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A USER'S MANUAL FOR THE SEQUENCE ACCOUNTABLE FATIGUE ANALYSIS COMPUTER PROGRAM

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NOTICE

This Technical Report has been reviewed and is approved.

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This report presents a detailed description of a computer program to calculate cumulative damage of notched structural members subjected to arbitrary spectra. The Sequence Accountable Fatigue Analysis computer program develops its sequence sensitivity by tracking residual stresses local to a notch throughout the spectrum of loads. Residual stress relaxation analysis is included to increase the generality of the results. An example spectrum and resulting cumulative damage analysis are illustrated.

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FOREWORD

This program was prepared by J. M. Potter of the Solid Mechanics Branch and R. A. Noble of the Experimental Branch, Structures Division, Air Force Flight Dynamics Laboratory. The work was conducted in-house under Project 1347 "Structural Testing of Flight Vehicles", Task 134704 "Structural Testing Criteria". This report covers work accomplished over a time period of 1 October 1972 to 1 May 1973. The essence of the analysis was presented in AFFDL-TM-73-131-FBR in October 1973.

This manuscript was released by the authors in January 1974.

ABSTRACT

This report presents a detailed description of a computer program to calculate cumulative damage of notched structural members subjected to arbitrary spectra. The Sequence Accountable Fatigue Analysis computer program develops its sequence sensitivity by tracking residual stresses local to a notch throughout the spectrum of loads. Residual stress relaxation analysis is included to increase the generality of the results. An example spectrum and resulting cumulative damage analysis are illustrated.

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SYMBOLS

σ_{res}	Residual stress
σ_{max}	Maximum local stress level
σ_{min}	Minimum local stress level
σ_{ys}	Yield stress
$\sigma_{res_{EQ}}$	Equilibrium component of the residual stress
ε_t	Local strain, total
ε_e	Elastic component of total strain
ε_p	Plastic component of total strain
$\varepsilon_{f'}$	Strain intercept at one reversal on a log ε_p-log life curve
c	Slope of the log ε_p-log life curve
S_{max}	Maximum applied stress level
S_{min}	Minimum applied stress level
S_{mean}	Mean applied stress level, $(S_{max}+S_{min})/2$
K_t	Elastic stress concentration Factor
D	Damage
I	Integer describing the level number
N_{EP}	Equilibrium period, number of cycles for the local stresses to return approximately to the equilibrium conditions following an overload
C1	Residual stress relaxation constant
E1, E2	Relaxation function exponents
N	Number of cycles
E	Modulus of elasticity
N_f	Number of cycles of life at a given stress or strain cycling level

SECTION I

INTRODUCTION

Cumulative damage analyses based upon the local stress-strain behavior at a notch appear to be reasonably successful in anticipating trends in fatigue life behavior of notched specimens subjected to spectrum loading [1-6]. The type of behavior that usually occurs is that peak tensile loads tend to increase the fatigue life and peak compressive loads tend to decrease the life of notched structures compared to structures experiencing load spectra not having those peaks [5,6]. Local behavior analyses, such as those developed by Smith [7] and Neuber [8], help to explain this phenomenon as being a result of the tensile peak load creating a compressive residual stress at the notch and, conversely, the compressive peak creating a tensile residual stress. The change in life occurs because the residual stress state modifies the subsequent damage accumulation rates.

The Sequence Accountable Fatigue Analysis computer program was developed to incorporate the local stress-strain approach with a recent residual stress relaxation analysis [6] in order to improve the sequence sensitivity of cumulative damage analysis. This technical memorandum presents the details of the resultant computer program and an example of its use. The correlation of predictions made with this analysis to actual results of tests experiencing spectrum loading is presented by Potter [9], and Potter, Gallagher, and Stalnaker [10].

SECTION II

PROGRAM OUTLINE

The Sequence Accountable Fatigue Analysis traces the stress-strain behavior local to a notch throughout an applied load spectrum and calculates the damage based on the local experience. The computer program is divided generally into the four parts or modules outlined in Fig. 1.

The basic input data for the material, specimen geometry, fatigue behavior qualities and spectrum, are developed in Module I. The information required in Module I is discussed further in Section III. Module II takes the input information and determines the local stress-strain behavior. Module III references the Range Pair Counting Method Subroutine to cycle count the local stress spectrum. Module IV determines the damage in the local stress-strain spectrum.

The basic analyses used in Modules II, III and IV are presented below.

Module II - Local Stress-Strain Behavior - The analysis used during the determination of the local stress behavior during the spectrum of loading is a combination of analyses developed by Smith [7], Neuber [8] and Potter [6]. Smith's simple analysis indicated that the residual stress could be approximated by assuming that the initial stress-strain behavior was elastic upon unloading following plastic flow. Thus, the residual stress could be calculated knowing the maximum local stress and the maximum applied stress as in Eq. 1 and in Fig. 2.

$$\sigma_{res_i} = \sigma_{max_i} - K_t S_{max_i} \qquad (1)$$

The Sequence Accountable Fatigue Analysis computer program currently incorporates elastic-perfectly plastic stress-strain behavior. Therefore, σ_{max_i} is equal to the yield stress. For the cycles immediately following the peak stress, the residual stress determined in Eq. 1 modifies the elastic solution as shown in Eqs. 2 and 3 (provided that the following maximum applied stress is less than S_{max} and that there is no change in the residual stress due to a minimum applied stress causing reversed yielding).

$$\sigma_{max_i} = \sigma_{res_{i-1}} + K_t S_{max_i} \qquad (2)$$

$$\sigma_{min_i} = \sigma_{res_{i-1}} + K_t S_{min_i} \qquad (3)$$

The analysis developed by Neuber [8] has been extended to cyclic loading by Wetzel [2] and Wetzel, Morrow and Topper [3] and used by many others [1,4-6] primarily to determine local stress-strain behavior. It is used in this program only to calculate plastic strains occurring when the residual stress undergoes a step change. The plastic strain calculation routine is accessed only when the σ_{max_i} or σ_{min_i} terms in Eqs. 2 and 3 exceed tensile or compressive yield stress levels, respectively. Figure 3 illustrates the calculation of the plastic strain.

The local stress-strain behavior, according to Wetzel [2] is related to the applied load by Eq. 4

$$\sigma \cdot \varepsilon = (K_t S_{max})^2 / E \qquad (4)$$

The plastic strain can be found by subtracting the elastic component from the total strain.

$$\varepsilon_p = \varepsilon_t - \varepsilon_e = (K_t S_{max})^2/E \cdot \sigma_{max} - \sigma_{max}/E$$

Therefore, the plastic strain associated with S_{max_i} is given in Eq. 5.

$$\varepsilon_{p_i} = (K_t S_{max_i})^2/E\sigma_{ys} - \sigma_{ys}/E \qquad (5)$$

If a residual stress existed prior to this plastic strain excursion, the plastic strain associated with that prior excursion is subtracted from Eq. 5 as shown in Eq. 6.

$$\varepsilon_{p_i} = (K_t S_{max_i})^2/E\sigma_{ys} - (\sigma_{ys} - \sigma_{res_{i-1}})^2/E\sigma_{ys} \qquad (6)$$

A similar calculation is made for plastic strains occurring during the minimum stress peak.

In the analysis developed by Potter [6] the residual stress cyclically relaxes toward zero or an equilibrium residual stress as shown in Fig. 4 according to Eq. 7.

$$\sigma_{res_{N=1,2,...}} = (\sigma_{res_{N=1}} - \sigma_{res_{EQ}})\exp(N/N_{EP_i} \ln(0.1)) \qquad (7)$$

The N_{EP} term, the Equilibrium Period, is dependent upon the applied stress and the Residual Stress Relaxation Constant.

$$N_{EP_i} = (C1/\left|K_t S_{max_i}\right|^{E1} \cdot \left|K_t S_{mean_i}\right|^{E2}) \qquad (8)$$

The Residual Stress Relaxation Constant, C1, has not yet been experimentally defined but should be a constant for a material.

Module III - Cycle Counting Method

After the local stress and plastic strain behavior is calculated, the local stress spectrum is Range Pair Counted using a computer program developed by Tischler.[11]

Module IV - Damage Calculation

Damage is calculated separately for the plastic strain excursions and the elastic stress spectrum. The damage is determined from the conventional $D = \sum \frac{n}{N}$ calculation. Damage from each of the plastic strain cycles is determined from the Coffin-Manson [12] form

$$D_i = 1./N_{f_i} = 1./(\varepsilon_{p_i}/\varepsilon_{f'})^{1/c}$$

Damage from the elastic stress cycles is determined in a similar manner. The maximum and minimum local stress levels are sequentially compared to unnotched S-N data in a Modified Goodman Diagram format. Damage is summed, and failure of the coupon is defined as the event occurring when the summed damage equals unity.

SECTION III

INPUT DATA REQUIREMENTS

In general, each spectrum analyzed will require slightly different programming in order to get the load history into a usable format for the core program. The basic program requires a certain family of information before any analytical predictions can be made. Appendix I contains a program listing for the Sequence Accountable Fatigue Analysis. The subroutine CORE which accesses the subroutines having to do with RPCM, the Range Pair Counting Method, contains the basic analysis. Subroutine SAL reads the data input and then references subroutine CORE. The subroutine SAL shown is one in which a block of cycles is repeated with optional cycles. A list of the input data cards and the resulting analysis is given in Appendix II.

The specific data requirements are given below.

1. Stress-Strain Behavior - The stress-strain behavior is presumed to be elastic-perfectly plastic with the tensile yield stress being equal to the compressive yield stress. The yield stress value used is an average of the monotonic behavior generally being above the 0.2% yield value and below the engineering ultimate strength.

2. Residual Stress Relaxation - The residual stress relaxation behavior of Eq. 7 and 8 is characterized by C1, the Residual Stress Relaxation Constant and E1 and E2, the relaxation equation exponents. The Residual Stress Relaxation Constant, C1, has not yet been adequately determined. It should be a material property if the relaxation function

is correct and must be assumed. A reasonably accurate estimate of the Residual Stress Relaxation Constant for aluminum material falls in the range of 5-20 x 10^6 (cycles) $(Ksi)^2$. Further experimentation on the part of the analyst should develop a C1 usable for his set of conditions until actual measurement of residual stress relaxation behavior defines the relaxation function and constants. At present E1 and E2 are considered to be equal to 1.0.

3. Specimen Geometry - The elastic K_t value (if available) is entered into the analysis. If that value is not available then an estimate from some other method may be used. In certain cases, a value may be determined from a constant amplitude fatigue test of a similar structure by fitting several values of K_t to the analysis and determining the best correlation as is done with the K_f solution. Once a stress concentration factor, K_t, is determined for a specimen, that value is not changed from test-to-test of the same coupon configuration.

4. Load Multiplier - Different spectra are presented for analysis in different manners. Some data are presented in percent of maximum stress, others in terms of nominal stress, and others in terms of bending moment. The value of the load multiplier defines the nominal stress history.

5. Cumulative Damage Analysis - The damage from the range-paired elastic stress spectrum is determined by calculating a simple $\frac{n}{N}$ value for each level and accumulating the total. The N_{f_i} value is determined from unnotched coupon S-N data in the Modified Goodman Diagram format.

The program requires the input of four second order equations describing the maximum and minimum stress levels at lives of 10^4, 10^5, 10^6 and 10^7 cycles. The coefficients of the equations are derived by least square fitting the S-N data presented in the form of Eq. 9.

$$S_{max} = A(I) S_{min}^2 + B(I) S_{min} + C(I) \qquad (9)$$

The A, B, and C coefficients for several typical materials are presented in Appendix IV. The S-N data shown was derived from various sources but usually from the MIL-HDBK-5A [13]. The C coefficients correspond to the maximum stress level at zero to maximum applied stress conditions on the unnotched coupons.

The damage from the plastic strain cycles is determined using the Coffin-Manson relation to calculate the N_{f_i} value. The conventional plastic strain intercept at one reversal and the ε_p - life slope values are used in the analysis. Specific measured values from the literature are used when available and typical values when they are not available.

6. Analysis or Test Spectrum - The last information needed is the order and magnitude of application of the spectrum used in the test.

SECTION IV

OUTPUT OPTIONS

The Computer Program prints the following output in the process of the analysis.

1. Maximum and minimum applied stress and local stress response through the spectrum. Also printed out is the residual stress, equilibrium stress, applied cycles, and the equilibrium period.

2. The elastic local stress history as input into the Range Pair Subroutine and the resulting Range Paired spectrum.

3. The plastic strain occurrence during the spectrum and the damage associated with each strain reversal.

4. The accumulated damage associated with the plastic strains.

5. The Range Paired elastic stress spectrum and the damage associated with each level.

6. The accumulated damage associated with the current block of loading including the plastic strain damage and the total damage since the initiation of cycling.

At the option of the analyst, he can print out all the above items or only two. The IPRINT value controls what data is printed.

If IPRINT = 1, all six items are printed for each flight or block.

If IPRINT = 2, all items except 2. above are printed.

If IPRINT = 3, only items 4. and 6. above are printed.

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13. Metallic Materials and Elements for Aerospace Vehicle Structures, MIL-HDBK-5A, Department of Defense, Washington, D. C., Feb. 1966.

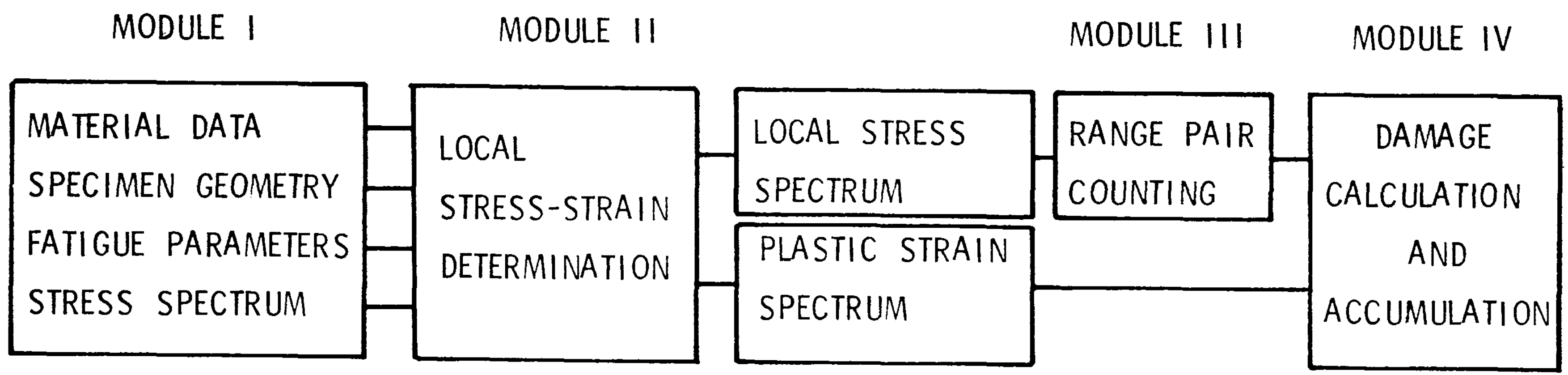


FIGURE 1. PROCEDURE USED IN THE SEQUENCE ACCOUNTABLE FATIGUE ANALYSIS

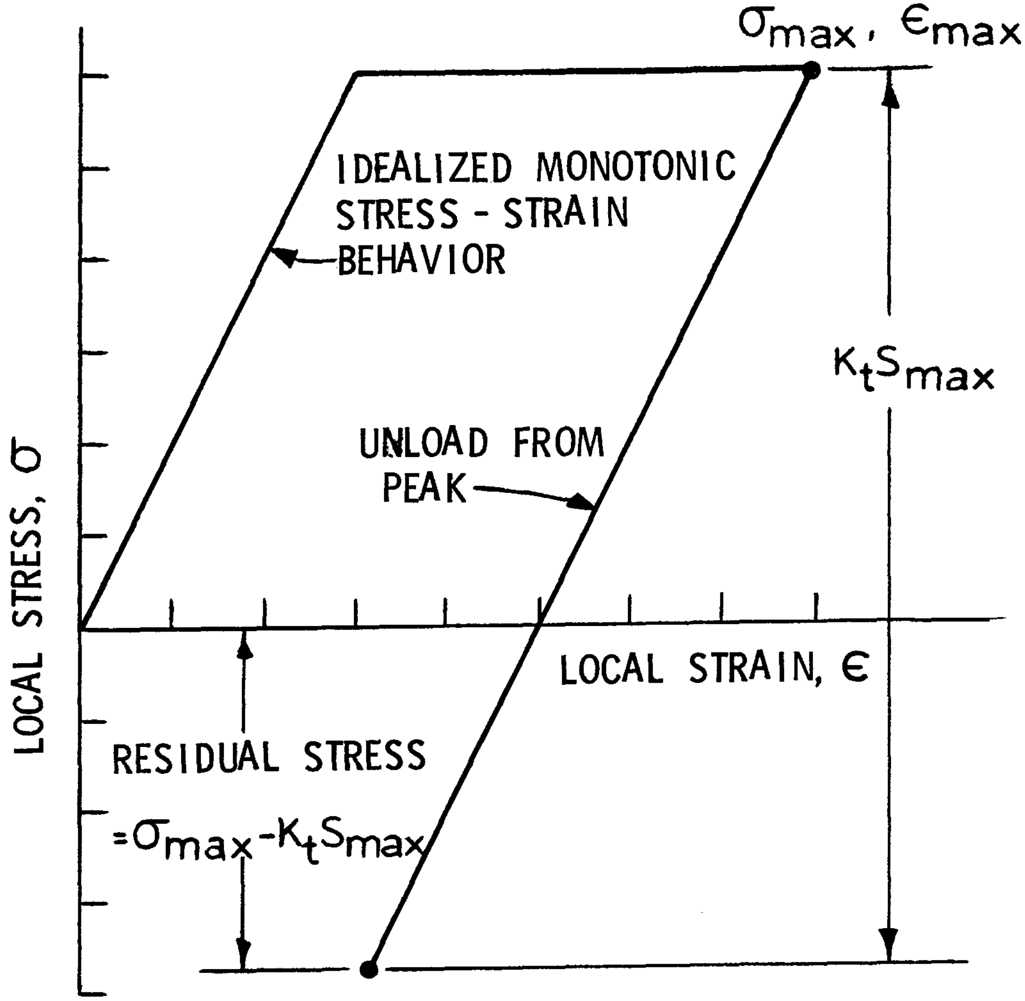


FIGURE 2. METHOD OF DETERMINING THE RESIDUAL STRESS FOLLOWING A PEAK LOAD

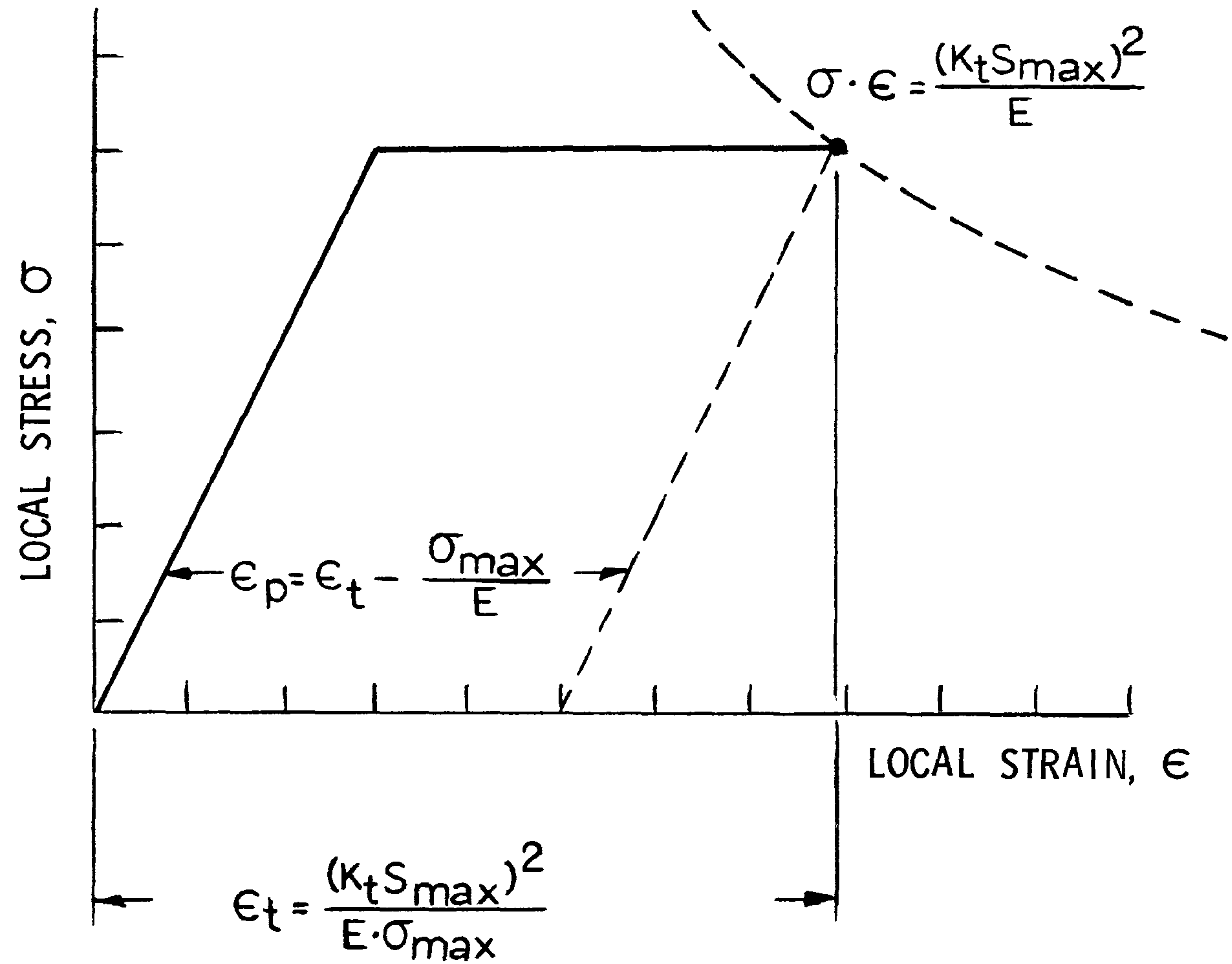
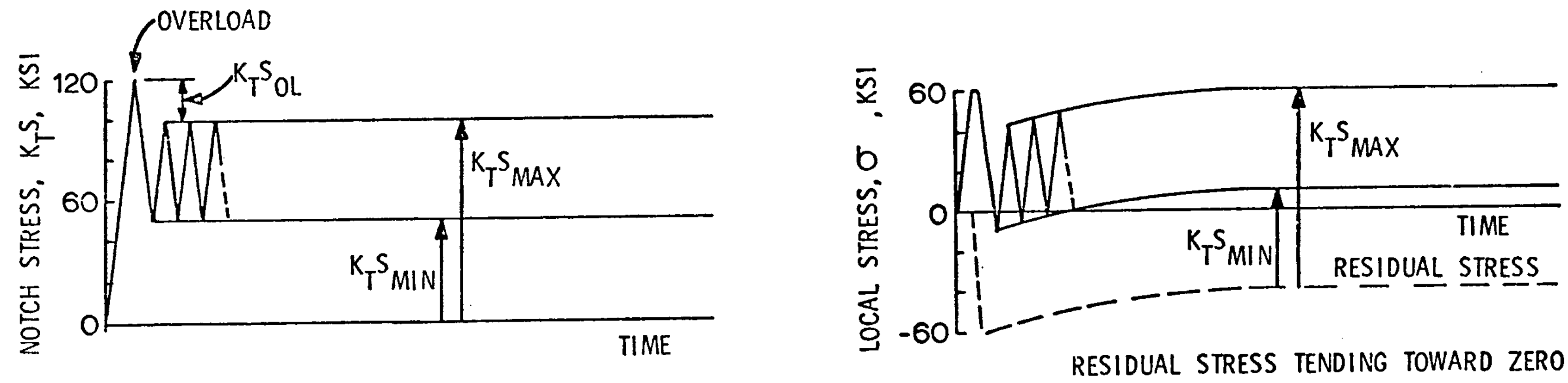


FIGURE 3. METHOD OF DETERMINING PLASTIC STRAIN LEVELS



APPLIED STRESS HISTORY

LOCAL STRESS RESPONSE

FIGURE 4. LOCAL STRESS RESPONSE FOR APPLIED CONSTANT AMPLITUDE LOADING WITH RESIDUAL STRESS RELAXATION

APPENDIX I

PROGRAM LIST


```
      PROGRAM SAL(INPUT,TAPE5=INPUT,OUTPUT,TAPE6=OUTPUT)
C
C     ************************************************************************
C
C
C                            MODULE I
C                   INPUT ROUTINE FOR THE
C      SEQUENCE ACCOUNTABLE FATIGUE ANALYSIS
C
C     ************************************************************************
C
C             PROGRAM DEVELOPED BY  JOHN M. POTTER AND ROBERT A. NOBLE
C                 OF THE AIR FORCE FLIGHT DYNAMICS LABORATORY
C                      MARCH 1973
C                   ADDRESS; AFFDL/FBR
C                           WRIGHT-PATTERSON AFB,OHIO  45433
C                   TELEPHONE  (513) 255-6104  OR  255-6106
C
C     INPUT
C
C
C     DATA CARD 1.    NDECK = THE NUMBER OF DATA DECKS TO BE RUN SEQUENTIALLY.
C                     IPRINT   THE VALUE CONTROLLING THE WRITE STATEMENTS
C                                1  PERMITS MAXIMUM PRINTOUT
C                                2  SUPPRESSES RANGE-PAIR PRINTING
C                                3  MAXIMUM SUPPRESSION OF PRINTOUT
C                     IRPCM= THE VALUE CONTROLLING THE ENTRY INTO THE
C                            RANGE PAIR COUNTING SUBROUTINE
C                                1  ENTER RANGE PAIR COUNTING SUBROUTINE
C                                2  SKIP RANGE PAIR COUNTING SUBROUTINE
C                     FORMAT   3I4
C
C     EACH DATA DECK CONTAINS THE FOLLOWING CARDS --
C
C     CARD 1.      TEST IDENTIFYING INFORMATION
C                  FORMAT  8A8
C
C     CARD 2.      TM     = MATERIAL TYPE
C                  TYS    = TENSILE YIELD STRESS (KSI)
C                  EPSD   = LCF STRAIN INTERCEPT
C                  COFMAN = INVERSE OF COFFIN-MANSON SLOPE
C                  ELMOD=  MODULUS OF ELASTICITY  (KSI)
C                  FORMAT 2A8,3F18.5,F10.2
C
C     CARDS 3,...,6.  A(N)   N=4,7    (A,B,C ARE COEFFICIENTS OF SECOND
C                                     (ORDER LEAST SQUARE FIT OF S-N DATA,
C                     B(N)            (FOR CURVE OF 10**N CYCLES.)
C                     C(N)            (STMAX = A(N)*STMIN**2 + B(N)*STMIN + C(N))
C                     TITLE1          (TITLE1,TITLE2 IDENTIFIES THE      )
C                     TITLE2          (SOURCE OF THE S-N DATA            )
C                     N               (PUNCHED IN COLUMN 72. FOR INFO.)
C                     MATERIAL TYPE  (COLUMNS 73-80. FOR INFO ONLY.  )
C                     FORMAT 3F18.5,2A8
C
C     CARD 7.      C1                 (CONSTANTS TO BE USED IN CALCULA-.)
```

```
      C                E1              (TION OF EQUILIBRIUM PERIOD, ENEP.)
      C                E2              (ENEP=C1/(KTSMAX**E1*KTSMEAN**E2) )
      C                FORMAT  3F18.5
      C
      C     CARD 8.    AKT = STRESS CONCENTRATION FACTOR USED THE FIRST
      C                      TIME THROUGH THE PROGRAM
      C                FORMAT   F18.5
      C
      C     CARD 9.    NBLOCK = NUMBER OF BLOCKS (NO. OF TIMES TO REPEAT LIST
      C                                                          OF LOADS)
      C                NLEVEL = NUMBER OF LOADS
      C                NTYPE  = NUMBER OF TYPES OF LOADS
      C                FORMAT  3I10
      C
      C     CARD 10.   TLL = LIMIT LOAD
      C                FORMAT  F18.5
      C
      C     CARDS 11,...,NLEVEL + 10.
      C                K               THE KTH STEP       (K=1,NLEVEL)
      C                ITYPE(K) = THE IDENTIFYING TYPE OF THE KTH LOAD
      C                STMIN(K) = THE KTH MINIMUM (DECIMAL FRACTION OF TLL)
      C                STMAX(K) = THE KTH MAXIMUM (DECIMAL FRACTION OF TLL)
      C                ENN(K)   = NUMBER OF CYCLES AT THE KTH LOAD
      C                FORMAT  2(I4,2X),3(F18.5,1X)
      C
      C     CARDS NLEVEL + 11,...,NLEVEL + 10 + NBLOCK.
      C                JJ                 THE JJTH BLOCK      (JJ=1,NBLOCK)
      C                NN(JJ,1)    = TYPE OF LOAD INCLUDED IN JJTH BLOCK
      C                NN(JJ,2)    =        (THERE WILL BE ONE NN VALUE      )
      C                NN(JJ, )    =        (ON THE CARD FOR EACH DIFFERENT )
      C                FORMAT  9I5          (TYPE OF LOAD INCLUDED IN THE    )
      C                                     (JJTH BLOCK                      )
      C
            COMMON/MSAL/RNCYC(200),KPMAX,IPRINT
            DIMENSION RTMIN(200),RTMAX(200),RNN(200),ITYPE(200)
            COMMON/MCOR1/NLEVEL,IRPCM,IPLOT,ELMOD,TYS,EPSO,COFMAN,C1,E2,E1,
           *RES(200),AKT,SUMENN,SUMNC
            COMMON/MCOR2/STMIN(200),STMAX(200),ENN(200),A(10),B(10),C(10),
           *R(10),NN(20,10)
            READ(5,4) NDECK,IPRINT,IRPCM
      4      FORMAT(3I4)
            WRITE(6,3) NDECK
      3     FORMAT(1H1,I4,32H DATA DECKS ARE TO BE PROCESSED.)
            IF(IRPCM.GE.2)GO TO 6
            WRITE(6,11)
            GO TO 13
          6 WRITE(6,7)
          7 FORMAT(25H NO COUNTING METHODS USED)
         13 CONTINUE
            DO 595 LMN = 1,NDECK
            WRITE(6,5)
      5     FORMAT(40H SEQUENCE ACCOUNTABLE FATIGUE EVALUATION)
            READ(5,9)T1,T2,T3,T4,T5,T6,T7,T8
      9      FORMAT(8A8)
            WRITE(6,8)T1,T2,T3,T4,T5,T6,T7,T8
```

```
  8     FORMAT(16H1SPECTRUM FROM  ,8A8)
  C
  C          INPUT OF DATA PECULIAR TO A MATERIAL
  C
        READ(5,10)TM1,TM2,TYS,EPSD,COFMAN,ELMOD
  10    FORMAT(2A8,3F18.5,F10.2)
        WRITE(6,12)TM1,TM2,TYS,EPSD,COFMAN,ELMOD
  12    FORMAT(18H MATERIAL TYPE -- ,2A8,//30H TENSILE YIELD STRESS (KSI)
       *--,F18.5,//23H LCF STRAIN INTERCEPT =,F18.5,//31H INVERSE OF COFFI
       *N-MANSON SLOPE,F18.5,//18H ELASTIC MODULUS =,F18.5)
        READ(5,14)  (A(N),B(N),C(N),TITLE1,TITLE2,N=4,7)
  14    FORMAT(3F18.5,2A8)
        WRITE(6,16)
  16    FORMAT(58H0COEFFICIENTS OF SECOND ORDER LEAST SQUARE FIT OF S-N DA
       *TA)
        WRITE(6,18)
  18    FORMAT(44H        SMAX = A(I)*SMIN**2 + B(I)*SMIN + C(I))
        WRITE(6,20)
  20    FORMAT(5X,5H LIFE,10X,5H A(I),14X,5H B(I),14X,5H C(I))
        WRITE(6,22) (N,A(N),B(N),C(N),N=4,7)
  22    FORMAT(8H    10**,I2,3F18.5)
        WRITE(6,56) TITLE1,TITLE2
  56    FORMAT(39H0UNNOTCHED COUPON S-N DATA DERIVED FROM/28H INFORMATION
       *SUPPLIED FROM  ,2A8)
        READ(5,14) C1,E1,E2
        WRITE(6,24)
  24    FORMAT(36H0RESIDUAL STRESS RELAXATION FUNCTION)
        WRITE(6,26)
  26    FORMAT(/42H       ENEP = C1/(KTSMAX**E1 * KTSMEAN**E2)/)
        WRITE(6,28) C1,E1,E2
  28    FORMAT(13H+WHERE   C1 =,E15.8,9H ,   E1 =,F10.3,10H AND  E2 =,F10.
       *3)
  C
  C
  C
  C          INPUT OF DATA PECULIAR TO A SEQUENCE
  C
  C
        READ(5,65)AKT
  65     FORMAT(F18.5)
        READ(5,32) NBLOCK,JLEVEL,NTYPE
  32    FORMAT(3I10)
        WRITE(6,34) NBLOCK,JLEVEL
  34    FORMAT(// I10,23H TIMES THROUGH BLOCK OF,I10,6H LOADS)
        READ(5,35) TLL
  35    FORMAT(F18.5)
        WRITE(6,33) TLL
  33    FORMAT(/ 5X,13H LOAD LIMIT =,F18.5)
        READ(5,36)(IDUMMY  ,ITYPE(K),RTMIN(K),RTMAX(K),RNN(K),K=1,JLEVEL)
  36    FORMAT(I4,2X,I4,2X,F18.5,1X,F18.5,1X,F18.5,1X)
        WRITE(6,38)
  38    FORMAT(//11H STEP  TYPE,10X,6H STMIN,14X,6H STMAX,15X,4H ENN)
        WRITE(6,36)(    K   ,ITYPE(K),RTMIN(K),RTMAX(K),RNN(K),K=1,JLEVEL)
        WRITE(6,39)
  39    FORMAT(//47H BLOCK  TYPE TYPE TYPE TYPE TYPE TYPE TYPE TYPE/)
```

```
      DO 42 JJ=1,NBLOCK
      READ(5,40) IDUMMY    ,(NN(JJ,KK),KK=1,NTYPE)
      WRITE(6,40)    JJ     ,(NN(JJ,KK),KK=1,NTYPE)
   40 FORMAT(9I5)
   42 CONTINUE
      SUMENN=0.
      SUMNC=0.
      RES(1)=0.
       WRITE(6,8)T1,T2,T3,T4,T5,T6,T7,T8
      WRITE(6,51) (AKT)
   51 FORMAT(/7H AKT = ,(F6.2))
        WRITE(6,55)C1
   55 FORMAT(//24H RELAXATION CONSTANT C1=,F15.2)
       IF(IRPCM.GE.2)GO TO 59
      WRITE(6,11)
   11 FORMAT(56H0SPECTRUM SUBJECTED TO THE RANGE-PAIR COUNTING TECHNIQUE)
     *)
   59 CONTINUE
      DO 1002 KFL=1,NBLOCK
       JJJ=1
      DO 60 J=1,JLEVEL
      DO 70 KK=1,NTYPE
       IF(NN(KFL,KK).EQ.0) GO TO 60
       IF(ITYPE(J).EQ.NN(KFL,KK))GO TO 150
   70 CONTINUE
  150  STMIN(JJJ)=RTMIN(J)*TLL
       STMAX(JJJ)=RTMAX(J)*TLL
       ENN(JJJ)=RNN(J)
      JJJ=JJJ+1
   60 CONTINUE
       NLEVEL=JJJ-1
      CALL CORE(KFL)
       IPRINT=2
 1002 CONTINUE
  597 CONTINUE
  595 CONTINUE
  596 CONTINUE
  580 STOP
      END
```

```
      SUBROUTINE CORE(KFL)
C     *****************************************************************
C
C                    CORE PROGRAM OF
C              THE SEQUENCE ACCOUNTABLE FATIGJE ANALYSIS
C
C
C                         MODULE II
C
C              LOCAL STRESS AND STRAIN DETERMINATION
C
C     *****************************************************************
C
      COMMON/MDEC1/SIGMAX(200),SIGMIN(200)
      COMMON/MSAL/RNCYC(200),KPMAX,IPRINT
      DIMENSION PLSTRA(200),EN(200),EX(200)
      COMMON/MCOR1/NLEVEL,IRPCM,IPLOT,ELMOD,TYS,EPSO,COFMAN,C1,E2,E1,
     *RES(200),AKT,SUMENN,SUMNC
      COMMON/MCOR2/STMIN(200),STMAX(200),ENN(200),A(10),B(10),C(10),
     *R(10),NN(20,10)
      JJ=KFL
      IF(JJ.GT.3) IPRINT=3
      IRAIN=1
      WRITE(6,54)JJ
   54 FORMAT(20H FLIGHT OR BLOCK NO.,I5)
      IF(IPRINT.GE.3) GO TO 61
      WRITE(6,62)
   62 FORMAT(66H STMAX    STMIN   SIGMAX  SIGMIN   RES    EQRES    ENN
     *        NEP)
   61 CONTINUE
C
C
  148 DO 570 J=1,NLEVEL
  149 I=J+1
      PLSTRA(J)=0.
C
C       DETERMINE SEQUENCE ACCOUNTABLE RESIDUAL STRESS AND CORRESPONDING
C         PLASTIC STRAIN
C
  150 ASMAX=AKT*STMAX(J)
      ASMIN=AKT*STMIN(J)
      ASMEAN=(ASMAX+ASMIN)/2.
      JA=0
  170 IF(RES(I-1)+ASMIN+TYS) 190,190,200
  190 JA=1
      AAA=RES(I-1)+ASMIN
      PLSTRA(J)=    -1.*(AAA/ELMOD)*(1.+AAA/TYS)
  200 JB=0
  202 IF(RES(I-1)+ASMAX-TYS) 220,210,210
  210 JB=-1
      AAA=ASMAX
      BBB=TYS-RES(I-1)
      IF(BBB.GE.TYS) GO TO 214
  212 BBB=0.
  214 PLSTRA(J)=    AAA*AAA/(ELMOD*TYS)-BBB*BBB/(ELMOD*TYS)
```

```
220   IF(JA+JB) 230,250,240                                          CORE     57
230   RES(I)=TYS-ASMAX                                               CORE     58
      GO TO 290                                                      CORE     59
240   RES(I)=-TYS-ASMIN                                              CORE     60
      GO TO 290                                                      CORE     61
250   IF(JA) 260,260,270                                             CORE     62
260   RES(I)=RES(I-1)                                                CORE     63
      GO TO 290                                                      CORE     64
270   RES(I)=-ASMEAN                                                 CORE     65
290   SIGMAX(IRAIN)=RES(I)+ASMAX                                     CORE     66
      SIGMIN(IRAIN)=RES(I)+ASMIN                                     CORE     67
      RNCYC(IRAIN)=ENN(J)                                            CORE     68
      IF(ASMAX.LE.TYS) GO TO 410                                     CORE     69
400   EQRES=-ASMAX+TYS                                               CORE     70
      GO TO 440                                                      CORE     71
410   IF(ASMIN.GE.-TYS) GO TO 430                                    CORE     72
420   EQRES=-ASMIN-TYS                                               CORE     73
      GO TO 440                                                      CORE     74
430   EQRES=0.                                                       CORE     75
440   DIF=RES(I)-EQRES                                               CORE     76
C                                                                    CORE     77
C       CALCULATE RELAXATION FUNCTION                                CORE     78
C                                                                    CORE     79
      ABMAX=ABS(ASMAX)                                               CORE     80
      ABMIN=ABS(ASMIN)                                               CORE     81
      ABMEAN=ABS(ASMEAN)                                             CORE     82
       IF(ABMAX.LT.1.)ABMAX=1.                                       CORE     83
       IF(ABMEAN.LT.1.)ABMEAN=0.5                                    CORE     84
      IF(ABMIN-ABMAX) 444,444,442                                    CORE     85
442   ABM=ABMIN                                                      CORE     86
      GO TO 446                                                      CORE     87
444   ABM=ABMAX                                                      CORE     88
446   ENEP=C1/(ABM**E1*ABMEAN**E2)                                   CORE     89
      IF(IPRINT.GE.3)GO TO 351                                       CORE     90
      WRITE(6,350) STMAX(J),STMIN(J),SIGMAX(IRAIN),SIGMIN(IRAIN),    CORE     91
     *RES(J),EQRES,ENN(J),ENEP,J,IRAIN                               CORE     92
350   FORMAT(6(F7.2,1X),F6.2,1X,E15.8,5X,I6,4X,I6)                   STD       1
351      CONTINUE                                                    CORE     94
C                                                                    CORE     95
C        CALCULATE RESIDUAL STRESS RELAXATION                        CORE     96
C                                                                    CORE     97
      IRAIN=IRAIN+1                                                  CORE     98
      ABDIF=ABS(DIF)                                                 CORE     99
      GO TO 360                                                      CORE    100
      GO TO 560                                                      CORE    101
360   IF(ABDIF.LT.5.) GO TO 560                                      CORE    102
370   IF(1000.*ENN(J).LT.ENEP) GO TO 560                             CORE    103
       IF(ENN(J).LE.10.) GO TO 560                                   CORE    104
380   NFLAG=0                                                        CORE    105
      NFLAG2=10                                                      CORE    106
      IRAIN=IRAIN-1                                                  CORE    107
      DUMMY=ENN(J)                                                   CORE    108
450   IF(DUMMY-ENEP) 470,460,460                                     CORE    109
460   DUMMY=DUMMY/2.                                                 CORE    110
      NFLAG=NFLAG+1                                                  CORE    111
```

```
            GO TO 450                                                          CORE
      470   CYCINT=DUMMY/10.                                                   CORE
            DO 500 K=1,10                                                      CORE
            DECK=FLOAT(K)                                                      CORE
            EN(K)=CYCINT*DECK                                                  CORE
            IF(K.EQ.1) GO TO 490                                               CORE
      480   EX(K)=EXP(-2.303*EN(K-1)/ENEP)+EXP(-2.303*EN(K)/ENEP)              CORE
            GO TO 500                                                          CORE
      490   EX(K)=1.+EXP(-2.303*EN(K)/ENEP)                                    CORE
      500   CONTINUE                                                           CORE
            IF(NFLAG.EQ.0) GO TO 530                                           CORE
      510   NFLAG2=NFLAG+10                                                    CORE
            DO 520 K=11,NFLAG2                                                 CORE
            EN(K)=2.*DUMMY                                                     CORE
            EX(K)=EXP(-2.303*EN(K-1)/ENEP)+EXP(-2.303*EN(K)/ENEP)              CORE
            DUMMY=2.*DUMMY                                                     CORE
      520   CONTINUE                                                           CORE
      530   DO 559 K=1,NFLAG2                                                  CORE
            SIGMAX(IRAIN)=ASMAX+EQRES+DIF*EX(K)/2.                             CORE
            SIGMIN(IRAIN)=SIGMAX(IRAIN)-ASMAX+ASMIN                            CORE
            RNCYC(IRAIN)=EN(K)                                                 CORE
      545   IF(K.EQ.1) GO TO 540                                               CORE
      539   RNCYC(IRAIN)=RNCYC(IRAIN)-EN(K-1)                                  CORE
      540   IF(IPRINT.GE.3)GO TO 551                                           CORE
            WRITE(6,550)SIGMAX(IRAIN),SIGMIN(IRAIN),RNCYC(IRAIN),IRAIN         CORE
      550   FORMAT(16H RELAXATION     ,2(F7.2,1X),16X,F6.2,31X,I6)             CORE
      551    CONTINUE                                                          CORE
            IRAIN=IRAIN+1                                                      CORE
      559    CONTINUE                                                          CORE
      560   CONTINUE                                                           CORE
            RES(I)=EQRES+DIF*EXP(-2.303*ENN(J)/ENEP)                           CORE
      570   CONTINUE                                                           CORE
      569   RES(1)=RES(J)                                                      CORE
            IN=IRAIN-1                                                         CORE
      C                                                                        CORE
      C     ****************************************************************** CORE
      C                                                                        CORE
      C                                 MODULE III                             CORE
      C                         CYCLE COUNTING TECHNIQUE                       CORE
      C                                                                        CORE
      C     ****************************************************************** CORE
      C                                                                        CORE
      C       CALL SUBROUTINE TO RANGE PAIR COUNT SPECTRUM                     CORE
      C                                                                        CORE
             IF(IRPCM.GT.1)GO TO 591                                           CORE
            CALL RPCM(IN)                                                      CORE
            GO TO 592                                                          CORE
      591   CONTINUE                                                           CORE
            KPMAX=IN                                                           CORE
      592   CONTINUE                                                           CORE
      C                                                                        CORE
      C     ****************************************************************** CORE
      C                                                                        CORE
      C                                 MODULE IV                              CORE
      C                         DAMAGE ACCUMULATION CALCULATION                CORE
```

```
      C
      C     ****************************************************************
      C
            IF(IPRINT.GE.3)GO TO 552
            WRITE(6,53)
       53   FORMAT(//60H LOCAL STRESSES AND PLASTIC STRAINS W/RESULTING FATIGU
           *E LIFE//10X,4HSTEP,10X,14HPLASTIC STRAIN,10X,10HMAX OR MIN,15X,6HD
           *AMAGE)
      552    CONTINUE
      C
      C       CALCULATE DAMAGE FROM PLASTIC STRAIN CYCLES
      C
            SUMDEL=0.
            DO 531 JKL=1,NLEVEL
            AA=1.
            IF(PLSTRA(JKL)) 532,531,533
      532   AA=-1.
      533   PLSTRA(JKL)=AA*PLSTRA(JKL)
            CYCLES=(PLSTRA(JKL)/EPSD)**COFMAN
            DAM=1./CYCLES
            SUMNC=SUMNC+DAM
            SUMDEL=SUMDEL+DAM
            IF(IPRINT.GE.3) GO TO 531
            IF (AA) 535,535,537
      535   WRITE(6,199)JKL,PLSTRA(JKL),DAM
      199   FORMAT(10X,I4,12X,F10.5,15X,3HMIN,15X,E14.6)
             GO TO 531
      537   WRITE(6,219)JKL,PLSTRA(JKL),DAM
      219   FORMAT(10X,I4,12X,F10.5,15X,3HMAX,15X,E14.6)
      531   CONTINUE
            WRITE(6,541) SUMDEL
      541   FORMAT(63X,29H DAMAGE FROM PLASTIC STRAINS=,E15.8)
            IF(IPRINT.GE.3) GO TO 536
            WRITE(6,13)
       13   FORMAT(/16X,15H SIGMAX  SIGMIN,18X,6H RNCYC,20X,25H CYCLES
           *    ENN/CYC)
      536   CONTINUE
      C
      C       CALCULATE ELASTIC CYCLE DAMAGE FROM LEAST SQUARE FITTED S-N DATA
      C         (MODIFIED GOODMAN DIAGRAM FORMAT)
      C
            DO 600 JKL=1,KPMAX
      534   TTYS=TYS/5.
            IF(SIGMAX(JKL)-SIGMIN(JKL).LT.1.6*TYS)GO TO 310
            CYCLES=10.**4.
            GO TO 340
      310   IF(SIGMAX(JKL).GE.TTYS)GO TO 320
      447   CYCLES=10.**9.
             GO TO 340
      320   N=4
            DO 330 M=1,4
            R(N)=A(N)*SIGMIN(JKL)**2+B(N)*SIGMIN(JKL)+C(N)-SIGMAX(JKL)
            N=N+1
      330   CONTINUE
      332   IF(R(7)*R(4)) 338,338,334
```

```
  334 ABR7=ABS(R(7))                                                     CORE
      ABR4=ABS(R(4))                                                     CORE
      IF(ABR7.LE.ABR4 ) GO TO 336                                        CORE
  335 EXPO=4.+R(4)/(R(4)-R(5))                                           CORE
      GO TO 339                                                          CORE
  336 EXPO=7.+R(7)/(R(6)-R(7))                                           CORE
      GO TO 339                                                          CORE
  338 SUMR=R(4)+R(5)+R(6)+R(7)                                           CORE
      SUMR2=R(4)**2+R(5)**2+R(6)**2+R(7)**2                              CORE
      SUMR3=R(4)**3+R(5)**3+R(6)**3+R(7)**3                              CORE
      SUMR4=R(4)**4+R(5)**4+R(6)**4+R(7)**4                              CORE
      SUMRN=4.*R(4)+5.*R(5)+6.*R(6)+7.*R(7)                              CORE
      SUMR2N=4.*R(4)**2+5.*R(5)**2+6.*R(6)**2+7.*R(7)**2                 CORE
      DEL1=4.*SUMR2*SUMR4-4.*SUMR3**2                                    CORE
      DEL2=SUMR*SUMR2*SUMR3-SUMR4*SUMR**2                                CORE
      DEL3=SUMR*SUMR2*SUMR3-SUMR2**3                                     CORE
      DO1=22.*SUMR2*SUMR4-22.*SUMR3**2                                   CORE
      DO2=SUMR2*SUMR3*SUMRN-SUMR*SUMR4*SUMRN                             CORE
      DO3=SUMR*SUMR3*SUMR2N-SUMR2N*SUMR2**2                              CORE
      EXPO=(DO1+DO2+DO3)/(DEL1+DEL2+DEL3)                                CORE
  339 CYCLES=10.**EXPO                                                   CORE
      IF(EXPO.LE.4.)CYCLES=10.**4.                                       CORE
  340 ENNCYC=RNCYC(JKL)/CYCLES                                           CORE
      SUMNC=SUMNC+ENNCYC                                                 CORE
      SUMDEL=SUMDEL+ENNCYC                                               CORE
      IF(IPRINT.GE.3)GO TO 600                                           CORE
      WRITE(6,599) SIGMAX(JKL),SIGMIN(JKL),RNCYC(JKL),CYCLES,ENNCYC      CORE
  599  FORMAT(16X,2(F7.2,1X),16X,F6.0,17X,2(E15.8,1X))                   CORE
  600 CONTINUE                                                           CORE
      WRITE(6,593) SUMDEL                                                CORE
  593 FORMAT(/69X,21H DAMAGE PER THIS SET=,E15.8)                        CORE
      WRITE(6,575) SUMNC                                                 CORE
  575 FORMAT(/69X,18H  TOTAL ENN/CYC =,E15.8)                            CORE
      END                                                                CORE
```

```
      SUBROUTINE RPCM(NPKS)                                                 CORE  256
C                                                                           CORE  257
C     THIS PROGRAM EMPLOYS THE RANGE PAIR CYCLE COUNTING METHOD TO GENER   CORE  258
C     ANALYSIS SPECTRUM FROM A GIVEN LOAD SPECTRUM                         CORE  259
C                                                                           CORE  260
C                                                                           CORE  261
C                              PROGRAM ARRAYS                               CORE  262
C                 (INFORMATION NEEDED TO CHANGE DIMENSIONS)                 CORE  263
C                                                                           CORE  264
C     ARRAY NAME             DEFINITION                      DIMENSION     CORE  265
C       SIGMAX    PEAKS OF THE INPUT LOAD SPECTRUM          NPKS + KK      CORE  266
C             KK = THE NUMBER OF ADDITIONAL CYCLES (EXCLUDING INPUT CYCL   CORE  267
C                 WHICH THE PROGRAM WILL GENERATE                          CORE  268
C       SIGMIN    VALLEYS OF THE INPUT LOAD SPECTRUM        NPKS + KK      CORE  269
C       RNCYC     K COUNTERS OF THE PEAKS AND VALLEYS       NPKS + KK      CORE  270
C       NSTEP     STEP NUMBERS OF THE INPUT SPECTRUM        NPKS + KK      CORE  271
C       RES       RESIDUE SPECTRUM                           2*NPKS        CORE  272
C       INDEX     STEP NUMBERS OF ELEMENTS IN RES            2*NPKS        CORE  273
C       CYCLE     RANGE PAIR COUNTED CYCLES                 NPKS + KK      CORE  274
C       RNECYC    K COUNTERS OF THE CYCLES OF THE           NPKS + KK      CORE  275
C                 UNSORTED ANALYSIS SPECTRUM                               CORE  276
C       NNSTEP    STEP NUMBERS OF ELEMENTS OF THE           NPKS + KK      CORE  277
C                 UNSORTED ANALYSIS SPECTRUM                               CORE  278
C       ISAVE     VALUES OF NSTEP(J) SUCH THAT RNCYC(J)         99         CORE  279
C                 IS < 1.0 AND VALUES OF NSTEP(J) SUCH                     CORE  280
C                 THAT SIGMAX(J-1) = SIGMAX(J) AND                         CORE  281
C                 SIGMIN(J-1) = SIGMIN(J)                                  CORE  282
C                                                                           CORE  283
C                                                                           CORE  284
      COMMON/MSAL/RNCYC(200),KPMAX,IPRINT                                  CORE  285
      COMMON/MDEC1/SIGMAX(200),SIGMIN(200)                                 CORE  286
      COMMON/MDEC2/NSTEP(200),LR,KMAX,KMIN,K31                             CORE  287
      COMMON/MDECR/RES(450),INDEX(450),IND1,IND2,IND3,IND4,KIND            CORE  288
      COMMON/MCYG/CYCLE(200,2),RNECYC(200),NNSTEP(200)                     CORE  289
      COMMON/MCGDE/L,LIND                                                  CORE  290
      DIMENSION ISAVE(99),TITLE(8)                                         CORE  291
 9999 NPUNCH = 0                                                           CORE  292
      DO 8000 I = 1,NPKS                                                   CORE  293
 8000 NSTEP(I) = I                                                         CORE  294
      IF(IPRINT.GE.2)GO TO 103                                             CORE  295
      WRITE(6,20) NPKS                                                     CORE  296
   20 FORMAT(1H0,60HTHE NUMBER OF PEAKS OR VALLEYS IN THE INPUT LOAD SPE   CORE  297
     1CTRUM = ,I5//)                                                       CORE  298
      WRITE(6,22)                                                          CORE  299
   22 FORMAT(60X,5HSIGMA/31X,4HSTEP,13X,7HMAXIMUM,16X,7HMINIMUM,13X,       CORE  300
     1       9HCOUNTER K/)                                                 CORE  301
      WRITE(6,25) (NSTEP(I),SIGMAX(I),SIGMIN(I),RNCYC(I), I = 1,NPKS)      CORE  302
   25 FORMAT(29X,I5,10X,E13.6,10X,E13.6,10X,F10.5)                         CORE  303
  103  CONTINUE                                                            CORE  304
C                                                                           CORE  305
C     SORT THROUGH THE LOAD SPECTRUM - PULL OUT THOSE PEAKS AND VALLEYS    CORE  306
C     COUNTER K IS LESS THAN 1.0                                           CORE  307
C                                                                           CORE  308
      J = 1                                                                CORE  309
      L = 0                                                                CORE  310
```

```
      NRES = 1
      NCYNO = 100
      JMAX = 0
      DO 100 I = 1,NPKS
      IF (RNCYC(I) .GE. 1.0) GO TO 100
      X1 = SIGMAX(I)
      X2 = SIGMIN(I)
      CALL CYCGEN(X1,X2   ,RNCYC(I),NSTEP(I))
      ISAVE(J) = I
      J = J + 1
  100 CONTINUE
      JMAX = J - 1
      NPKSN = NPKS - JMAX
      IF (JMAX .EQ. 0) GO TO 200
      WRITE(6,23) (ISAVE(K), K = 1,JMAX)
      IF(IPRINT.GE.2)GO TO 101
   23 FORMAT(1H0,93HSTEP NUMBERS OF THOSE PEAKS AND VALLEYS IN THE LOAD
     1SPECTRUM WHOSE COUNTER K IS LESS THAN 1.0//(17I7))
  101 CONTINUE
      DO 110 J = 1,JMAX
      I = ISAVE(J) - (J-1)
      NPKN = NPKS - J
      IF (I .EQ. NPKN) GO TO 110
      DO 115 II = I,NPKN
      SIGMAX(II) = SIGMAX(II+1)
      SIGMIN(II) = SIGMIN(II+1)
      NSTEP(II) = NSTEP(II+1)
      RNCYC(II) = RNCYC(II+1)
  115 CONTINUE
  110 CONTINUE
  200 CONTINUE
C
C     SORT THROUGH THE LOAD SPECTRUM DATA - COMBINE STEPS WITH IDENTICAL
C     AND VALLEYS WHICH OCCUR CONSECUTIVELY
C
      J = 1
      DO 300 I = 2,NPKSN
      IF (SIGMAX(I) .NE. SIGMAX(I-1)) GO TO 300
      IF (SIGMIN(I) .NE. SIGMIN(I-1)) GO TO 300
      ISAVE(J) = I
      RNCYC(I-1) = RNCYC(I-1) + RNCYC(I)
      J = J + 1
  300 CONTINUE
      IF (J .EQ. 1) GO TO 6000
      JMAS = J - 1
      DO 311 J = 1,JMAS
      I = ISAVE(J) - (J-1)
      NPKN = NPKSN - J
      IF (I .EQ. NPKN) GO TO 311
      DO 316 II = I,NPKN
      SIGMAX(II) = SIGMAX(II+1)
      SIGMIN(II) = SIGMIN(II+1)
      NSTEP(II) = NSTEP(II+1)
      RNCYC(II) = RNCYC(II+1)
  316 CONTINUE
```

```
  311 CONTINUE
      NPKSN = NPKSN - JMAS
C
C     RANGE PAIR COUNT THE ADJUSTED LOAD SPECTRUM
C
 6000 I = 1
      KB = 0
      L = JMAX
      KMIN = 0
      KMAX = 0
      LR = 0
      K31 = 0
    1 IF (RNCYC(I) .GT. 1.0) GO TO 400
      IF (KB .NE. 0) GO TO 5
      X1 = SIGMAX(I)
      X2 = SIGMIN(I)
      IND1 = NSTEP(I)
      IND2 = IND1
      I = I + 1
      KB = 1
      GO TO 1
    5 X3 = SIGMAX(I)
      X4 = SIGMIN(I)
      IND3 = NSTEP(I)
      IND4 = IND3
      KMIN = 1
      KMAX = 0
      K31 = 0
      IF (RNCYC(I) .EQ. 1.0) GO TO 6
      KEY = 1
      KIND = 1
      GO TO 415
    6 KEY = 0
       CYCNO = AINT(RNCYC(I)+0.5)
      CALL DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)
 1000 GO TO (10,10,30),KCYGEN
   10 KB = 1
      I = I + 1
      IF (KMIN .NE. 1) GO TO 36
      IF (I .LE. NPKSN) GO TO 5
      RES(LR+1) = X1
      RES(LR+2) = X2
      INDEX(LR+1) = IND1
      INDEX(LR+2) = IND2
      LRMAX = LR + 2
      GO TO 2000
 30   IF (KMIN .NE. 1) GO TO 35
 12   I = I + 1
      IF (I .LE. NPKSN) GO TO 31
      RES(LR+1) = X1
      RES(LR+2) = X2
      RES(LR+3) = X3
      INDEX(LR+1) = IND1
      INDEX(LR+2) = IND2
      INDEX(LR+3) = IND3
```

```
      LRMAX = LR + 3                                                    CORE  421
      GO TO 2000                                                        CORE  422
   31 X4 = SIGMAX(I)                                                    CORE  423
      IND4 = NSTEP(I)                                                   CORE  424
      KMAX = 1                                                          CORE  425
      KMIN = 0                                                          CORE  426
      K31 = 1                                                           CORE  427
   32 IF (RNCYC(I) .GT. 1.0) GO TO 40                                   CORE  428
      GO TO 6                                                           CORE  429
   40 KEY = 1                                                           CORE  430
      KIND = 0                                                          CORE  431
      GO TO 415                                                         CORE  432
   35 X4 = SIGMIN(I)                                                    CORE  433
      IND4 = NSTEP(I)                                                   CORE  434
      KMIN = 1                                                          CORE  435
      KMAX = 0                                                          CORE  436
      K31 = 0                                                           CORE  437
      GO TO 32                                                          CORE  438
   36 X3 = SIGMIN(I)                                                    CORE  439
      IND3 = NSTEP(I)                                                   CORE  440
      KMIN = 1                                                          CORE  441
      KMAX = 0                                                          CORE  442
      GO TO 12                                                          CORE  443
  400 KEY = 1                                                           CORE  444
      IF (KB .NE. 0) GO TO 410                                          CORE  445
      X1 = SIGMAX(I)                                                    CORE  446
      X2 = SIGMIN(I)                                                    CORE  447
      X3 = SIGMAX(I)                                                    CORE  448
      X4 = SIGMIN(I)                                                    CORE  449
      IND1 = NSTEP(I)                                                   CORE  450
      IND2 = IND1                                                       CORE  451
      IND3 = IND1                                                       CORE  452
      IND4 = IND1                                                       CORE  453
      KMIN = 1                                                          CORE  454
      KMAX = 0                                                          CORE  455
      K31 = 0                                                           CORE  456
      IF (RNCYC(I) .LE. 2.0) GO TO 401                                  CORE  457
      RNCYC(I) = RNCYC(I) - 1.0                                         CORE  458
      GO TO 402                                                         CORE  459
  401 RNCYC(I) = RNCYC(I) - 2.0                                         CORE  460
  402 KIND = 0                                                          CORE  461
      GO TO 415                                                         CORE  462
  410 X3 = SIGMAX(I)                                                    CORE  463
      X4 = SIGMIN(I)                                                    CORE  464
      IND3 = NSTEP(I)                                                   CORE  465
      IND4 = IND3                                                       CORE  466
      KMIN = 1                                                          CORE  467
      KMAX = 0                                                          CORE  468
      K31 = 0                                                           CORE  469
      KIND = 1                                                          CORE  470
      RNCYC(I) = RNCYC(I) - 1.0                                         CORE  471
      KB = 0                                                            CORE  472
  415  CYCNO = AINT(RNCYC(I)+0.5)                                       CORE  473
      CALL DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)                       CORE  474
      GO TO 1000                                                        CORE  475
```

```
 2000 LMAX = L                                                           CORE     476
      IF (LRMAX .LT. 4) GO TO 5000                                       CORE     477
      IF (NCYNO .EQ. 0) GO TO 5000                                       CORE     478
C                                                                        CORE     479
C     RANGE PAIR COUNT OF RESIDUE SPECTRUMS                              CORE     480
C                                                                        CORE     481
      NRES = NRES + 1                                                    CORE     482
      CALL DECRES(LRMAX,NCYNO)                                           CORE     483
      GO TO 2000                                                         CORE     484
 5000 IF (LRMAX .LE. 1) GO TO 3000                                       CORE     485
C                                                                        CORE     486
C     COUNT THE LAST RESIDUE SPECTRUM - RANGE PAIR COUNTING WILL YIELD N CORE     487
C     ADDITIONAL CYCLES                                                  CORE     488
C                                                                        CORE     489
      KK = 0                                                             CORE     490
      RESMAX = RES(1)                                                    CORE     491
      RESMIN = RES(1)                                                    CORE     492
      IMAX = 1                                                           CORE     493
      IMIN = 1                                                           CORE     494
      DO 500 I = 2,LRMAX                                                 CORE     495
      IF (RES(I) .LT. RESMAX) GO TO 490                                  CORE     496
      RESMAX = RES(I)                                                    CORE     497
      IMAX = I                                                           CORE     498
      GO TO 500                                                          CORE     499
  490 IF (RES(I) .GT. RESMIN) GO TO 500                                  CORE     500
      RESMIN = RES(I)                                                    CORE     501
      IMIN = I                                                           CORE     502
  500 CONTINUE                                                           CORE     503
      CALL CYCRES(RESMAX,RESMIN,1.0,INDEX(IMAX))                         CORE     504
      KK = KK + 1                                                        CORE     505
  510 J = IMAX - 2                                                       CORE     506
      IF (J .LE. 0) GO TO 550                                            CORE     507
      CALL CYCRES(RES(J),RES(J+1),1.0,INDEX(J))                          CORE     508
      KK = KK + 1                                                        CORE     509
      IMAX = J                                                           CORE     510
      GO TO 510                                                          CORE     511
  550 J = IMIN + 2                                                       CORE     512
      IF (J .GT. LRMAX) GO TO 575                                        CORE     513
      CALL CYCRES(RES(J-1),RES(J),1.0,INDEX(J-1))                        CORE     514
      KK = KK + 1                                                        CORE     515
      IMIN = J                                                           CORE     516
      GO TO 550                                                          CORE     517
  575 KMAX = KK                                                          CORE     518
      LMAX = L                                                           CORE     519
C                                                                        CORE     520
C     SORT THE ANALYSIS SPECTRUM TO PRODUCE THE RANGE PAIR COUNTED SPECT CORE     521
C                                                                        CORE     522
 3000 KP = 0                                                             CORE     523
      DO 605 JJ = 1,NPKS                                                 CORE     524
      KC = 0                                                             CORE     525
      DO 600 I = 1,LMAX                                                  CORE     526
      IF (NNSTEP(I) .NE. JJ) GO TO 600                                   CORE     527
      KP = KP + 1                                                        CORE     528
      KC = KC + 1                                                        CORE     529
      NSTEP(KP) = KP                                                     CORE     530
```

```
      SIGMAX(KP) = CYCLE(I,1)
      SIGMIN(KP) = CYCLE(I,2)
      RNCYC(KP) = RNECYC(I)
      IF (KC .LT. 2) GO TO 600
      IF (SIGMAX(KP) .NE. SIGMAX(KP-1)) GO TO 600
      IF (SIGMIN(KP) .NE. SIGMIN(KP-1)) GO TO 600
  595 KP = KP - 1
      RNCYC(KP) = RNCYC(KP) + 1.0
  600 CONTINUE
  605 CONTINUE
      KPMAX = KP
      IF(IPRINT.GE.2)GO TO 104
      WRITE(6,2010)
 2010 FORMAT(1H1,48X,33HRANGE PAIR CYCLE COUNTED SPECTRUM//)
      WRITE(6,22)
      WRITE(6,25)  (NSTEP(I),SIGMAX(I),SIGMIN(I),RNCYC(I),I = 1,KPMAX)
  102 FORMAT(5X,3F10.2)
 104  CONTINUE
      END
```

```
      SUBROUTINE CYCGEN(Y1,Y2,  CYCPF,NSTEPP)                           CORE     550
      COMMON/MCYG/CYCLE(200,2),RNECYC(200),NNSTEP(200)                  CORE     551
      COMMON/MCGDE/L,LIND                                               CORE     552
C                                                                       CORE     553
C     THIS SUBROUTINE GENERATES CYCLES FOR THE ANALYSIS SPECTRUM FROM DA CORE     554
C     SUPPLIED BY SUBROUTINE DECIDE                                     CORE     555
C                                                                       CORE     556
      LIND = 0                                                          CORE     557
      L = L + 1                                                         CORE     558
      CYCLE(L,1) = Y1                                                   CORE     559
      CYCLE(L,2) = Y2                                                   CORE     560
      RNECYC(L) = CYCPF                                                 CORE     561
      NNSTEP(L) = NSTEPP                                                CORE     562
      IF (L .EQ. 1) GO TO 100                                           CORE     563
      IF (CYCLE(L-1,1) .NE. CYCLE(L,1)) GO TO 100                       CORE     564
      IF (CYCLE(L-1,2) .NE. CYCLE(L,2)) GO TO 100                       CORE     565
   10 L = L - 1                                                         CORE     566
      RNECYC(L) = RNECYC(L) + 1.0                                       CORE     567
      LIND = 1                                                          CORE     568
  100 RETURN                                                            CORE     569
      END                                                               CORE     570
```

SUBROUTINE DECIDE CDC 6600 FTN V3.0-367A OPT=1 04/26/74 10.40.58. PAGE 1

```
      SUBROUTINE DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)
      COMMON/MDEC1/SIGMAX(200),SIGMIN(200)
      COMMON/MDEC2/NSTEP(200),LR,KMAX,KMIN,K31
      COMMON/MDECR/RES(450),INDEX(450),IND1,IND2,IND3,IND4,KIND
      COMMON/MCYG/CYCLE(200,2),RNECYC(200),NNSTEP(200)
      COMMON/MCGDE/L,LIND
C
C     THIS SUBROUTINE DECIDES WHETHER OR NOT THE VALUES X1,X2,X3, AND X4
C     FROM THE ADJUSTED LOAD SPECTRUM SATISFY THE RANGE PAIR COUNTING CO
C
      KFIRST = 0
      IF (K31 .NE. 0) GO TO 11
   10 IF (X3 .LE. X2) GO TO 200
   11 IF (X2 .GT. X1) GO TO 210
      IF (X2 .LT. X4 .OR. X3 .GT. X1) GO TO 500
  150 IF (X2 .GT. X3) GO TO 151
      CALL CYCGEN(X3,X2,1.0,NSTEP(I))
      GO TO 152
  151 CALL CYCGEN(X2,X3,  1.0,NSTEP(I))
  152 X1 = X1
      X2 = X4
      IF (IND3 .NE. IND2) LIND = 1
      IND2 = IND4
      KCYGEN = 1
      IF (KEY .NE. 0) GO TO 110
      RETURN
  210 IF (X2 .GT. X4 .OR. X3 .LT. X1) GO TO 500
      GO TO 150
  200 X1 = X1
      X2 = X4
      IND2 = IND4
      KCYGEN = 2
      IF (KEY .EQ. 0) RETURN
      CYCNO = CYCNO - 1.0
      GO TO 110
C
C     ADD X1 TO THE RESIDUE SPECTRUM
C
  500 LR = LR + 1
      RES(LR) = X1
      INDEX(LR) = IND1
      X1 = X2
      X2 = X3
      X3 = X4
      IND1 = IND2
      IND2 = IND3
      IND3 = IND4
      KCYGEN = 3
      IF (KEY .NE. 0) GO TO 110
      RETURN
  110 GO TO (1150,1200,1500),KCYGEN
 1150 IF (CYCNO .GT. 1.0) GO TO 1151
      IF(CYCNO .LE. 0.0) RETURN
 1153 CYCNO = CYCNO - 1.0
      GO TO 1152
```

```
 1151 IF (LIND .EQ. 1) GO TO 1153                                   CORE   626
      IF (IND3 .NE. IND4) GO TO 1153                                CORE   627
      RNECYC(L) = RNECYC(L) + CYCNO - 2.0                           CORE   628
      CYCNO = 1.0                                                   CORE   629
 1152 IF (KMAX .NE. 1) GO TO 111                                    CORE   630
      X3 = SIGMIN(I)                                                CORE   631
      IND3 = NSTEP(I)                                               CORE   632
      IF (CYCNO .GT.0.0) GO TO 112                                  CORE   633
      KMIN = 1                                                      CORE   634
      KMAX = 0                                                      CORE   635
      KCYGEN = 3                                                    CORE   636
      RETURN                                                        CORE   637
 1200 IF(CYCNO .LE. 0.0) RETURN                                     CORE   638
      CYCNO = CYCNO - 1.0                                           CORE   639
      X3 = SIGMAX(I)                                                CORE   640
      X4 = SIGMIN(I)                                                CORE   641
      KFIRST = 1                                                    CORE   642
      GO TO 113                                                     CORE   643
  111 X3 = SIGMAX(I)                                                CORE   644
      X4 = SIGMIN(I)                                                CORE   645
      IF (KFIRST .NE. 0) GO TO 113                                  CORE   646
      CYCNO = CYCNO - 1.0                                           CORE   647
      KFIRST = 1                                                    CORE   648
  113 IND3 = NSTEP(I)                                               CORE   649
      IND4 = IND3                                                   CORE   650
      KMIN = 1                                                      CORE   651
      KMAX = 0                                                      CORE   652
      GO TO 10                                                      CORE   653
 1500 IF (KMAX .NE. 0) GO TO 1510                                   CORE   654
      IF(CYCNO .LE. 0.0) RETURN                                     CORE   655
      CYCNO = CYCNO - 1.0                                           CORE   656
  112 X4 = SIGMAX (I)                                               CORE   657
      IND4 = NSTEP(I)                                               CORE   658
      KMAX = 1                                                      CORE   659
      KMIN = 0                                                      CORE   660
      GO TO 11                                                      CORE   661
 1510 X4 = SIGMIN(I)                                                CORE   662
      IND4 = NSTEP(I)                                               CORE   663
      KMAX = 0                                                      CORE   664
      KMIN = 1                                                      CORE   665
      GO TO 10                                                      CORE   666
      END                                                           CORE   667
```

```
      SUBROUTINE DECRES(LRMAX,NCYNO)
      COMMON/MCGDE/L,LIND
      COMMON/MDECR/RES(450),INDEX(450),IND1,IND2,IND3,IND4,KIND
C
C     THIS SUBROUTINE DECIDES WHETHER OR NOT THE ELEMENTS OF THE RESIDUE
C     SPECTRUM SATISFY THE RANGE PAIR COUNTING CONDITIONS
C
      K = 0
      NCYNO = 0
      X1 = RES(1)
      X2 = RES(2)
      X3 = RES(3)
      X4 = RES(4)
      IND1 = INDEX(1)
      IND2 = INDEX(2)
      IND3 = INDEX(3)
      IND4 = INDEX(4)
      J = 4
   10 IF (X2 .GT. X1) GO TO 100
      IF (X2 .LT. X4 .OR. X3 .GT. X1) GO TO 500
  150 IF (X2 .GT. X3) GO TO 151
      CALL CYCRES(X3,X2,1.0,IND3)
      GO TO 152
  151 CALL CYCRES(X2,X3,1.0,IND2)
  152 NCYNO = NCYNO + 1
      X1 = X1
      X2 = X4
      IND2 = IND4
      IF (J .EQ. LRMAX) GO TO 300
      IF ((J + 1) .EQ. LRMAX) GO TO 315
      X3 = RES(J+1)
      X4 = RES(J+2)
      IND3 = INDEX(J+1)
      IND4 = INDEX(J+2)
      J = J+2
      GO TO 10
  100 IF (X2 .GT. X4 .OR. X3 .LT. X1) GO TO 500
      GO TO 150
  500 K = K + 1
      RES(K) = X1
      INDEX(K) = IND1
      J = J + 1
      IF (J .GT. LRMAX) GO TO 330
      X1 = X2
      X2 = X3
      X3 = X4
      X4 = RES(J)
      IND1 = IND2
      IND2 = IND3
      IND3 = IND4
      IND4 = INDEX(J)
      GO TO 10
  300 K = K + 1
      RES(K) = X1
      RES(K+1) = X2
```

```
      INDEX(K) = IND1                                  CORE     723
      INDEX(K+1) = IND2                                CORE     724
      LRMAX = K + 1                                    CORE     725
      RETURN                                           CORE     726
  315 K = K + 1                                        CORE     727
      RES(K) = X1                                      CORE     728
      RES(K+1) = X2                                    CORE     729
      RES(K+2) = RES(J+1)                              CORE     730
      INDEX(K) = IND1                                  CORE     731
      INDEX(K+1) = IND2                                CORE     732
      INDEX(K+2) = INDEX(J+1)                          CORE     733
      LRMAX = K + 2                                    CORE     734
      RETURN                                           CORE     735
  330 K = K + 1                                        CORE     736
      RES(K) = X2                                      CORE     737
      RES(K+1) = X3                                    CORE     738
      RES(K+2) = X4                                    CORE     739
      INDEX(K) = IND2                                  CORE     740
      INDEX(K+1) = IND3                                CORE     741
      INDEX(K+2) = IND4                                CORE     742
      LRMAX = K + 2                                    CORE     743
      RETURN                                           CORE     744
      END                                              CORE     745
```

```
      SUBROUTINE CYCRES(Y1,Y2,  CYCPF,NSTEPP)                           CORE   746
      COMMON/MCYG/CYCLE(200,2),RNECYC(200),NNSTEP(200)                  CORE   747
      COMMON/MCGDE/L,LIND                                               CORE   748
C                                                                       CORE   749
C     THIS SUBROUTINE GENERATES CYCLES FOR THE ANALYSIS SPECTRUM FROM DA CORE   750
C     SUPPLIED BY SUBROUTINE DECRES                                     CORE   751
C                                                                       CORE   752
      L = L + 1                                                         CORE   753
      CYCLE(L,1) = Y1                                                   CORE   754
      CYCLE(L,2) = Y2                                                   CORE   755
      RNECYC(L) = CYCPF                                                 CORE   756
      NNSTEP(L) = NSTEPP                                                CORE   757
      RETURN                                                            CORE   758
      END                                                               CORE   759
```

APPENDIX II

SAMPLE PROBLEM WITH INPUT DATA LISTING

```
1 DATA DECKS ARE TO BE PROCESSED.

SPECTRUM SUBJECTED TO THE RANGE-PAIR COUNTING TECHNIQUE
SEQUENCE ACCOUNTABLE FATIGUE EVALUATION
```

```
SPECTRUM FROM     B-1 SPECTRUM  --  TRUNCATION LEVEL  270,000 CYCLES
MATERIAL TYPE --  2219-T851 AL

TENSILE YIELD STRESS (KSI) --          55.00000

LCF STRAIN INTERCEPT =            .40000

INVERSE OF COFFIN-MANSON SLOPE          -1.83600

ELASTIC MODULUS =        10000.00000

COEFFICIENTS OF SECOND ORDER LEAST SQUARE FIT OF S-N DATA
     SMAX = A(I)*SMIN**2 + B(I)*SMIN + C(I)
     LIFE            A(I)              B(I)              C(I)
   10** 4           -.00217           .22041           55.82462
   10** 5           -.00178           .33210           48.26657
   10** 6           -.00149           .46283           39.66455
   10** 7           -.00243           .64199           31.70955

UNNOTCHED COUPON S-N DATA DERIVED FROM
INFORMATION SUPPLIED FROM  NORTH AMERICAN

RESIDUAL STRESS RELAXATION FUNCTION

     ENEP = C1/(KTSMAX**E1 * KTSMEAN**E2)
WHERE   C1 =  .25000000E+07 ,   E1 =     1.000 AND  E2 =     1.000

        7 TIMES THROUGH BLOCK OF        44 LOADS

     LOAD LIMIT =          26.90000
```

STEP	TYPE	STMIN	STMAX	ENN
1	1	-.14800	-.02900	1.00000
2	3	.58400	1.00000	1.00000
3	2	.58400	.89500	1.00000
4	1	.58400	.68400	1.00000
5	1	.45500	.58400	1.00000
6	1	.64800	.69300	1.00000
7	1	.39500	.69900	1.00000
8	1	.48800	.56300	3.00000
9	1	.23500	.50900	1.00000
10	1	.50900	.62700	2.00000
11	1	.43400	.50900	1.00000
12	1	.36400	.69000	1.00000
13	1	.13300	.36400	1.00000
14	1	.36400	.48200	6.00000
15	1	.30400	.36400	1.00000
16	1	.30700	.75600	1.00000
17	1	.31600	.52700	1.00000
18	2	.54500	.70800	1.00000
19	1	.33400	.61700	1.00000
20	1	.40100	.51200	7.00000
21	1	.12700	.54800	1.00000
22	1	.22900	.37700	48.00000
23	1	-.00600	.34000	1.00000
24	1	.13000	.24400	35.00000
25	1	.07800	.72300	1.00000
26	1	.11100	.55700	9.00000
27	1	.18700	.37700	10.00000
28	3	.52700	.99100	1.00000

29	2	-.12000	.88300	1.00000
30	1	.52700	.74700	1.00000
31	1	-.14900	-.02900	1.00000
32	1	.55700	.84600	1.00000
33	1	.50900	.88000	1.00000
34	1	.33100	.52700	1.00000
35	1	.52700	.61700	19.00000
36	1	.46400	.52700	2.00000
37	1	.48200	.81000	1.00000
38	1	.58100	.68700	1.00000
39	1	.32200	.70200	1.00000
40	1	.39500	.44900	9.00000
41	1	.43100	.59000	5.00000
42	1	.46100	.54500	29.00000
43	1	-.14800	-.02900	1.00000
44	1	-.13600	-.03900	1.00000

BLOCK	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE
1	1	-0	-0					
2	1	-0	-0					
3	2	1	-0					
4	1	-0	-0					
5	3	1	-0					
6	1	-0	-0					
7	1	-0	-0					

SPECTRUM FROM B-1 SPECTRUM -- TRUNCATION LEVEL 270,000 CYCLES

AKT = 4.50

RELAXATION CONSTANT C1= 2500000.00

SPECTRUM SUBJECTED TO THE RANGE-PAIR COUNTING TECHNIQUE
FLIGHT OR BLOCK NO. 1

STMAX	STMIN	SIGMAX	SIGMIN	RES	EQRES	ENN	NEP		
-.78	-3.98	-3.51	-17.92	0.00	0.00	1.00	.13025831E+05	1	1
18.40	15.71	55.00	42.89	0.00	-27.80	1.00	.39342782E+03	2	2
15.71	12.24	42.89	27.28	-27.80	-15.69	1.00	.56235689E+03	3	3
18.64	17.43	55.00	49.55	-27.75	-28.89	1.00	.36717948E+03	4	4
16.80	10.63	55.00	18.20	-28.89	-29.61	1.00	.44621680E+03	5	5
15.14	13.13	38.54	29.46	-29.61	-13.15	3.00	.57657259E+03	6	6
13.69	6.32	32.20	-.97	-29.42	-6.61	1.00	.90105168E+03	7	7
16.87	13.69	46.54	32.25	-29.36	-20.90	2.00	.47906511E+03	8	8
13.69	11.67	32.34	23.26	-29.28	-6.61	1.00	.71090397E+03	9	9
15.56	9.79	54.32	14.86	-29.21	-28.52	1.00	.46919213E+03	10	10
9.79	3.58	14.86	-13.10	-29.20	0.00	1.00	.18861779E+04	11	11
12.97	9.79	29.18	14.90	-29.17	-3.35	6.00	.83680259E+03	12	12
9.79	8.18	15.32	8.06	-28.74	0.00	1.00	.14033389E+04	13	13
20.34	8.26	55.00	.65	-28.70	-36.51	1.00	.42460525E+03	14	14
14.18	8.50	27.28	1.74	-36.51	-8.79	1.00	.76807252E+03	15	15
16.60	8.98	38.26	4.00	-36.43	-19.69	1.00	.58153350E+03	16	16
13.77	10.79	25.61	12.18	-36.36	-6.98	7.00	.72996103E+03	17	17
14.74	3.42	30.61	-20.35	-35.72	-11.34	1.00	.92247814E+03	18	18
10.14	6.16	9.97	-7.94	-35.66	0.00	48.00	.14935730E+04	19	19
RELAXATION		10.11	-7.81			4.80			19
RELAXATION		10.37	-7.55			4.80			20
RELAXATION		10.63	-7.29			4.80			21
RELAXATION		10.89	-7.03			4.80			22
RELAXATION		11.14	-6.77			4.80			23
RELAXATION		11.40	-6.52			4.80			24
RELAXATION		11.65	-6.27			4.80			25
RELAXATION		11.90	-6.02			4.80			26
RELAXATION		12.15	-5.77			4.80			27
RELAXATION		12.40	-5.52			4.80			28
9.15	-.16	8.04	-33.84	-33.12	0.00	1.00	.30047963E+04	20	29
6.56	3.50	-3.56	-17.36	-33.09	0.00	35.00	.37392025E+04	21	30
RELAXATION		-3.52	-17.32			3.50			30
RELAXATION		-3.45	-17.25			3.50			31
RELAXATION		-3.38	-17.18			3.50			32
RELAXATION		-3.31	-17.11			3.50			33
RELAXATION		-3.24	-17.04			3.50			34
RELAXATION		-3.17	-16.97			3.50			35
RELAXATION		-3.10	-16.90			3.50			36
RELAXATION		-3.03	-16.83			3.50			37
RELAXATION		-2.96	-16.76			3.50			38
RELAXATION		-2.89	-16.69			3.50			39
19.45	2.10	55.00	-23.08	-32.39	-32.52	1.00	.58920931E+03	22	40
14.93	2.99	34.91	-19.08	-32.52	-12.42	9.00	.91708325E+03	23	41
10.14	5.03	13.57	-9.43	-32.07	0.00	10.00	.16047965E+04	24	42
20.09	14.18	55.00	26.37	-31.61	-35.42	1.00	.35835054E+03	25	43
-.78	-3.98	-38.93	-53.34	-35.42	0.00	1.00	.13025831E+05	26	44
22.76	14.98	55.00	20.02	-35.42	-47.41	1.00	.28748314E+03	27	45
23.67	13.69	55.00	10.09	-47.41	-51.52	1.00	.27916148E+03	28	46
14.18	8.90	12.27	-11.46	-51.52	-8.79	1.00	.75464468E+03	29	47
16.60	14.18	23.29	12.40	-51.39	-19.69	19.00	.48342514E+03	30	48
RELAXATION		23.44	12.54			1.90			48
RELAXATION		23.72	12.83			1.90			49

RELAXATION		24.00	13.11			1.90			50
RELAXATION		24.28	13.39			1.90			51
RELAXATION		24.56	13.66			1.90			52
RELAXATION		24.83	13.94			1.90			53
RELAXATION		25.11	14.21			1.90			54
RELAXATION		25.37	14.48			1.90			55
RELAXATION		25.64	14.75			1.90			56
RELAXATION		25.91	15.01			1.90			57
14.18	12.48	15.14	7.52	-48.65	-8.79	2.00	.65336542E+03	31	58
21.79	12.97	49.68	9.98	-48.37	-43.05	1.00	.32605652E+03	32	59
18.48	15.63	34.83	22.00	-48.33	-28.16	1.00	.39170979E+03	33	60
18.88	8.66	36.76	-9.24	-48.21	-29.98	1.00	.47468264E+03	34	61
12.08	10.63	6.23	-.31	-48.13	0.00	9.00	.90043347E+03	35	62
15.87	11.59	24.39	5.14	-47.03	-16.42	5.00	.56645141E+03	36	63
14.66	12.40	19.56	9.39	-46.41	-10.97	29.00	.62236611E+03	37	64
RELAXATION		19.75	9.58			2.90			64
RELAXATION		20.12	9.95			2.90			65
RELAXATION		20.50	10.33			2.90			66
RELAXATION		20.86	10.70			2.90			67
RELAXATION		21.23	11.06			2.90			68
RELAXATION		21.59	11.42			2.90			69
RELAXATION		21.94	11.78			2.90			70
RELAXATION		22.30	12.13			2.90			71
RELAXATION		22.65	12.48			2.90			72
RELAXATION		22.99	12.82			2.90			73
-.78	-3.98	-40.60	-55.00	-42.81	0.00	1.00	.13025831E+05	38	74
-1.05	-3.66	-41.80	-53.54	-37.08	0.00	1.00	.14337171E+05	39	75

THE NUMBER OF PEAKS OR VALLEYS IN THE INPUT LOAD SPECTRUM = 75

	SIGMA		
STEP	MAXIMUM	MINIMUM	COUNTER K
1	-.351045E+01	-.179154E+02	1.00000
2	.550000E+02	.428950E+02	1.00000
3	.428950E+02	.272795E+02	1.00000
4	.550000E+02	.495527E+02	1.00000
5	.550000E+02	.182008E+02	1.00000
6	.385372E+02	.294585E+02	3.00000
7	.321966E+02	-.971139E+00	1.00000
8	.465387E+02	.322548E+02	2.00000
9	.323357E+02	.232570E+02	1.00000
10	.543191E+02	.148568E+02	1.00000
11	.148601E+02	-.131024E+02	1.00000
12	.291797E+02	.148958E+02	6.00000
13	.153186E+02	.805562E+01	1.00000
14	.550000E+02	.648550E+00	1.00000
15	.272796E+02	.173800E+01	1.00000
16	.382570E+02	.399989E+01	1.00000
17	.256130E+02	.121764E+02	7.00000
18	.306127E+02	-.203494E+02	1.00000
19	.101054E+02	-.781000E+01	4.80000
20	.103674E+02	-.754800E+01	4.80000
21	.106275E+02	-.728793E+01	4.80000
22	.108856E+02	-.702978E+01	4.80000
23	.111419E+02	-.677353E+01	4.80000
24	.113962E+02	-.651917E+01	4.80000
25	.116487E+02	-.626669E+01	4.80000
26	.118993E+02	-.501607E+01	4.80000
27	.121481E+02	-.576729E+01	4.80000
28	.123950E+02	-.552036E+01	4.80000
29	.803921E+01	-.338441E+02	1.00000
30	-.352099E+01	-.173203E+02	3.50000
31	-.344941E+01	-.172491E+02	3.50000
32	-.337838E+01	-.171781E+02	3.50000

33	-.330750E+01	-.171072E+02	3.50000
34	-.323678E+01	-.170365E+02	3.50000
35	-.316621E+01	-.169659E+02	3.50000
36	-.309579E+01	-.168955E+02	3.50000
37	-.302552E+01	-.168252E+02	3.50000
38	-.295540E+01	-.167551E+02	3.50000
39	-.288544E+01	-.166851E+02	3.50000
40	.550000E+02	-.230772E+02	1.00000
41	.349057E+02	-.190826E+02	9.00000
42	.135658E+02	-.943374E+01	10.00000
43	.550000E+02	.283690E+02	1.00000
44	-.389348E+02	-.533397E+02	1.00000
45	.550000E+02	.200165E+02	1.00000
46	.550000E+02	.100905E+02	1.00000
47	.122694E+02	-.114564E+02	1.00000
48	.234369E+02	.125424E+02	1.90000
49	.237213E+02	.128268E+02	1.90000
50	.240031E+02	.131036E+02	1.90000
51	.242824E+02	.133879E+02	1.90000
52	.245592E+02	.136647E+02	1.90000
53	.248335E+02	.139390E+02	1.90000
54	.251053E+02	.142108E+02	1.90000
55	.253747E+02	.144802E+02	1.90000
56	.256416E+02	.147471E+02	1.90000
57	.259062E+02	.150117E+02	1.90000
58	.151434E+02	.751720E+01	2.00000
59	.496805E+02	.997609E+01	1.00000
60	.348288E+02	.219975E+02	1.00000
61	.367628E+02	-.923622E+01	1.00000
62	.622539E+01	-.311306E+00	9.00000
63	.243886E+02	.514165E+01	5.00000
64	.197465E+02	.957830E+01	2.90000
65	.201228E+02	.995459E+01	2.90000
66	.204951E+02	.103269E+02	2.90000
67	.208634E+02	.106952E+02	2.90000
68	.212277E+02	.110595E+02	2.90000
69	.215882E+02	.114200E+02	2.90000
70	.219448E+02	.117766E+02	2.90000
71	.222977E+02	.121295E+02	2.90000
72	.226467E+02	.124785E+02	2.90000
73	.229920E+02	.128238E+02	2.90000
74	-.405950E+02	-.550000E+02	1.00000
75	-.417990E+02	-.535408E+02	1.00000

RANGE PAIR CYCLE COUNTED SPECTRUM

STEP	SIGMA MAXIMUM	SIGMA MINIMUM	COUNTER K
1	-.351045E+01	-.179154E+02	1.00000
2	.550000E+02	.272795E+02	1.00000
3	.550000E+02	.495527E+02	1.00000
4	.550000E+02	-.550000E+02	1.00000
5	.321966E+02	.294585E+02	1.00000
6	.465387E+02	.322548E+02	1.00000
7	.465387E+02	.232570E+02	1.00000
8	.323357E+02	.322548E+02	1.00000
9	.543191E+02	-.971139E+00	1.00000
10	.148601E+02	.148568E+02	1.00000
11	.291797E+02	.148958E+02	5.00000
12	.291797E+02	.805562E+01	1.00000
13	.153186E+02	.148958E+02	1.00000
14	.550000E+02	-.131024E+02	1.00000
15	.272796E+02	.173300E+01	1.00000
16	.382570E+02	.648550E+00	1.00000
17	.306127E+02	.121764E+02	1.00000
18	.101054E+02	-.781000E+01	5.00000
19	.103674E+02	-.754800E+01	5.00000
20	.106275E+02	-.728733E+01	5.00000
21	.108856E+02	-.702978E+01	5.00000
22	.111419E+02	-.677353E+01	5.00000
23	.113962E+02	-.651917E+01	5.00000
24	.116487E+02	-.626669E+01	5.00000
25	.118993E+02	-.601607E+01	5.00000
26	.121481E+02	-.576729E+01	5.00000
27	.123950E+02	-.552036E+01	4.00000
28	.123950E+02	-.203494E+02	1.00000
29	.803921E+01	-.552036E+01	1.00000
30	-.352059E+01	-.173203E+02	4.00000
31	-.344941E+01	-.172491E+02	4.00000
32	-.337838E+01	-.171781E+02	4.00000
33	-.330750E+01	-.171072E+02	4.00000
34	-.323678E+01	-.170365E+02	4.00000
35	-.316621E+01	-.169659E+02	4.00000
36	-.309579E+01	-.168955E+02	4.00000
37	-.302552E+01	-.168252E+02	4.00000
38	-.295540E+01	-.167551E+02	4.00000
39	-.288544E+01	-.166851E+02	4.00000
40	.550000E+02	-.190826E+02	1.00000
41	.135658E+02	-.943374E+01	10.00000
42	.550000E+02	-.338441E+02	1.00000
43	.550000E+02	.200165E+02	1.00000
44	.550000E+02	-.533397E+02	1.00000
45	.234369E+02	.125424E+02	2.00000
46	.237213E+02	.128268E+02	2.00000
47	.240031E+02	.131036E+02	2.00000
48	.242824E+02	.133879E+02	2.00000
49	.245592E+02	.136647E+02	2.00000
50	.248335E+02	.139390E+02	2.00000
51	.251053E+02	.142108E+02	2.00000
52	.253747E+02	.144802E+02	2.00000
53	.256416E+02	.147471E+02	2.00000
54	.259062E+02	.150117E+02	1.00000
55	.259062E+02	.751720E+01	1.00000
56	.151434E+02	.150117E+02	1.00000

57	.151434E+02	.751720E+01	1.00000
58	.496805E+02	-.114564E+02	1.00000
59	.348288E+02	.219975E+02	1.00000
60	.367628E+02	.997609E+01	1.00000
61	.243886E+02	.514165E+01	4.00000
62	.243886E+02	-.311306E+00	1.00000
63	.197465E+02	.357830E+01	3.00000
64	.201228E+02	.995459E+01	3.00000
65	.204951E+02	.103269E+02	3.00000
66	.208634E+02	.106952E+02	3.00000
67	.212277E+02	.110595E+02	3.00000
68	.215882E+02	.114200E+02	3.00000
69	.219448E+02	.117766E+02	3.00000
70	.222977E+02	.121295E+02	3.00000
71	.226467E+02	.124785E+02	3.00000
72	.229920E+02	.128238E+02	2.00000
73	.229920E+02	.514165E+01	1.00000
74	-.417990E+02	-.535408E+02	1.00000

LOCAL STRESSES AND PLASTIC STRAINS W/RESULTING FATIGUE LIFE

STEP	PLASTIC STRAIN	MAX OR MIN	DAMAGE
2	.00636	MAX	.589085E-03
4	.00035	MAX	.236703E-05
5	.00022	MAX	.105771E-05
14	.00249	MAX	.891548E-04
22	.00004	MAX	.498022E-07
25	.00123	MAX	.242990E-04
27	.00420	MAX	.233133E-03
28	.00156	MAX	.379281E-04
38	.00063	MIN	.718916E-05

DAMAGE FROM PLASTIC STRAINS= .98426328E-03

SIGMAX	SIGMIN	RNCYC	CYCLES	ENN/CYC
-3.51	-17.92	1.	.10000000E+10	.10000000E-08
55.00	27.28	1.	.14807856E+06	.67531722E-05
55.00	49.55	1.	.69900694E+09	.14306010E-08
55.00	-55.00	1.	.10000000E+05	.10000000E-03
32.20	29.46	1.	.46901918E+12	.21321090E-11
46.54	32.25	1.	.11536870E+09	.86678619E-08
46.54	23.26	1.	.51785551E+07	.19310405E-06
32.34	32.25	1.	.36726287E+13	.27228454E-12
54.32	-.97	1.	.14931857E+05	.66970305E-04
14.86	14.86	1.	.50066416E+12	.19973463E-11
29.18	14.90	5.	.12665797E+10	.39476395E-08
29.18	8.06	1.	.14052164E+09	.71163418E-08
15.32	14.90	1.	.42187482E+12	.23703714E-11
55.00	-13.10	1.	.10000000E+05	.10000000E-03
27.28	1.74	1.	.53004668E+08	.18866263E-07
38.26	.65	1.	.17454008E+07	.57293429E-06
30.61	12.18	1.	.27966528E+09	.35757031E-08
10.11	-7.81	5.	.10000000E+10	.50000000E-08
10.37	-7.55	5.	.10000000E+10	.50000000E-08
10.63	-7.29	5.	.10000000E+10	.50000000E-08
10.89	-7.03	5.	.10000000E+10	.50000000E-08
11.14	-6.77	5.	.56054816E+09	.89198403E-08
11.40	-6.52	5.	.56088584E+09	.89144700E-08
11.65	-6.27	5.	.56115089E+09	.89102593E-08
11.90	-6.02	5.	.56134367E+09	.89071993E-08
12.15	-5.77	5.	.56146456E+09	.89052816E-08
12.40	-5.52	4.	.56151397E+09	.71235984E-08
12.40	-20.35	1.	.27376289E+08	.36527961E-07
8.04	-5.52	1.	.10000000E+10	.10000000E-08
-3.52	-17.32	4.	.10000000E+10	.40000000E-08
-3.45	-17.25	4.	.10000000E+10	.40000000E-08

-3.38	-17.18	4.	.10000000E+10	.40000000E-08
-3.31	-17.11	4.	.10000000E+10	.40000000E-08
-3.24	-17.04	4.	.10000000E+10	.40000000E-08
-3.17	-16.97	4.	.10000000E+10	.40000000E-08
-3.10	-16.90	4.	.10000000E+10	.40000000E-08
-3.03	-16.83	4.	.10000000E+10	.40000000E-08
-2.96	-16.76	4.	.10000000E+10	.40000000E-08
-2.89	-16.69	4.	.10000000E+10	.40000000E-08
55.00	-19.08	1.	.10000000E+05	.10000000E-03
13.57	-9.43	10.	.16603817E+09	.60227117E-07
55.00	-33.84	1.	.10000000E+05	.10000000E-03
55.00	20.02	1.	.63546690E+05	.15736461E-04
55.00	-53.34	1.	.10000000E+05	.10000000E-03
23.44	12.54	2.	.52786328E+10	.37888599E-09
23.72	12.83	2.	.52805280E+10	.37875000E-09
24.00	13.11	2.	.52807566E+10	.37873361E-09
24.28	13.39	2.	.52793259E+10	.37883625E-09
24.56	13.66	2.	.52762450E+10	.37905745E-09
24.83	13.94	2.	.52715248E+10	.37939687E-09
25.11	14.21	2.	.52651779E+10	.37985421E-09
25.37	14.48	2.	.52572184E+10	.38042931E-09
25.64	14.75	2.	.52476624E+10	.38112208E-09
25.91	15.01	1.	.52365271E+10	.19096626E-09
25.91	7.52	1.	.37589154E+09	.26603419E-08
15.14	15.01	1.	.48307951E+12	.20700526E-11
15.14	7.52	1.	.15515977E+11	.64449697E-10
49.68	-11.46	1.	.24152055E+05	.41404344E-04
34.83	22.00	1.	.15814258E+10	.63234078E-09
36.76	9.98	1.	.15038306E+08	.66496353E-07
24.39	5.14	4.	.31310615E+09	.12775220E-07
24.39	-.31	1.	.77428372E+08	.12915152E-07
19.75	9.58	3.	.67337984E+10	.44551379E-09
20.12	9.95	3.	.67798754E+10	.44248601E-09
20.50	10.33	3.	.68230691E+10	.43968484E-09
20.86	10.70	3.	.68633296E+10	.43710563E-09
21.23	11.06	3.	.69006119E+10	.43474405E-09
21.59	11.42	3.	.69348755E+10	.43259609E-09
21.94	11.78	3.	.69660846E+10	.43065799E-09
22.30	12.13	3.	.69942085E+10	.42892630E-09
22.65	12.48	3.	.70192214E+10	.42739783E-09
22.99	12.82	2.	.70411021E+10	.28404644E-09
22.99	5.14	1.	.49378912E+09	.20251560E-08
-41.80	-53.54	1.	.10000000E+10	.10000000E-08

DAMAGE PER THIS SET= .16162546E-02

TOTAL ENN/CYC =, .16162546E-02

FLIGHT OR BLOCK NO. 2

STMAX	STMIN	SIGMAX	SIGMIN	RES	EQRES	ENN	NEP		
-.78	-3.98	-40.58	-54.99	-37.07	0.00	1.00	.13025831E+05	1	1
18.40	15.71	45.73	33.63	-37.07	-27.80	1.00	.39342782E+03	2	2
15.71	12.24	33.68	18.07	-37.01	-15.69	1.00	.56235689E+03	3	3
18.64	17.43	46.96	41.52	-36.92	-28.89	1.00	.36717948E+03	4	4
18.80	10.63	47.74	10.94	-36.87	-29.61	1.00	.44621680E+03	5	5
15.14	13.13	31.31	22.24	-36.84	-13.15	3.00	.57667259E+03	6	6
13.69	6.32	25.06	-8.11	-36.55	-6.61	1.00	.90105168E+03	7	7
16.87	13.69	39.42	25.14	-36.48	-20.90	2.00	.47906511E+03	8	8
13.69	11.67	25.29	16.21	-36.33	-6.61	1.00	.71090397E+03	9	9
18.56	9.79	47.29	7.83	-36.23	-28.52	1.00	.46919213E+03	10	10
9.79	3.58	7.87	-20.10	-36.20	0.00	1.00	.18851779E+04	11	11
12.97	9.79	22.20	7.91	-36.15	-3.35	6.00	.83680259E+03	12	12
9.79	8.18	8.45	1.19	-35.61	0.00	1.00	.14033389E+04	13	13
20.34	8.26	55.00	.65	-35.56	-36.51	1.00	.42460525E+03	14	14
14.18	8.50	27.28	1.74	-36.51	-8.79	1.00	.76807252E+03	15	15
16.60	8.98	38.26	4.00	-36.43	-19.69	1.00	.58153350E+03	16	16
13.77	10.79	25.61	12.18	-36.36	-6.98	7.00	.72996103E+03	17	17

14.74	3.42	30.61	-20.35	-35.72	-11.34	1.00	.92247814E+03	18	18
10.14	6.16	9.97	-7.94	-35.66	0.00	48.00	.14935730E+04	19	19
RELAXATION		10.11	-7.81			4.80			19
RELAXATION		10.37	-7.55			4.80			20
RELAXATION		10.63	-7.29			4.80			21
RELAXATION		10.89	-7.03			4.80			22
RELAXATION		11.14	-6.77			4.80			23
RELAXATION		11.40	-6.52			4.80			24
RELAXATION		11.65	-6.27			4.80			25
RELAXATION		11.90	-6.02			4.80			26
RELAXATION		12.15	-5.77			4.80			27
RELAXATION		12.40	-5.52			4.80			28
9.15	-.16	8.04	-33.84	-33.12	0.00	1.00	.30047963E+04	20	29
6.56	3.50	-3.56	-17.36	-33.09	0.00	35.00	.37392025E+04	21	30
RELAXATION		-3.52	-17.32			3.50			30
RELAXATION		-3.45	-17.25			3.50			31
RELAXATION		-3.38	-17.18			3.50			32
RELAXATION		-3.31	-17.11			3.50			33
RELAXATION		-3.24	-17.04			3.50			34
RELAXATION		-3.17	-16.97			3.50			35
RELAXATION		-3.10	-16.90			3.50			36
RELAXATION		-3.03	-16.83			3.50			37
RELAXATION		-2.96	-16.76			3.50			38
RELAXATION		-2.89	-16.69			3.50			39
13.45	2.10	55.00	-23.08	-32.39	-32.52	1.00	.58920931E+03	22	40
14.98	2.99	34.91	-19.08	-32.52	-12.42	9.00	.91708325E+03	23	41
10.14	5.03	13.57	-9.43	-32.07	0.00	10.00	.16047965E+04	24	42
20.09	14.18	55.00	28.37	-31.61	-35.42	1.00	.35855054E+03	25	43
-.78	-3.98	-38.93	-53.34	-35.42	0.00	1.00	.13025831E+05	26	44
22.76	14.98	55.00	20.02	-35.42	-47.41	1.00	.28748314E+03	27	45
23.67	13.69	55.00	10.09	-47.41	-51.52	.00	.27916148E+03	28	46
14.18	8.90	12.27	-11.46	-51.52	-8.79	1.00	.75464468E+03	29	47
16.60	14.18	23.29	12.40	-51.39	-19.69	19.00	.48342514E+03	30	48
RELAXATION		23.44	12.54			1.90			48
RELAXATION		23.72	12.83			1.90			49
RELAXATION		24.00	13.11			1.90			50
RELAXATION		24.28	13.39			1.90			51
RELAXATION		24.56	13.66			1.90			52
RELAXATION		24.83	13.94			1.90			53
RELAXATION		25.11	14.21			1.90			54
RELAXATION		25.37	14.48			1.90			55
RELAXATION		25.64	14.75			1.90			56
RELAXATION		25.91	15.01			1.90			57
14.18	12.48	15.14	7.52	-48.65	-8.79	2.00	.65336542E+03	31	58
21.79	12.97	49.68	9.98	-48.37	-43.05	1.00	.32605652E+03	32	59
18.48	15.63	34.83	22.00	-48.33	-28.16	1.00	.39170979E+03	33	60
18.88	8.66	36.76	-9.24	-48.21	-29.98	1.00	.47468264E+03	34	61
12.08	10.63	6.23	-.31	-48.13	0.00	9.00	.90043347E+03	35	62
15.87	11.59	24.39	5.14	-47.03	-16.42	5.00	.56645141E+03	36	63
14.66	12.40	19.56	9.39	-46.41	-10.97	29.00	.62236611E+03	37	64
RELAXATION		19.75	9.58			2.90			64
RELAXATION		20.12	9.95			2.90			65
RELAXATION		20.50	10.33			2.90			66
RELAXATION		20.86	10.70			2.90			67
RELAXATION		21.23	11.06			2.90			68
RELAXATION		21.59	11.42			2.90			69
RELAXATION		21.94	11.78			2.90			70
RELAXATION		22.30	12.13			2.90			71
RELAXATION		22.65	12.48			2.90			72
RELAXATION		22.99	12.82			2.90			73
-.78	-3.98	-40.60	-55.00	-42.81	0.00	1.00	.13025831E+05	38	74
-1.05	-3.66	-41.80	-53.54	-37.08	0.00	1.00	.14337171E+05	39	75

LOCAL STRESSES AND PLASTIC STRAINS W/RESULTING FATIGUE LIFE

STEP	PLASTIC STRAIN	MAX OR MIN	DAMAGE
14	.00032	MAX	.202856E-05
22	.00004	MAX	.498022E-07
25	.00123	MAX	.242990E-04
27	.00420	MAX	.233133E-03
28	.00156	MAX	.379281E-04
38	.00063	MIN	.718916E-05

DAMAGE FROM PLASTIC STRAINS= .30462764E-03

SIGMAX	SIGMIN	RNCYC	CYCLES	ENN/CYC
-40.58	-54.99	1.	.10000000E+10	.10000000E-08
45.73	18.07	1.	.24093777E+07	.41504493E-06
33.68	33.63	1.	.43206072E+13	.23144895E-12
46.96	41.52	1.	.23661145E+11	.42263381E-10
47.74	-20.10	1.	.19780666E+05	.50554416E-04
25.06	22.24	1.	.27937764E+12	.35793846E-11
39.42	25.14	1.	.50516846E+09	.19795377E-08
39.42	16.21	1.	.24432813E+08	.40928567E-07
25.29	25.14	1.	.15753982E+13	.63476016E-12
47.23	-8.11	1.	.58801786E+05	.17006285E-04
7.87	7.83	1.	.10000000E+10	.10000000E-08
22.20	7.91	5.	.15461310E+10	.32338787E-08
22.20	1.19	1.	.21206560E+09	.47155219E-08
8.45	7.91	1.	.10000000E+10	.10000000E-08
55.00	-53.34	1.	.10000000E+05	.10000000E-03
27.28	1.74	1.	.53004668E+08	.18866263E-07
38.26	.65	1.	.17454008E+07	.57293429E-06
30.61	12.18	1.	.27966528E+09	.35757031E-08
10.11	-7.81	5.	.10000000E+10	.50000000E-08
10.37	-7.55	5.	.10000000E+10	.50000000E-08
10.63	-7.29	5.	.10000000E+10	.50000000E-08
10.89	-7.03	5.	.10000000E+10	.50000000E-08
11.14	-6.77	5.	.56054816E+09	.89198403E-08
11.40	-6.52	5.	.56088584E+09	.89144700E-08
11.65	-6.27	5.	.56115089E+09	.89102593E-08
11.90	-6.02	5.	.56134367E+09	.89071993E-08
12.15	-5.77	5.	.56146456E+09	.89052816E-08
12.40	-5.52	4.	.56151397E+09	.71235984E-08
12.40	-20.35	1.	.27376289E+08	.36527961E-07
8.04	-5.52	1.	.10000000E+10	.10000000E-08
-3.52	-17.32	4.	.10000000E+10	.40000000E-08
-3.45	-17.25	4.	.10000000E+10	.40000000E-08
-3.38	-17.18	4.	.10000000E+10	.40000000E-08
-3.31	-17.11	.	.10000000E+10	.40000000E-08
-3.24	-17.04	.	.10000000E+10	.40000000E-08
-3.17	-16.97	.	.10000000E+10	.40000000E-08
-3.10	-16.90	4.	.10000000E+10	.40000000E-08
-3.03	-16.83	4.	.10000000E+10	.40000000E-08
-2.96	-16.76	4.	.10000000E+10	.40000000E-08
-2.89	-16.69	4.	.10000000E+10	.40000000E-08
55.00	-19.08	1.	.10000000E+05	.10000000E-03
13.57	-9.43	10.	.16603817E+09	.60227117E-07
55.00	-33.84	1.	.10000000E+05	.10000000E-03
55.00	20.02	1.	.63546690E+05	.15736461E-04
55.00	-55.00	1.	.10000000E+05	.10000000E-03
23.44	12.54	2.	.52786328E+10	.37888539E-09
23.72	12.83	2.	.52805280E+10	.37875000E-09
24.00	13.11	2.	.52807566E+10	.37873361E-09
24.28	13.39	2.	.52793259E+10	.37883625E-09
24.56	13.66	2.	.52762450E+10	.37905745E-09
24.83	13.94	2.	.52715248E+10	.37939687E-09
25.11	14.21	2.	.52651779E+10	.37985421E-09
25.37	14.48	2.	.52572184E+10	.38042931E-09
25.64	14.75	2.	.52476624E+10	.38112208E-09
25.91	15.01	1.	.52365271E+10	.19096626E-09
25.91	7.52	1.	.37589154E+09	.26603419E-08

15.14	15.01	1.	.48307951E+12	.20700526E-11
15.14	7.52	1.	.15515977E+11	.64449697E-10
49.68	-11.46	1.	.24152055E+05	.41404344E-04
34.83	22.00	1.	.15814258E+10	.63234078E-09
36.76	9.98	1.	.15038306E+08	.66496853E-07
24.39	5.14	4.	.31310615E+09	.12775220E-07
24.39	-.31	1.	.77428372E+08	.12915162E-07
19.75	9.58	3.	.67337984E+10	.44551379E-09
20.12	9.95	3.	.67798754E+10	.44248601E-09
20.50	10.33	3.	.68230691E+10	.43968484E-09
20.86	10.70	3.	.68633296E+10	.43710563E-09
21.23	11.06	3.	.69006119E+10	.43474405E-09
21.59	11.42	3.	.69348755E+10	.43259609E-09
21.94	11.78	3.	.69660846E+10	.43065799E-09
22.30	12.13	3.	.69942085E+10	.42892630E-09
22.65	12.48	3.	.70192214E+10	.42739783E-09
22.99	12.82	2.	.70411021E+10	.28404644E-09
22.99	5.14	1.	.49378912E+09	.20251560E-08
-41.80	-53.54	1.	.10000000E+10	.10000000E-08

DAMAGE PER THIS SET= .83070929E-03

TOTAL ENN/CYC =, .24469639E-02

FLIGHT OR BLOCK NO. 3

STMAX	STMIN	SIGMAX	SIGMIN	RES	EQRES	ENN	NEP		
-.78	-3.98	-40.58	-54.99	-37.07	0.00	1.00	.13025831E+05	1	1
24.08	15.71	55.00	17.35	-37.07	-53.34	1.00	.25777999E+03	2	2
18.40	15.71	29.46	17.35	-53.34	-27.80	1.00	.39342782E+03	3	3
15.71	12.24	17.50	1.89	-53.19	-15.69	1.00	.56235689E+03	4	4
18.64	17.43	30.85	25.40	-53.04	-28.89	1.00	.36717948E+03	5	5
18.30	10.63	31.73	-5.07	-52.89	-29.61	1.00	.44621680E+03	6	6
15.14	13.13	15.38	6.31	-52.77	-13.15	3.00	.57667259E+03	7	7
13.69	6.32	9.32	-23.85	-52.29	-6.61	1.00	.90105168E+03	8	8
16.87	13.69	23.72	9.44	-52.18	-20.90	2.00	.47906511E+03	9	9
13.69	11.67	9.74	.66	-51.88	-6.61	1.00	.71090397E+03	10	10
18.56	9.79	31.79	-7.67	-51.73	-28.52	1.00	.46919213E+03	11	11
9.79	3.58	-7.56	-35.52	-51.62	0.00	1.00	.18861779E+04	12	12
12.97	9.79	6.79	-7.49	-51.56	-3.35	6.00	.83680259E+03	13	13
9.79	8.18	-6.70	-13.97	-50.77	0.00	1.00	.14033389E+04	14	14
20.34	8.26	40.83	-13.52	-50.68	-36.51	1.00	.42460525E+03	15	15
14.18	8.50	13.19	-12.35	-50.61	-8.79	1.00	.76807252E+03	16	16
19.05	14.66	35.22	15.49	-50.48	-30.70	1.00	.38464145E+03	17	17
16.50	8.98	24.32	-9.93	-50.36	-19.69	1.00	.58153350E+03	18	18
13.77	10.79	11.74	-1.70	-50.24	-6.98	7.00	.72996103E+03	19	19
14.74	3.42	17.04	-33.92	-49.30	-11.34	1.00	.92247814E+03	20	20
10.14	6.16	-3.57	-21.48	-49.20	0.00	48.00	.14935730E+04	21	21
RELAXATION		-3.39	-21.30			4.80			21
RELAXATION		-3.02	-20.94			4.80			22
RELAXATION		-2.66	-20.58			4.80			23
RELAXATION		-2.31	-20.22			4.80			24
RELAXATION		-1.96	-19.87			4.80			25
RELAXATION		-1.60	-19.52			4.80			26
RELAXATION		-1.26	-19.17			4.80			27
RELAXATION		-.91	-18.83			4.80			28
RELAXATION		-.57	-18.48			4.80			29
RELAXATION		-.23	-18.14			4.80			30
9.15	-.16	-4.54	-46.42	-45.69	0.00	1.00	.30047963E+04	22	31
6.56	3.50	-16.12	-29.92	-45.66	0.00	35.00	.37392025E+04	23	32
RELAXATION		-16.07	-29.87			3.50			32
RELAXATION		-15.97	-29.77			3.50			33
RELAXATION		-15.88	-29.68			3.50			34
RELAXATION		-15.78	-29.58			3.50			35
RELAXATION		-15.68	-29.48			3.50			36
RELAXATION		-15.58	-29.38			3.50			37
RELAXATION		-15.49	-29.29			3.50			38
RELAXATION		-15.39	-29.19			3.50			39

RELAXATION		-15.29	-29.09			3.50			40
RELAXATION		-15.20	-29.00			3.50			41
19.45	2.10	42.84	-35.24	-44.68	-32.52	1.00	.58920931E+03	24	42
14.98	2.99	22.79	-31.20	-44.64	-12.42	9.00	.91708325E+03	25	43
10.14	5.03	1.72	-21.28	-43.92	0.00	10.00	.16047965E+04	26	44
23.75	-3.23	60.71	-60.71	-43.29	-51.89	1.00	.50647169E+03	27	45
20.09	14.18	44.22	17.59	-46.21	-35.42	1.00	.35855054E+03	28	46
-.78	-3.98	-40.60	-55.00	-46.14	0.00	1.00	.13025831E+05	29	47
22.76	14.98	55.00	20.02	-37.08	-47.41	1.00	.28748314E+03	30	48
23.67	13.69	55.00	10.09	-47.41	-51.52	1.00	.27916148E+03	31	49
14.18	8.90	12.27	-11.46	-51.52	-8.79	1.00	.75464468E+03	32	50
16.50	14.18	23.29	12.40	-51.39	-19.69	19.00	.48342514E+03	33	51
RELAXATION		23.44	12.54			1.90			51
RELAXATION		23.72	12.83			1.90			52
RELAXATION		24.00	13.11			1.90			53
RELAXATION		24.28	13.39			1.90			54
RELAXATION		24.56	13.66			1.90			55
RELAXATION		24.83	13.94			1.90			56
RELAXATION		25.11	14.21			1.90			57
RELAXATION		25.37	14.48			1.90			58
RELAXATION		25.64	14.75			1.90			59
RELAXATION		25.91	15.01			1.90			60
14.18	12.48	15.14	7.52	-48.65	-8.79	2.00	.65336542E+03	34	61
21.79	12.97	49.68	9.98	-48.37	-43.05	1.00	.32605652E+03	35	62
18.48	15.63	34.83	22.00	-48.33	-28.16	1.00	.39170979E+03	36	63
18.88	8.66	36.76	-9.24	-48.21	-29.98	1.00	.47468264E+03	37	64
12.08	10.63	6.23	-.31	-48.13	0.00	9.00	.90043347E+03	38	65
15.87	11.59	24.39	5.14	-47.03	-16.42	5.00	.56645141E+03	39	66
14.66	12.40	19.56	9.39	-46.41	-10.97	29.00	.62236611E+03	40	67
RELAXATION		19.75	9.58			2.90			67
RELAXATION		20.12	9.95			2.90			68
RELAXATION		20.50	10.33			2.90			69
RELAXATION		20.86	10.70			2.90			70
RELAXATION		21.23	11.06			2.90			71
RELAXATION		21.59	11.42			2.90			72
RELAXATION		21.94	11.78			2.90			73
RELAXATION		22.30	12.13			2.90			74
RELAXATION		22.65	12.48			2.90			75
RELAXATION		22.99	12.82			2.90			76
-.78	-3.98	-40.60	-55.00	-42.81	0.00	1.00	.13025831E+05	41	77
-1.05	-3.66	-41.80	-53.54	-37.08	0.00	1.00	.14337171E+05	42	78

LOCAL STRESSES AND PLASTIC STRAINS W/RESULTING FATIGUE LIFE

STEP	PLASTIC STRAIN	MAX OR MIN	DAMAGE
2	.00593	MAX	.438461E-03
27	.00321	MAX	.141845E-03
29	.00105	MIN	.183981E-04
30	.00365	MAX	.180144E-03
31	.00156	MAX	.379281E-04
41	.00063	MIN	.718916E-05

DAMAGE FROM PLASTIC STRAINS= .82396546E-03

SIGMAX	SIGMIN	RNCY	CYCLES	ENN/CYC
-40.58	-54.99	1.	.10000000E+10	.10000000E-08
55.00	-46.42	1.	.10000000E+05	.10000000E-03
29.46	17.35	1.	.29397878E+10	.34016060E-09
17.50	17.35	1.	.63030870E+12	.15872797E-11
30.85	25.40	1.	.77590688E+11	.12888145E-10
31.73	1.89	1.	.14305010E+08	.69905579E-07
9.32	6.31	1.	.10000000E+10	.10000000E-08
23.72	9.44	1.	.15092544E+10	.66257884E-09
23.72	.66	1.	.11830863E+09	.84524691E-08
9.74	9.44	1.	.10000000E+10	.10000000E-08
31.79	-23.85	1.	.46704942E+06	.21411011E-05

-7.56	-7.67	1.	.10000000E+10	.10000000E-08
6.79	-7.49	5.	.10000000E+10	.50000000E-08
6.79	-13.97	1.	.10000000E+10	.10000000E-08
-6.70	-7.49	1.	.10000000E+10	.10000000E-08
40.83	-35.52	1.	.26004162E+05	.38455383E-04
13.19	-12.35	1.	.97971982E+08	.10207000E-07
35.22	-13.52	1.	.65291215E+06	.15315996E-05
11.74	-1.70	7.	.19249496E+10	.36364588E-08
17.04	-9.93	1.	.66014698E+08	.15148142E-07
-3.02	-20.94	5.	.10000000E+10	.50000000E-08
-2.66	-20.58	5.	.10000000E+10	.50000000E-08
-2.31	-20.22	5.	.10000000E+10	.50000000E-08
-1.96	-19.87	5.	.10000000E+10	.50000000E-08
-1.60	-19.52	5.	.10000000E+10	.50000000E-08
-1.26	-19.17	5.	.10000000E+10	.50000000E-08
-.91	-18.83	5.	.10000000E+10	.50000000E-08
-.57	-18.48	5.	.10000000E+10	.50000000E-08
-.23	-18.14	4.	.10000000E+10	.40000000E-08
-.23	-21.30	1.	.10000000E+10	.10000000E-08
-4.54	-18.14	1.	.10000000E+10	.10000000E-08
-16.07	-29.87	4.	.10000000E+10	.40000000E-08
-15.97	-29.77	4.	.10000000E+10	.40000000E-08
-15.88	-29.68	4.	.10000000E+10	.40000000E-08
-15.78	-29.58	4.	.10000000E+10	.40000000E-08
-15.68	-29.48	4.	.10000000E+10	.40000000E-08
-15.58	-29.38	4.	.10000000E+10	.40000000E-08
-15.49	-29.29	4.	.10000000E+10	.40000000E-08
-15.39	-29.19	4.	.10000000E+10	.40000000E-08
-15.29	-29.09	4.	.10000000E+10	.40000000E-08
-15.20	-29.00	4.	.10000000E+10	.40000000E-08
42.84	-31.20	1.	.24336594E+05	.41006136E-04
1.72	-21.28	10.	.10000000E+10	.10000000E-07
60.71	-55.00	1.	.10000000E+05	.10000000E-03
55.00	20.02	1.	.63546690E+05	.15736461E-04
55.00	-55.00	1.	.10000000E+05	.10000000E-03
23.44	12.54	2.	.52786328E+10	.37888599E-09
23.72	12.83	2.	.52805280E+10	.37875000E-09
24.00	13.11	2.	.52807566E+10	.37873361E-09
24.28	13.39	2.	.52793259E+10	.37883625E-09
24.56	13.66	2.	.52762450E+10	.37905745E-09
24.83	13.94	2.	.52715248E+10	.37939687E-09
25.11	14.21	2.	.52651779E+10	.37985421E-09
25.37	14.48	2.	.52572184E+10	.38042931E-09
25.64	14.75	2.	.52476624E+10	.38112208E-09
25.91	15.01	1.	.52365271E+10	.19096626E-09
25.91	7.52	1.	.37589154E+09	.26603419E-08
15.14	15.01	1.	.48307951E+12	.20700526E-11
15.14	7.52	1.	.15515977E+11	.64449697E-10
49.68	-11.46	1.	.24152055E+05	.41404344E-04
34.83	22.00	1.	.15814258E+10	.63234078E-09
36.76	9.98	1.	.15038306E+08	.66496853E-07
24.39	5.14	4.	.31310615E+09	.12775220E-07
24.39	-.31	1.	.77428372E+08	.12915162E-07
19.75	9.58	3.	.67337984E+10	.44551379E-09
20.12	9.95	3.	.67798754E+10	.44248601E-09
20.50	10.33	3.	.68230691E+10	.43968484E-09
20.86	10.70	3.	.68633296E+10	.43710563E-09
21.23	11.06	3.	.69006119E+10	.43474405E-09
21.59	11.42	3.	.69348755E+10	.43259609E-09
21.94	11.78	3.	.69660846E+10	.43065799E-09
22.30	12.13	3.	.69942085E+10	.42892630E-09
22.65	12.48	3.	.70192214E+10	.42739783E-09
22.99	12.82	2.	.70411021E+10	.28404644E-09
22.99	5.14	1.	.49378912E+09	.20251560E-08
-41.80	-53.54	1.	.10000000E+10	.10000000E-08

```
                                          DAMAGE PER THIS SET=  .12645622E-02
                                           TOTAL ENN/CYC =,  .37115261E-02
FLIGHT OR BLOCK NO.   4
                                          DAMAGE FROM PLASTIC STRAINS=  .30462764E-03
                                          DAMAGE PER THIS SET=  .83070929E-03
                                           TOTAL ENN/CYC =,  .45422354E-02
FLIGHT OR BLOCK NO.   5
                                          DAMAGE FROM PLASTIC STRAINS=  .22665690E-02
                                          DAMAGE PER THIS SET=  .26509046E-02
                                           TOTAL ENN/CYC =,  .71931400E-02
FLIGHT OR BLOCK NO.   6
                                          DAMAGE FROM PLASTIC STRAINS=  .30462764E-03
                                          DAMAGE PER THIS SET=  .83070929E-03
                                           TOTAL ENN/CYC =,  .80238493E-02
FLIGHT OR BLOCK NO.   7
                                          DAMAGE FROM PLASTIC STRAINS=  .30462764E-03
                                          DAMAGE PER THIS SET=  .83070929E-03
                                           TOTAL ENN/CYC =,  .88545586E-02
```

```
1    1    1
3-1 SPECTRUM  --  TRUNCATION LEVEL  270,000 CYCLES
2219-T851 AL      55.          .49           -1.836        10000.
-.00217           .22041       55.82462      NORTH AMERICAN  4  2219
-.00178           .33210       48.26657      NORTH AMERICAN  5  2219
-.01149           .46283       39.66455      NORTH AMERICAN  6  2219
-.01243           .64139       31.70955      NORTH AMERICAN  7  2219
2500000.          1.           1.
4.5
          7      44      3
  26.9
1    1    -.148        -.029        1.
2    3    .584         1.           1.
3    2    .584         .895         1.
4    1    .584         .684         1.
5    1    .455         .584         1.
6    1    .648         .693         1.
7    1    .335         .699         1.
8    1    .488         .563         3.
9    1    .235         .509         1.
10   1    .529         .627         2.
11   1    .434         .509         1.
12   1    .364         .69          1.
13   1    .133         .364         1.
14   1    .364         .482         6.
15   1    .304         .364         1.
16   1    .307         .756         1.
17   1    .316         .527         1.
18   2    .545         .738         1.
19   1    .334         .617         1.
20   1    .431         .512         7.
21   1    .127         .548         1.
22   1    .229         .377         48.
23   1    -.006        .340         1.
24   1    .13          .244         35.
25   1    .278         .723         1.
26   1    .111         .557         9.
27   1    .187         .377         10.
28   3    .527         .931         1.
29   2    -.12         .883         1.
30   1    .527         .747         1.
31   1    -.148        -.029        1.
32   1    .557         .846         1.
33   1    .509         .889         1.
34   1    .331         .527         1.
35   1    .527         .617         19.
36   1    .464         .527         2.
37   1    .432         .81          1.
38   1    .581         .687         1.
39   1    .322         .702         1.
40   1    .335         .449         9.
41   1    .431         .59          5.
42   1    .461         .545         29.
43   1    -.148        -.029        1.
44   1    -.136        -.039        1.
```

```
          1   1
          2   1
          3   2   1
          4   1
  60      5   3   1
          6   1
          7   1
```

APPENDIX III

LIST OF COMPUTER PROGRAM SYMBOLS AND DEFINITIONS

A	Coefficient of the x^2 term in the equation of a line on a constant life fatigue diagram where minimum stress is x and maximum stress is y. $(R = Ax^2 + Bx + C - y)$
AA	An assigned value of +1. or -1.
AAA	A stress used in the calculation of plastic strain.
ABDIF	The absolute value of DIF.
ABM	The absolute value of ASMAX or of ASMIN, as assigned.
ABMAX	The absolute value of ASMAX.
ABMEAN	The absolute value of ASMEAN.
ABMIN	The absolute value of ASMIN.
ABR4	The absolute value of R(4).
ABR7	The absolute value of R(7).
ABS	The name of a routine calling for the absolute value of a quantity.
AKT	Stress concentration factor, K_t
ASMAX	The product (AKT) (STMAX)
ASMEAN	The quantity (ASMAX + ASMIN)/2
ASMIN	The product (AKT) (STMIN)
AVSGMN	Average value of SIGMIN over an interval.
AVSGMX	Average value of SIGMAX over an interval.

B	Coefficient of the x term. (See A.)
BBB	A stress used in the calculation of plastic strain.
C	The constant. (See A.)
COFMAN	Inverse of the Coffin-Manson slope.
CYCINT	The number of cycles in an interval.
CYCLES	The calculated number of cycles expected to be indicated on a constant life fatigue diagram for the applied combination of maximum and minimum stress.
C1	The Residual Stress Relaxation Constant (See ENEP.)
DAM	Damage.
DECK	Decimal or real value of integer K after conversion.
DEL2	A portion of a least-squares-method solution.
DIF	The difference between residual stress and equilibrium residual stress. (RES(I) - EQRES)
DO2	A portion of a least-squares-method solution.
DUMMY	A variable used in the calculation of the number of cycles to be considered as an interval for relaxation determination.
ELMOD	The elastic modulus.
EN	The number of cycles from the beginning of the relaxation process to the end of the current interval.
ENEP	The number of cycles required for overload residual stress effect to return to within one-tenth of its original difference from equilibrium conditions. ($N_{ep} = C1/(ABM)^{E1}(ABMEAN)^{E2}$)

ENN	The number of applied cycles at a load level.
ENNCYC	The ratio of the number of applied cycles to the number of cycles to failure. (ENN/CYCLES)
EPSD	LCF strain intercept.
EQRES	Equilibrium residual stress.
EX	An exponential function depicting the relaxation of residual stress.
EXP	The name of a routine calling for the exponential value of a quantity.
EXPO	An exponent. The power of 10 which indicates the number of cycles to failure.
E1 E2	Residual stress Relaxation Exponents.
FLOAT	The name of a routine calling for integer-to-real conversion.
I	A variable subscript.
IBLOCK	The identifying number of a block the blocks being numbered consecutively from 1 to NBLOCK.
IFIX	The name of a routine calling for real-to-integer conversion.
IN	The number of steps input to the range pair counting subroutine.
IPRINT	Value controlling the WRITE statements.
IRAIN	A counter.
IRPCM	Value controlling entry into the range pair counting subroutine.

ISTEP	The identifying step number, the steps being numbered from 1 to NLEVEL.
ITYPE	The identifying type number, the types being numbered from 1 to NTYPE.
J	A variable subscript.
JA	Value of +1 or 0, as assigned for branch determination.
JB	Value of -1 or 0, as assigned for branch determination.
JJ	An index variable.
JJJ	An index variable.
JKL	An index variable.
K	An index variable.
KK	An index variable.
KPMAX	The number of steps output from the range pair counting subroutine.
L	An index variable.
LMN	An index variable.
M	An index variable.
N	An index variable with values of N=4-7 indicating the power of 10, and thus identifying a particular life cycle curve.
NBLOCK	The total number of times to execute a block of loads.
NDECK	The number of data decks to be run sequentially.
NFLAG	An integer used as a counter.
NFLAG2	An integer used as a counter.

NLEVEL	The total number of steps, or levels, of loads in a block.
NN	A subscripted variable used to indicate which types of loads are experienced in which blocks.
NTYPE	The total number of different types.
PLSTRA	Plastic strain.
R	Residue term in damage calculation.
RES	Residual stress.
RNCYC	The number of cycles for a level after exitting the range pair counting subroutine.
SIGMAX	Maximum stress.
SIGMIN	Minimum stress.
STMAX	Maximum applied stress.
STMIN	Minimum applied stress.
SUMDEL	Summation of damage for a flight.
SUMENN	Accumulated total of applied cycles. (Summation of ENN).
SUMNC	Accumulated cycle ratio. (Summation of ENN/CYCLES).
SUMR	Summation of R(N), N=4,7.
SUMRN	Summation of N R(N), N=4,7.
SUMR2	Summation of $R(N)^2$, N=4,7.
SUMR2N	Summation of $N R(N)^2$, N=4,7.
SUMR3	Summation of $R(N)^3$, N=4,7.
SUMR4	Summation of $R(N)^4$, N=4,7.
TITLE1,TITLE2	Identification of the source of the SN data.
TLL	Tensile load limit.
TM1,TM2	Material type.

TTYS One-fifth of tensile yield stress.

TYS Tensile yield stress.

T1,T2,T3,T4,T5,T6,T7,T8 Test identifying information.

X Variable equivalent to SIGMIN.

Y Variable equivalent to SIGMAX.

APPENDIX IV

FATIGUE LIFE INPUT DATA FOR SEVERAL MATERIALS

MATERIAL	YIELD STRESS	STRAIN INTERCEPT	INVERSE OF SLOPE	LIFE, 10^{I}	S-N LIFE COEFFICIENTS A(I)	B(I)	C(I)
2024-T4	58.	0.4 (2)	-1.836 (2)	4	-.0020	.2091	62.6 (3)
				5	-.0032	.4366	51.4
				6	-.0035	.6207	42.2
				7	-.0042	.7003	36.1
2219-T851	55.	0.4 (2)	-1.836 (2)	4	-.0022	.2204	55.8 (4)
				5	-.0018	.3320	48.3
				6	-.0015	.4628	39.7
				7	-.0024	.6420	31.7
7075-T6	72.	0.4 (1)	-1.836 (1)	4	-.0020	.2801	71.7 (3)
				5	-.0022	.5154	56.3
				6	-.0014	.6141	44.6
				7	-.0013	.6838	38.1
RQC-100	125.	0.54 (5)	-1.493 (5)	4	0.0	.2136	98.3 (5)
				5	0.0	.2927	88.5
				6	0.0	.3669	79.1
				7	0.0	.4376	70.3
Man-Ten	55.	1.11 (5)	-1.667 (5)	4	0.0	.2257	63.5 (5)
				5	0.0	.3520	53.1
				6	0.0	.4669	43.7
				7	0.0	.5678	35.4
4340 Steel	160.	0.4 (2)	-1,836 (2)	4	-.0002	.2567	162.4 (3)
				5	-.0007	.5248	126.9
				6	-.0005	.5557	113.5
				7	-.0005	.5557	108.5
Ti-6-4	158.	0.4 (2)	-1.836 (2)	4	-.0009	.2368	154.2 (3)
				5	-.0006	.4640	110.3
				6	-.0000	.4650	88.9
				7	.0001	.4752	84.2

(1) Data from Endo, T., and Morrow, J., NAEC-ASL-1105, Naval Air Engineering Center, Philadelphia, PA, June 1966.

(2) Data not available - Source 1 data considered typical.

(3) Derived from Metallic Materials and Elements for Aerospace Vehicles Structures, MIL-HDBK-5A, Dept. of Defense, Washington, D.C., February 1966.

(4) Information supplied from Rockwell International.

(5) Information supplied by Society of Automotive Engineers Cumulative Damage Division, Courtesy of Mr. H.R. Jaekel.

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