENDING (Sb)   |<-- 2w -->|
C    = 1 CENTER CRACK TENSION (CCT), S                      |          |
C    = 2 COMPACT OR EXTENDED COMPACT SPECIMEN               |//////////|
C          LTYP=0  COMPACT (INPUT: S=P/(wt))                      S
C          LTYP=1  EXTENDED COMPACT (INPUT: S=P/(wt))
C    = 3 SINGLE-EDGE CRACK TENSION, S
C    = 4 SINGLE-EDGE CRACK BEND, Sb
C          (Sb = 6M/(tw^2))
C    = 5 THROUGH CRACK IN PRESSURIZED CYLINDER
C          (S = PRESSURE*RADIUS/THICKNESS)
C    = 6 CORNER CRACK (a = c) IN SQUARE BAR (w = t) SPECIMEN, S
C          (ONE-DIMENSIONAL CRACK GROWTH; AGARD SPECIMEN)
C    = 7 CORNER CRACK IN PLATE UNDER TENSION (S) AND BENDING (Sb)
C          (LTYP=0 INPUT S; LTYP=1 INPUT Sb; LTYP=2 INPUT S AND GAMMA)
C    = 8 DOUBLE-EDGE CRACK TENSION, S
C
C    = 99 CRACK CONFIGURATION INPUT BY USER, S
C
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C !! NEGATIVE NTYP MUST BE USED FOR CRACKS FROM HOLE OR NOTCH !!
C     NTYP = 99 or -99 ARE USER INPUT CRACK CONFIGURATIONS
C          INPUT IN THE FORM OF c/w AGAINST FC (w IS INPUT WIDTH)
C          FOR EQUATION (KTAB = 0) OR TABLE (KTAB > 0).
C          FOR EQUATION, PUT USER DEVELOPED EQUATION FC=f(c/w) IN
C          SUBROUTINE SIF99 AND RE-COMPILE CODE.  FOR TABLE, PUT
C          TABLE-LOOKUP c/w AGAINST FC IN FASTRAN INPUT FILE AS
C          CWTAB(I),FCTAB(I),I=1 TO KTAB (MAXIMUM KTAB IS 50)
C          CURRENT VERSION IS FOR THROUGH CRACKS BUT VERSION CAN BE
C          USED FOR 3D CRACKS WITH a/c EQUAL CONSTANT WITH CRACK
C          GROWTH 'ONLY' IN THE c-DIRECTION
C     NTYP = 0  WITH  LTYP = 2  REQUIRES INPUT OF MOMENT (GAMMA)
C     NTYP = 7  WITH  LTYP = 2  REQUIRES INPUT OF MOMENT (GAMMA)
C     NTYP = -10 REQUIRES INPUT OF MOMENT (GAMMA)
C          GAMMA=RATIO OF OUTER FIBER BENDING TO REMOTE STRESS (Sb/S)
C     NTYP = -7, -8, AND -9 REQUIRES INPUT OF STRESS CONCENTRATION KT
C          AND SELECTION OF FINITE-WIDTH CORRECTION NBCF (SEE SUB BCF)
C          NBCF = 0  UNIFORM STRESS BCF (H/W=2, RAD/W=1/16)
C                 1  UNIFORM DISPLACEMENT BCF (H/W=1.5, RAD/W=1/16)
C                 2  UNIFORM DISPLACEMENT BCF (H/W=2, RAD/W=1/16)
C                 3  UNIFORM DISPLACEMENT BCF (H/W=3, RAD/W=1/8)
C     NTYP = 5  REQUIRES INPUT OF PRESSURE VESSEL RADIUS
C     NTYP = -12 & -13  REQUIRES INPUT OF RIVET PITCH OR SPACING
(RIVETS),
C          RIVET LOAD RATIOS (RLF1 & RLF2) IN A TWO-ROW LAP-SPLICE JOINT,
C          BENDING MOMENT AT RIVET LOCATION (GAMMA), AND INTERFERENCE
C          (DELTA).  RIVET SPACING USED TO CALCULATE WR (HALF-WIDTH OF
C          RIVET STRIP).  RLF1 IS PRIMARY RIVET LOAD (HOLE WITH CRACK)
C          AND RLF2 IS THE BY-PASS LOAD RATIO (MAY BE USED FOR MULTI-ROW
C          BY-PASS).  GAMMA = RATIO OF LOCAL BENDING STRESS TO REMOTE
C          APPLIED STRESS (Sigma_b/S).  DELTA = CHANGE IN RIVET RADIUS
C          (RIVET IS SAME MATERIAL AS SHEETS.)  w = ONE-HALF JOINT WIDTH.
C          INPUT TOTAL APPLIED REMOTE STRESS, S (MAX AND MIN VALUES).
C          LAP-SPLICE JOINT HAS TWO SYMMETRIC CORNER OR THROUGH CRACKS
C          LOCATED AT OUTER RIVET HOLES ON ROW 1.  LOADING ON RIVET HOLES
C          IS ASSUMED TO BE [SIN(THETA)]^0.6.  CORNER CRACKS (NTYP = -13)
C          GROW WITH "CONSTANT" a/c RATIO, AS INPUT, AND BECOME THROUGH
C          CRACKS (NTYP = -12) WHEN a/t = 1. NTYP = -12 CHANGES TO
DOUBLE-
C          EDGE CRACK WHEN SIF'S MATCH FOR CRACK LENGTH GREATER THAN
C          HOLE RADIUS.  FIRST ROW LOADS ARE P1 AND SECOND ROW LOADS
C          ARE P2. OUTER RIVET LOADS (P1* & P2*) ARE HIGHER THAN OTHER
C          LOADS AND DECAY AS THE CRACK GROWS (SEE SUBROUTINE BCF).
C          (Note: Set NODKL = 0 to turnoff current load-decay equation in
C          Subroutine BCF or NODKL = 1 to use current equations.)
C          (FOR 50% BY-PASS, RLF1=RLF2=0.5. RLF1+RLF2 MUST EQUAL UNITY.)
C     CN=STARTER NOTCH LENGTH (FROM LOAD CENTERLINE OR SPECIMEN EDGE)
C     AN=STARTER NOTCH DEPTH
C     HN=ONE-HALF HEIGHT OF STARTER NOTCH
C     CI=INITIAL CRACK LENGTH (FROM LOAD CENTERLINE OR SPECIMEN EDGE)
C     AI=INITIAL CRACK DEPTH
C     W=ONE-HALF WIDTH (WIDTH FOR NTYP= -9, -8, -7, 2, 3, 6 AND 7)
C     T=SPECIMEN THICKNESS (ONE-HALF THICKNESS FOR NTYP=-5, -6 AND -7)
C     CF=FINAL CRACK LENGTH DESIRED (OR MAY BE SET EQUAL TO WIDTH)
C       NOTE: CI AND CF MEASURED FROM LOAD CENTERLINE OR SPECIMEN EDGE
C             CRACK LENGTH, C, IN THE PROGRAM IS UNDERSTOOD TO BE C*
C     C*=CURRENT CRACK LENGTH (FROM LOAD CENTERLINE OR SPECIMEN EDGE)
C     D=CURRENT CRACK LENGTH (C*) PLUS PLASTIC ZONE (FROM CENTERLINE)
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C     A=CURRENT CRACK DEPTH
C     RAD=RADIUS OF HOLE (AT CENTERLINE) OR SEMI-CIRCULAR EDGE NOTCH
C     C*-RAD=CRACK LENGTH MEASURED FROM EDGE OF HOLE OR NOTCH
C     MAT=MATERIAL DESIGNATION
C     SYIELD=YIELD STRESS (0.2 PERCENT OFFSET)
C     SULT=ULTIMATE TENSILE STRENGTH
C     SFLOW=FLOW STRESS (AVERAGE BETWEEN SYIELD AND SULT)
C     CRACK-GROWTH PROPERTIES OPTION:
C     IRATE = 1  da/dN IS EQUAL TO dc/dN AS FUNCTION OF DKEFF
C           = 2  da/dN AND dc/dN HAVE DIFFERENT DKEFF RELATIONS
C                (MUST USE EITHER EQUATIONS OR TABLES FOR BOTH)
C     CRACK-GROWTH PROPERTIES: C1(I,J),C2(I,J),C3(J),C4(J),C5(J),C6(J)
C         J = 1  PROPERTIES IN c-DIRECTION (PRIMARY DIRECTION)
C           = 2  PROPERTIES IN a-DIRECTION (THRU-THE-THICKNESS)
C     C1(I,J)=CRACK GROWTH COEFFICIENT FOR SEGMENT I AND PROPERTY J
C     C2(I,J)=CRACK GROWTH POWER FOR SEGMENT I AND PROPERTY J
C        I = 1 FOR CGR EQUATION AND I = 1 TO (NTAB-1) FOR CGR TABLE
C     C3(J) AND C4(J)=CRACK GROWTH THRESHOLD CONSTANTS
C     C5(J)=LIMITING VALUE OF MAXIMUM STRESS INTENSITY FACTOR
C           (CYCLIC FRACTURE TOUGHNESS)
C     C6(J)=POWER ON KMAX/KC TERM
C     NTAB(J) = 0  PROGRAM USES CRACK-GROWTH RATE EQUATION
C                  dc/dN = C1*DKEFF^C2 f(DKO)/g(Kmax)
C                  WHERE  DKO = C3*(1.-C4*R)
C                  (SEE SUBROUTINE RATE)
C     NTAB(J) =  VALUE GREATER THAN ONE INDICATES NUMBER OF DATA POINTS
C                USED TO DESCRIBE CRACK-GROWTH RATE DATA FOR TABLE LOOKUP
C                (SIF AND RATES MUST BE IN ASCENDING ORDER)
C                SEE SUBROUTINE RATE (MAXIMUM POINTS ALLOWED = 35)
C     NTAB(J) > 0 OPTIONS:
C     NDKTH = 0  dc/dN = f(DKEFF)  WITH DKO THRESHOLD
C           = 1  dc/dN = (dc/dN) FROM TABLE * 1/[1-(KMAX/KC)^C6]
C                   (C6 = 2.0 for aluminum alloys)
C                (A) KC = C5  INPUT CYCLIC FRACTURE TOUGHNESS
C                (B) KC = KIE (TPFC) IF C5 SET TO 9999 OR HIGHER
C           = 2  dc/dN = f(DKEFF-DKO)
C                WHERE  DKO = C3*(1.-C4*R)
C     RATE1=CRACK-GROWTH RATE NEAR START OF TRANSITION FROM FLAT-TO-
C      SLANT GROWTH (ALP=ALP1 AND BETA=BETA1 FOR RATES LESS THAN RATE1)
C     RATE2=CRACK-GROWTH RATE NEAR END OF TRANSITION FROM FLAT-TO-
C      SLANT GROWTH (ALP=ALP2 AND BETA=BETA2 FOR RATES > RATE2)
C          (RATE1 AND RATE2 ARE USED ONLY WITH NALP=1 OPTION)
C     KF=ELASTIC-PLASTIC FRACTURE TOUGHNESS
C     M=FRACTURE TOUGHNESS PARAMETER (RANGE 0 TO 1)
C     (SPECIMEN TYPE: NTYP = 99 or -99 USES LEFM: KF=KC AND M=0)
C     KIE=ELASTIC STRESS-INTENSITY FACTOR AT FAILURE (FROM KF AND M)
C     NFCODE = OUTPUT VALUE INDICATING CAUSE OF PROGRAM TERMINATION
C            = 0  KMAX > C5  (IERR=1; SEE NFCODE = 0 STATEMENT)
C            = 1  CRACK DRIVE > MATERIAL RESISTANCE (DKEFF-RATE CURVE)
C            = 2  KMAX > C5  (IERR=1; SEE NFCODE = 2 STATEMENT)
C            = 3  MAXIMUM APPLIED STRESS GREATER THAN 0.99*SFLOW
C            = 4  KMAX > KIE (ELASTIC SIF AT FAILURE)
C            = 5  CRACK LENGTH EXCEEDS WIDTH
C            = 6  CRACK LENGTH PLUS PLASTIC ZONE EXCEEDS WIDTH
C     LTYP=TYPE OF LOADING OR MODIFIED SPECIMEN
C         = 0  REMOTE TENSION
C              (INPUT TENSION STRESS, S)
C         = 1  REMOTE BENDING (NTYP = -2, -1, 0 AND 7 ONLY)
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C               (INPUT OUTER FIBER BENDING STRESS, Sb)
C         = 2  COMBINED TENSION AND BENDING (NTYP = 0 AND 7 ONLY)
C               (INPUT TENSION STRESS, S, AND RATIO OF OUTER FIBER
C                BENDING STRESS TO TENSION STRESS, Sb/S)
C         NOTE: COMPACT SPECIMEN LTYP = 0
C               EXTENDED COMPACT SPECIMEN LTYP = 1
C     SMAX=MAXIMUM APPLIED STRESS
C     SMIN=MINIMUM APPLIED STRESS
C     SIG=CURRENT APPLIED STRESS
C     SO=CRACK-OPENING STRESS (COMPUTED ONLY FOR NTYP= 1 AND -4)
C        (SO/SMAX RATIO ASSUMED TO APPLY FOR ALL OTHER SPECIMENS)
C        KO/KMAX IS EQUAL TO SO/SMAX (FOR ALL NFOPT OPTIONS KMAX IS
C        BASED ON HIGHEST STRESS IN BLOCK OR SPECTRUM, SMAXSP)
C     KOPEN = 0  SO COMPUTED FROM CRACK-SURFACE DISPLACEMENTS
C     KOPEN = 1  SO COMPUTED FROM CONTACT STRESS-INTENSITY FACTOR (SIF)
C      (KOPEN = 0 OR 1 GIVES NEARLY SAME  SO  UNDER CONSTANT-AMPLITUDE)
C     NEP = 0 DKEFF IS ELASTIC
C         = 1 DKEFF IS ELASTIC-PLASTIC (0.25*CYCLIC PLASTIC-ZONE
CORRECTED)
C         = 2 DKEFF IS ELASTIC-PLASTIC (0.25*PLASTIC-ZONE CORRECTED)
C     SOBAR=EQUIVALENT SO/SMAX VALUE (DAMAGE WEIGHTED AVERAGE)
C     LFAST = 0  NORMAL CRACK-CLOSURE MODEL
C           = 1  USES AN EQUIVALENT CRACK-OPENING STRESS (SOBAR) IF
C                C > CMAX AND NFLT > 2*MAXSEQ (FASTER THAN LFAST=0
OPTION)
C           = 2  LINEAR CUMULATIVE DAMAGE CALCULATIONS USING SO
C                EQUATION FOR CONSTANT-AMPLITUDE LOADING (SUB: SOEQN)
C           = 3  USES CONSTANT SO CONCEPT FOR PRECRACKING (SUB: SOEQN)
C                AND FOR BLOCK (OR FLIGHT) LOADING (SUB: SOFLY)
C           = 4  USES CONSTANT SO CONCEPT FOR PRECRACKING (SUB: SOEQN)
C                AND FOR BLOCK (OR FLIGHT) LOADING (MANUAL INPUT SO/SMAX
C                VALUE AND SET NRC TO -1)
C     NRC = 0  INPUT 'DVALUE' NOT USED
C         = 1  INPUT CRACK EXTENSION VALUE DURING PROOF TEST OR OVERLOAD
C              AT FIRST LOAD APPLICATION DURING PRIMARY LOADING INPUT
C         =-1  DVALUE IS SO/SMAX VALUE USED FOR LFAST=4 OPTION
C     CMAX = CI + 10 * MAXIMUM CYCLIC PLASTIC ZONE SIZE
C     PLANE STRESS SET ETA = 0.0 OR PLANE STRAIN SET ETA=POISSON'S RATIO
C     ALP=CONSTRAINT FACTOR = 1    PLANE STRESS
C                           = 1.73 IRWIN'S PLANE STRAIN
C                           = 3    PLANE STRAIN
C     NALP = 0  CONSTRAINT FACTORS (ALP AND BETA) ARE CONSTANT AS INPUT
C          = 1  CONSTRAINT FACTORS ARE VARIABLE (ALP VARIES FROM ALP1 TO
C               ALP2 AND BETA VARIES FROM BETA1 TO BETA2)
C     BETA=CONSTRAINT FACTOR ON COMPRESSIVE YIELDING (USUALLY SET TO 1)
C           BETA = 1    PLANE STRESS
C                = 1.4  PLANE STRAIN (CAUTION: HAS NOT BEEN VERIFIED)
C     KCONST = 0  APPLY STRESS OR LOAD FOR EXTERNAL LOADING
C            = 1  APPLY K (STRESS-INTENSITY FACTOR) FOR LOADING
C                 INPUT KMAX AND KMIN, USED ONLY FOR NTYP=1 OR 2,
C                 NFOPT<=1 AND LFAST=0)
C     NS=NUMBER OF ELEMENTS ON STARTER NOTCH LENGTH
C     NRHO=NUMBER OF ELEMENTS IN PLASTIC ZONE  (SET TO 10)
C     MELE=TOTAL NUMBER OF ELEMENTS (MAXIMUM ALLOWED= 50)
C     ERR=ERROR CHECK ON ELEMENT STRESSES
C     NMAX=MAXIMUM NUMBER OF CYCLES ALLOWED FOR PDX
C     USRMAX=MAX UNDERLOAD STRESS RANGE ALLOWED BEFORE MODEL EXERCISED
C     OSRMAX=MAX OVERLOAD STRESS RANGE ALLOWED BEFORE MODEL EXERCISED
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C     PDX=MINIMUM CRACK GROWTH INCREMENT (PDC*CYCLIC PLASTIC ZONE)
C     PDC=0.2  (SET IN PROGRAM)
C     NTC=TOTAL NUMBER OF CYCLES
C     NPRT = ZERO OR ANY NEGATIVE NUMBER INDICATES LIMITED CRACK-LENGTH-
C               CYCLES OUTPUT AT SPECIFIED CRACK-GROWTH INCREMENT (DCPR)
C          = ONE OR GREATER INDICATES LIMITED CRACK-LENGTH-CYCLES OUTPUT
C               AT NPRT CRACK-GROWTH INCREMENTS IN THE CLOSURE MODEL
C     (FOR LFAST=1  NPRT IS FOUR TIMES AS LARGE AS INPUT FOR C > CMAX)
C     NIPT = 0  INTERNAL PRINT OFF
C          = VALUE GREATER THAN ZERO INDICATES INTERNAL PRINT OUT
C               FOR ONE CYCLE AT NIPT CRACK-GROWTH INCREMENTS
C     NDKE = 0  PRINT OUT ELASTIC DELTA-K AND RATES
C          = 1  PRINT OUT DELTA-K EFFECTIVE AND RATES
C     NOTE: FOR NDKE = 0 AND KCONST = 0, ELASTIC DELTA-K's PRINTED OUT
C           USE HIGHEST AND LOWEST APPLIED STRESSES IN PRIMARY FATIGUE
C           LOADING.  DELTA-K EFFECTIVE ARE ACTUAL VALUES FOR NDKE = 1.
C     LSTEP=NUMBER OF LOAD STEPS FROM MIN TO MAX LOAD DURING PRINTOUT
C     S=ELEMENT STRESSES
C     Y=LENGTH OF ELEMENTS IN WAKE OF CRACK(RESIDUAL DEFORMATION)
C     V-Y=CRACK OPENING DISPLACEMENTS
C     FC=BOUNDARY CORRECTION FACTOR AT LENGTH C FOR REMOTE LOADING
C     FD=BOUNDARY CORRECTION FACTOR AT LENGTH D FOR REMOTE LOADING
C     FS(M)=BOUNDARY CORRECTION FACTOR FOR LOADING ON CRACK SURFACE
C     FA=BOUNDARY CORRECTION FACTOR AT DEPTH A FOR REMOTE LOADING
C  BLOCK (OR FLIGHT) LOADING VARIABLES:
C     SMAXP(I,J)=MAXIMUM STRESS OF LEVEL J IN BLOCK (OR FLIGHT) I
C       (FIRST MAXIMUM STRESS MUST BE POSITIVE AND GREATER THAN MINIMUM
C        PRECRACKING STRESS)
C     SMINP(I,J)=MINIMUM STRESS OF LEVEL J IN BLOCK (OR FLIGHT) I
C     SCALE=SCALES MAX. AND MIN. STRESS TO DESIRED LEVEL IN ALL BLOCKS
C           (OR FLIGHTS) FOR NFOPT = 0 OR 1 (SEE SUBROUTINE FLIGHT)
C     SPEAK=HIGHEST STRESS FOR NFOPT > 1 (OR LOWEST, NFOPT=4, INVERT=1)
C     SMEAN=MEAN STRESS FOR NFOPT = 2, 3 AND 6
C     NCYCP(I,J)=NUMBER OF CYCLES OF LEVEL J IN BLOCK (OR FLIGHT) I
C     MAXSEQ=TOTAL NUMBER OF BLOCKS (FLIGHTS) IN SEQUENCE TO BE REPEATED
C     MAXBLK=NUMBER OF DIFFERENT BLOCKS OR FLIGHTS (MAX. ALLOWED = 15)
C     NBLK=BLOCK (OR FLIGHT) NUMBER (MUST BE NUMBERED CONSECUTIVELY)
C     NSL(I)=NUMBER OF STRESS LEVELS FOR BLOCK I (MAXIMUM ALLOWED= 2500)
C     FOR CONSTANT-AMPLITUDE LOADING: MAXSEQ=MAXBLK=NBLK=NSL(1)=1
C     NFLT=BLOCK (OR FLIGHT) COUNTER
C     NFOPT=BLOCK (OR FLIGHT) SEQUENCE OPTION
C          = 0  CONSTANT-AMPLITUDE LOADING
C          = 1  BLOCKS (OR FLIGHTS) ARE APPLIED BY USER SPECIFIED
C                  PERIODIC SEQUENCE (INPUT:  NSQ(I))
C          = 2  TWIST FLIGHT-LOAD SEQUENCE (SMEAN=MEAN STRESS)
C                 (SEE INVERT OPTIONS UNDER MINI-TWIST)
C          = 3  MINI-TWIST FLIGHT-LOAD SEQUENCE (SMEAN=MEAN STRESS)
C                INVERT OPTIONS APPLY FOR TWIST OR MINI-TWIST
C                  INVERT = 0 OR 1 NORMAL SPECTRUM LEVEL I
C                  INVERT = 2 CLIP AT LEVEL II
C                  INVERT = 3 CLIP AT LEVEL III
C                  INVERT = 4 CLIP AT LEVEL IV
C                  INVERT = 5 CLIP AT LEVEL V
C          = 4  FALSTAFF FLIGHT-LOAD SEQUENCE
C                 INVERT = 0 NORMAL SPECTRUM (SPEAK=HIGHEST STRESS)
C                 INVERT = 1 INVERTED FALSTAFF (SPEAK=LOWEST STRESS)
C          = 5  SPACE SHUTTLE SPECTRUM (SPEAK=HIGHEST STRESS)
C                 SPECTRA = 'stsn'
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C                  INVERT = 0  FULL SHUTTLE SPECTRUM
C                  INVERT = 1  SHORT SHUTTLE SPECTRUM
C          = 6  GAUSSIAN (I=0.99) LOAD SEQUENCE
C                 (SPEAK=HIGHEST STRESS; SMEAN=MEAN STRESS)
C          = 7  HELICOPTER SPECTRUM (SPEAK = HIGHEST STRESS)
C                  INVERT = 1 FELIX/28 (Short version)
C                  INVERT = 2 HELIX/32 (Short version)
C          = 8  SPECTRUM READ FROM FILE7 (LIST OF MAX AND MIN VALUES)
C                 INPUT: TOTAL NUMBER OF STRESS POINTS (SMAX AND SMIN)
C                   IN SPECTRA; HIGHEST AND LOWEST STRESS VALUE;
C                   INVERT=0  STRESSES ARE: MAX, MIN, ..., MAX, MIN
C                         =1  STRESSES ARE: MIN, MAX, ..., MIN, MAX
C                   SPECTRUM IS REORDERED FOR INVERT=1 AND WRITTEN
C                   TO FILE8 = spectra8 WITH INVERT=0 INPUT.
C          = 9  SPECTRUM READ FROM FILE7 (FLIGHT-BY-FLIGHT)
C                 INPUT: TOTAL NUMBER OF FLIGHTS IN SPECTRA; HIGHEST
C                   AND LOWEST STRESS VALUE IN TOTAL SPECTRA;
C                   INVERT=0  STRESSES ARE: MAX, MIN, ..., MAX, MIN
C                         =1  STRESSES ARE: MIN, MAX, ..., MIN, MAX
C                   FOR EACH FLIGHT, INPUT FLIGHT NUMBER, NUMBER
C                   OF STRESS POINTS IN FLIGHT, AND STRESS VALUES.
C                   NUMBER OF STRESS POINTS IN A FLIGHT IS LIMITED TO
C                   5000.  (FLIGHTS WITH MORE STRESS POINTS CAN BE
C                   BROKEN DOWN INTO SEVERAL FLIGHTS.)
C                   SPECTRUM IS REORDERED FOR INVERT=1 AND WRITTEN
C                   TO FILE9 = spectra9 WITH INVERT=0 INPUT.
C          = 10 SPECTRUM READ FROM FILE7 (FLIGHT AND SCHEDULE INPUT)
C                 INPUT: NFLIGHT, MAXBLK, AND SPMAX (in spectrum file)
C                   NFLIGHT = NUMBER OF FLIGHTS IN TOTAL SPECTRUM
C                             (MAX VALUE IS 5000)
C                   MAXBLK = NUMBER OF DIFFERENT FLIGHTS IN SPECTRUM
C                             (MAX VALUE IS 15)
C                   SPMAX = MAXIMUM STRESS IN SPECTRUM
C                     NUMBER OF STRESS LEVELS IN ANY FLIGHT IS LIMITED
C                     TO 2500 AND INPUT STRESS VALUES ARE FREE FORMAT
C
C     LPRINT=VALUE USED TO PRINT OUT INTERNAL INFORMATION ON SPECTRA
C           = 0  NO INTERNAL PRINT OUT ON BLOCK OR FLIGHT INFORMATION
C           = 1  LIMITED OUTPUT ON BLOCK OR FLIGHT NUMBERS
C           = 2  OUTPUT ON BLOCK OR FLIGHT NUMBERS, STRESS LEVELS
C                AND CYCLES (MAY RESULT IN LARGE OUTPUT FILES)
C     MAXLPR = NUMBER OF BLOCKS OR FLIGHTS PRINTED OUT IN LPRINT OPTION
C              (ACTUAL NUMBERS PRINTED OUT MAY SLIGHTLY EXCEED MAXLPR)
C     NSQ(I)=PERIODIC SEQUENCE OF BLOCK I (USED ONLY WITH NFOPT = 1)
C            NSQ(I) MUST BE IN ASCENDING ORDER WITH NSQ(1) = 1
C  LOAD REDUCTION/INCREASING METHODS FOR THRESHOLD TESTING (NTYP=1 ONLY):
C     KTH = 0  NO LOAD REDUCTION (NORMAL PROGRAM)
C         = 1  ASTM RECOMMENDED PRACTICE (CONST = DK/DC/K)
C              Note: CONST = -2 (1/in.) or -80 (1/meter)
C         = 2  STRESS-INTENSITY GRADIENT PROCEDURE (CONST = DK/DC)
C         = 3  +/- PRT PERCENT REDUCTION PROCEDURE (CONST = DC)
C              Input PRT, like -5.0% every CONST crack increment.
C              (Note: PRT is used only for KTH = 3)
C         = 4  KMAX TEST PROCEDURE (CONST = DK/DC/K)
C              (SET KCONST = 1 for KTH = 4, K-CONTROLLED CRACK GROWTH)
C        CAUTION: USE ONLY LFAST=NFOPT=0 OPTION IN THRESHOLD TEST
C
C   UNITS:  SI - STRESS IN MPa AND LENGTHS IN meters
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C           ENGLISH - STRESS IN ksi AND LENGTHS IN inches
C*****************************************************************
C
End of File
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