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AFRPL-TR-67-314
Volume II

THE SENSITIVE TIME LAG THEORY AND ITS APPLICATION TO LIQUID ROCKET COMBUSTION INSTABILITY PROBLEMS

Volume II: Programmer's Manual

A. J. Smith, Jr.
F. H. Reardon
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TECHNICAL REPORT AFRPL-TR-67-314, VOLUME II

March 1968

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AIR FORCE ROCKET PROPULSION LABORATORY
Research and Technology Division
Air Force Systems Command
Edwards Air Force Base, California 93523

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FOREWORD

This is the final report submitted in fulfillment of Contract F04611-67-C-0019. The program had two Air Force Project Engineers, Lt. James D. Cox/RPRRC and, later, Capt. J. F. Ensminger/RPRRC. Volume I of this report contains the background, development, and critique of the Sensitive Time Lag Theory of combustion instability, a description of the computer program that is used to provide a solution of the analytical model, and the use of the model in the analysis and design of liquid rocket engines based on empirical correlations. Volume II contains the flowcharts and listings of the computer program. Therefore, Volume I is referred to as the Engineer's Handbook while Volume II is referred to as the Programmer's Handbook.

The contract effort was conducted by the Thrust Chamber Engineering Division of Liquid Rocket Operations under Dr. C. B. McGough, Program Manager; Dr. R. J. Hefner and, during the final phases of the contract, by Mr. J. M. McBride, Project Managers; Mr. A. J. Smith, Jr., Project Engineer; Dr. F. H. Reardon, of Sacramento State College, and Dr. L. M. Crocco, Dr. W. A. Sirignano, and Mr. D. T. Harrje, of Princeton University, Consultants. This report has been prepared in accordance with MIL-STD-847 (USAF) dated 25 February 1965. The period of this report is 2 September 1966 through 31 November 1967.

It is essential to give special acknowledgement to Dr. L. M. Crocco, originator of the Sensitive Time Lag Theory, and his co-workers whose individual contributions to this discertation are reflected throughout. In addition to contributing significant portions of the Background, Theory, and Conclusion sections, as well as Appendices I through III, they have reviewed the entire text and have made many helpful suggestions during the entire course of the contract.

This technical report has been reviewed and is approved.

Capt. J. F. Ensminger
USAF Project Engineer

ABSTRACT

The main objective of this report is to include, under one cover, all of the work concerned with the development of the Sensitive Time Lag Theory of liquid rocket engine combustion instability. This work includes all the aspects of the theory from the mathematical formulation of the analytical model to the application of the model to actual engine problems. The initial section of the report reviews the logical considerations of the instability phenomenon and relates how the time lag concept conforms analytically as well as experimentally to the problem. Thereafter, the mathematics of the model are developed with the major emphasis placed on the linearized model; however, various aspects of the nonlinear model are also discussed. The mathematical analysis gives rise to a computer program, which is presented in Volume I in the form of an Engineer's instruction manual and in Volume II in the form of a detailed description for the Programmer. The report then focuses its attention on the designer and instructs him in not only how to use the model in practical situations but also how to interpret and correlate test data. The main body of the text concludes with a critique of the time lag concept and outlines the kind of research that is needed in order to improve the time lag model.

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

```
$EXECUTE      IBJOB                                                    BLOK

$IBJOB        MAP,ALTIO                                                BLOK  10

$IBFTC BLOK   LIST,N94                                                 BLOK  20
      BLOCK DATA                                                       BLOK  30
C                                                                      BLOK  40
      COMMON  /PROLOG/  LOGIK(50), SL1, SL2, EORJ                      BLOK  50
      LOGICAL  LOGIK,  SL1,  SL2,  EORJ                                BLOK  60
C                                                                      BLOK  70
      DATA  SL1, SL2  /  .FALSE.,.FALSE.  /                            BLOK  80
      END                                                              BLOK  90



$IBFTC V8050  LIST,N94                                                 ....   0
      COMMON  /PROLOG/  LOGIK(50), SL1, SL2, EORJ                      ....  10
      LOGICAL  LOGIK,  SL1,  SL2,  EORJ                                ....  20
C                                                                      ....  30
   10 CALL  CHAMBR                                                     ....  40
C                                                                      ....  50
C         RETURNS FROM MAJOR PROGRAM IF AND ONLY IF AN INJECTOR PROGRAM ....  60
C          IS TO BE CALLED... INJCTR DETERMINES WHICH, WRITES SCRATCH   ....  70
C          TAPE, AND CALLS PROPER ROUTINE.                             ....  80
C                                                                      ....  90
      CALL  INJCTR                                                     .... 100
C                                                                      .... 110
      GO TO 10                                                         .... 120
        END                                                            .... 130



$IBFTC OUT    LIST,N94                                                 OUT
      SUBROUTINE OUTASS(A,K)                                           OUT   10
      DIMENSION A(12)                                                  OUT   20
      WRITE(6,10)(A(I),I=1,K)                                          OUT   30
   10 FORMAT(1X,12A6)                                                  OUT   40
      RETURN                                                           OUT   50
      END                                                              OUT   60



$IBFTC IN     LIST,N94                                                 IN
      SUBROUTINE INASS8(A)                                             IN    10
      DIMENSION A(12)                                                  IN    20
      READ(5,10)A                                                      IN    30
   10 FORMAT(12A6)                                                     IN    40
      RETURN                                                           IN    50
      END                                                              IN    60



$IBMAP *KTRAN  50,LIST,REF,DECK,N/94,RELMOD                            *KTR
*                                                                      *KTR  10
*     KISMET TRANSFER VECTOR AS APPLIED TO IBM 7094 IBSYS   9/  /64    *KTR  20
*                                                                      *KTR  30
      ENTRY   KOVFLO                                                   *KTR  40
      ENTRY   KUNFLO                                                   *KTR  50
      ENTRY   KDATEA                                                   *KTR  60
      ENTRY   KERROR                                                   *KTR  70
      ENTRY   KFINIS                                                   *KTR  80
      ENTRY   KINDX4                                                   *KTR  90
      ENTRY   KINDX1                                                   *KTR 100
      ENTRY   KINDX2                                                   *KTR 110
      ENTRY   KOPINP                                                   *KTR 120
      ENTRY   KISORG                                                   *KTR 130
      ENTRY   KDATEZ                                                   *KTR 140
KSTCHA EQU    29                                                       *KTR 150
KPRINT EQU    10                                                       *KTR 160
KPUNCH EQU    15                                                       *KTR 170
SYSDAT EQU    65                                                       *KTR 180
KOPINP TRA    1,4               LEFT FROM 704 DAYS OF OPTIONAL INPUT   *KTR 190
KFINAL TSX    KFINIS,4                                                 *KTR 200
       TTR    KERROR            AT KFINAL+1                            *KTR 210
KOVFLO TTR    KERROR            INOPERATIVE IN THE KISMET 9 SENSE      *KTR 220
KUNFLO TTR    KERROR            INOPERATIVE IN THE KISMET 9 SENSE      *KTR 230
KINDX1 PZE                                                             *KTR 240
KINDX2 PZE                                                             *KTR 250
KINDX4 PZE                                                             *KTR 260
KDATEA BCI    2,                NOT AVAILABLE W/OUT PROGRAMMER HELP    *KTR 270
KISORG PZE    1486,,1486        PROTECT NUCLEUS                        *KTR 280
KERROR TSX    KFINIS,4                                                 *KTR 290
KFINIS CALL   EXIT                                                     *KTR 300
*                                                                      *KTR 310
*     KDATEZ, TODAY-S DATE FOR KISMET-MAP OR FORTRAN IV PROGRAMS       *KTR 320
*                                                                      *KTR 330
KDATEZ TRA    1,4                                                      *KTR 340
       END                                                             *KTR 350
```

```
$IBMAP *AAS58                                                          *AAS0010
*  AS58K9                                                              *AAS0020
*                                                                      *AAS0030
        ENTRY   AS58                                                   *AAS0040
        ENTRY   AS138                                                  *AAS0050
KISORG  EQU     1480                                                   *AAS0060
 AS138  SAVE                                                           *AAS0070
        CAL     4,4                                                    *AAS0080
        ALS     18                                                     *AAS0090
        ORA     3,4                                                    *AAS0100
        SLW     BOGUS                                                  *AAS0110
        CAL     5,4                                                    *AAS0120
        LXA     GETOUT-2,4                                             *AAS0130
        TXH     BADGUY,4,0          CHECK FOR PREVIOUS EOF             *AAS0140
        STA     GETOUT                                                 *AAS0150
        TSX     AS58,4                                                 *AAS0160
 BOGUS  EQU     *                                                      *AAS0170
        PZE     **,,**              DATA,,TCARD                        *AAS0180
        TTR     GETOUT-2                                               *AAS0190
        TTR     GETOUT-2                                               *AAS0200
        PXA     **,0                EOF ENCOUNTERED FLAG IF ADDR UNZERO *AAS0210
        ADD     ONE                                                    *AAS0220
GETOUT  STO     **                                                     *AAS0230
        RETURN  AS138                                                  *AAS0240
BADGUY  EQU     *                                                      *AAS0250
        SXA     GETOUT-2,0          RESET EOF FLAG                     *AAS0260
        TTR     KFINIS              WRITE A NOTE....THEN FLUSH HIM     *AAS0270
EOFMES  BCI     9,1READING PAST END-OF-FILE OR INPUT TAPE...JOB FLUSHED *AAS0280
AS58    CLS     1,4                                                    *AAS0290
        SXA     58IR1,1                                                *AAS0300
        SXA     58IR2,2                                                *AAS0310
        SXD     58IR4,4                                                *AAS0320
AS58XA  LXD     58IR4,4                                                *AAS0330
        CAL     1,4                                                    *AAS0340
        STA     *+5                                                    *AAS0350
        STT     *+4                                                    *AAS0360
        ARS     18                                                     *AAS0370
        STA     *+6                                                    *AAS0380
        STT     *+5                                                    *AAS0390
        PXA     **,**                                                  *AAS0400
        SBM     *-1                                                    *AAS0410
        STA     AS58D               SETD,T FOR DATA                    *AAS0420
        STA     AS58X                                                  *AAS0430
        PXA     **,**                                                  *AAS0440
        SBM     *-1                                                    *AAS0450
        STA     AS58DZ              SET D,T FOR                        *AAS0460
        STA     AS58B               SET B,T AG FOR BCD HEADER          *AAS0470
        STO     AS58C2-3            SET TAPE ERROR FLAG REG.           *AAS0480
        SBM     AS58E+3             L(12) HEAD+12                      *AAS0490
        STA     AS58C1                                                 *AAS0500
        LXA     KOVFLO,2                                               *AAS0510
        SXA     AS58C+3,2                                              *AAS0520
        AXT     AS58Q,2                                                *AAS0530
        SXA     KOVFLO,2                                               *AAS0540
        STZ     58YYAS+2            0 TO CARD ERROR IND.               *AAS0550
        LXA     GETOUT-2,4          EOF CHECK                          *AAS0560
        TXH     BADGUY,4,0          READING PAST EOF                   *AAS0570
        LXA     AS58R,4                                                *AAS0580
        TXH     AS58A+4,KISORG      STORAGE INTO MONITOR               *AAS0590
        CALL    OUTAS8(58BCD,7)                                        *AAS0600
        TRA     KERROR                                                 *AAS0610
 58BCD  BCI     7, B,TAG TOO LOW IN MEMORY USING AS58 INPUT            *AAS0620
        BCI     2, DATA    D,T                                         *AAS0630
AS58Z   TXH     AS58A,4,0                                              *AAS0640
        TSX     OUTAS8,4                                               *AAS0650
        TRA     AS58A                                                  *AAS0660
        TTR     119                                                    *AAS0670
 AS58B  PZE     **                                                     *AAS0680
        CLA     =12                                                    *AAS0690
 AS58A  TSX     IMAS58,4                                               *AAS0700
        TRA     58IR4                                                  *AAS0710
        TTR     119                                                    *AAS0720
AS58DZ  PZE     **                                                     *AAS0730
 58IR4  TXL     *+3,,**             NORMAL RETURN                      *AAS0740
 58ERR  CLS     AS58C2-1                                               *AAS0750
        STO     AS58C2-3        ERROR FLAG                             *AAS0760
        CAL*    AS58B                                                  *AAS0770
        LRS     30                                                     *AAS0780
        SUB     AS38J                                                  *AAS0790
        TNZ     AS58C2                                                 *AAS0800
        CLA     AS58C2-2                                               *AAS0810
        LLS     30                                                     *AAS0820
AS58C   SLW*    AS58B                                                  *AAS0830
        LXD     58IPA,4                                                *AAS0840
        LDQ     AS58C2-3                                               *AAS0850
        CAL     58YYAS+2                                               *AAS0860
 58IR2  AXT     **,2                                                   *AAS0870
        AXT     **0,1               RESTORE TRA VECTOR                 *AAS0880
        SXA     KOVFLO,1                                               *AAS0890
 58IR1  AXT     **,1                                                   *AAS0900
        TQP     *+2                                                    *AAS0910
        TZE     4,4             NORMAL OR EOF EXIT                     *AAS0920
        LXD     58IR4,4                                                *AAS0930
        ' A     2,4             ERROR EXIT FROM AS58                   *AAS0940
 58EOF  LF      58IR4,4                                                *AAS0950
        5,4     GETOUT-2,4          EOF IND                            *AAS0960
        TX'     AS58C+2,4,1                                            *AAS0970
        TNX     AS58C+,2,1      SKIP IF END OF CARD                    *AAS0980
AS58C1  LDQ     **0,2                                                  *AAS0990
        TXI     AS58E+1,2,500       RETURN WITH NEXT BCD WORD IN MQ    *AAS1000
 AS58P  CALL    OUTAS8(58BCD+9,1)                                      *AAS1010
        CALL    OUTAS8(58BCD+1,6)                                      *AAS1020
AS58Q   AXT     0,4                 TRA HERE IF ERROR                  *AAS1030
        CLA     58YYAS+2                                               *AAS1040
        ALS     1                                                      *AAS1050
        TXH     **+2,4,0                                               *AAS1060
        ORA     58ONE               FX1                                *AAS1070
        STO     58YYAS+2                                               *AAS1080
        ORS     58YYAS+2                                               *AAS1090
        TXL     AS58Z,0,32      TO READ NEXT CARD                      *AAS1100
AS58C3  TXL     AS58Q+1,2,0                                            *AAS1110
        LXD     *-2,1                                                  *AAS1120
        TXI     AS58E,2,-1                                             *AAS1130
AS58J   OCT     65,21                                                  *AAS1140
        OCT 3000000,63,21                                              *AAS1150
        DEC 9000000,900000,90000,9000,900,90,9,294                     *AAS1160
        DEC 8000000,800000,80000,8000,800,80,8,128                     *AAS1170
        DEC 7000000,700000,70000,7000,700,70,7,216                     *AAS1180
        DEC 6000000,600000,60000,6000,600,60,6,163                     *AAS1190
        DEC 5000000,500000,50000,5000,500,50,5,280                     *AAS1200
        DEC 4000000,400000,40000,4000,400,40,4,136                     *AAS1210
```

```
         DEC  3000000,300000,30000,3000,300,30,3,384                    *AAS1220
         DEC  2000000,200000,20000,2000,200,20,2,19989                  *AAS1230
         DEC  1000000,100000,10000                                      *AAS1240
58MIL    DEC  1000                FX1000                                *AAS1250
58CENT   DEC  100                 FX100                                 *AAS1260
58TEN    DEC  10                  FX10                                  *AAS1270
58ONE    DEC  1                   FX1                                   *AAS1280
         DEC  1E9,1E8,1E7,1E6,1E5,1E4,1E3,1E2,1E1                       *AAS1290
         DEC  0,48                                                      *AAS1300
         SVN  0-1,7,-1                                                  *AAS1310
AS58C2   AXT   0,1                                                      *AAS1320
         AXT   0,2                                                      *AAS1330
         STP   AS58G+3                                                  *AAS1340
         STZ   AS58V1              ZERO FIRST NUMBER FLAG               *AAS1350
         TXI   AS58D1+1,2,13                                            *AAS1360
         LXA   0,2                                                      *AAS1370
         TXL   AS58F,2,KISOR6      STORAGE INTO MONITOR                 *AAS1380
         TXI   0,1,1               BUMP STORAGE ADDR.                   *AAS1390
AS58D    STO   0,0                                                      *AAS1400
         SXA   0-1,2                                                    *AAS1410
         SXA   AS58V1,2                                                 *AAS1420
         PXD   1,0                                                      *AAS1430
         TXL   0,2,1,56                                                 *AAS1440
         SSM                                                            *AAS1450
         STO   58YYAS+1                                                 *AAS1460
         LXD   AS58F1+3,2          RELOAD                               *AAS1470
AS58D1   LDQ   58YYAS+3                                                 *AAS1480
         SXD   AS58F,0                                                  *AAS1490
         SXD   AS58V,1             SAVE IR1                             *AAS1500
         STZ   58YYAS                                                   *AAS1510
         LXD   AS58F+1,4           7 TO IR4                             *AAS1520
         SXD   AS58K,4                                                  *AAS1530
         PXD   0,0                                                      *AAS1540
AS58E    TNX   AS58C1-1,2,100      TRA IF MB EXHAUSTED                  *AAS1550
         LGL   6                                                        *AAS1560
         ALS   3                                                        *AAS1570
         PAX   12,1                                                     *AAS1580
         TXH   AS58F1,1,72                                              *AAS1590
         CAL   58YYAS                                                   *AAS1600
         TXL   AS58F2,1,0                                               *AAS1610
AS58K    TXI   0,1,0                                                    *AAS1620
         ADD   AS58C2-4,1                                               *AAS1630
         SLW   58YYAS                                                   *AAS1640
         TIX   AS58E-2,4,1                                              *AAS1650
         STU   58YYAS+3                                                 *AAS1660
         ORA   58MIL-4                                                  *AAS1670
         FAD   58MIL-4                                                  *AAS1680
         LDQ   58YYAS+1                                                 *AAS1690
         LLS   0                                                        *AAS1700
         LXD   0,4                 7 TO IR4                             *AAS1710
AS58F    TXI   0,4,000                                                  *AAS1720
         TXL   0,4,7                                                    *AAS1730
         STO   58YYAS                                                   *AAS1740
         FMP   AS58C2-10           1E7                                  *AAS1750
         FAD   58YYAS                                                   *AAS1760
         STO   58YYAS+1                                                 *AAS1770
         LDQ   58YYAS+3                                                 *AAS1780
         SXD   AS58F,4                                                  *AAS1790
         TXL   AS58E-4,,64                                              *AAS1800
AS58F1   LXD   0-1,1                                                    *AAS1810
         CAS   58ONE+1,1                                                *AAS1820
         TIR   0-1,1,8                                                  *AAS1830
         TXH   AS58G-2,1,8                                              *AAS1840
         TIX   0-3,1,8                                                  *AAS1850
         TXL   AS58Q,0,000             BCD POSITION                     *AAS1860
AS58F2   ZET   AS58V1                                                   *AAS1870
         TRA   AS58E+10                                                 *AAS1880
         AXT   56,1                                                     *AAS1890
         SXA   AS58Y1,1                                                 *AAS1900
         TXL   AS58E-2,1,16                                             *AAS1910
AS58G    STQ   58YYAS+3                                                 *AAS1920
         SXD   AS58F1+3,2                                               *AAS1930
         LXD   AS58F,2                                                  *AAS1940
         NOP   AS58X-1                                                  *AAS1950
         TXH   AS58H,4,6                                                *AAS1960
         CLA   58YYAS                                                   *AAS1970
         ORA   58MIL-4                                                  *AAS1980
         FAD   58MIL-4                                                  *AAS1990
         FDP   AS58C2-3,4                                               *AAS2000
         CLA   58YYAS+1                                                 *AAS2010
         LRS   0                                                        *AAS2020
         STQ   58YYAS                                                   *AAS2030
         SXD   0,2,4                                                    *AAS2040
         LXD   AS58F+1,4           7                                    *AAS2050
         TNX   AS58H+1,4,000                                            *AAS2060
         SXD   0,4,4                                                    *AAS2070
         TXL   0,2,0                                                    *AAS2080
         LDQ   58YYAS+1                                                 *AAS2090
         FMP   AS58C2-3,4                                               *AAS2100
         TXI   0,2,000                                                  *AAS2110
AS58H    CLA   58YYAS+1                                                 *AAS2120
         FAD   58YYAS                                                   *AAS2130
         STO   58YYAS+1                                                 *AAS2140
         LXD   AS58V,4                                                  *AAS2150
         TXH   0,4,48                                                   *AAS2160
         TXH   AS58V+1,4,40                                             *AAS2170
         TXL   0,1,48                                                   *AAS2180
         TXL   AS58D+3,2,0                                              *AAS2190
         TXH   AS58D-3,1,48        TO STORE RESULT                      *AAS2200
         TXL   AS58W,1,40                                               *AAS2210
         SXD   AS58F,2                                                  *AAS2220
         SXD   0,4,2                                                    *AAS2230
         LXD   AS58F1+3,2                                               *AAS2240
         LDQ   58YYAS+3                                                 *AAS2250
AS58V    TXL   AS58D1+2,0,000          CODE                             *AAS2260
         TNX   AS58M-1,2,000                                            *AAS2270
         CLA   58YYAS+1                                                 *AAS2280
         TXL   0,4,9                                                    *AAS2290
         FDP   AS58C2-12           1E9                                  *AAS2300
         STQ   58YYAS+1                                                 *AAS2310
         TXI   0-4,2,-9                                                 *AAS2320
         TXL   0,4,0                                                    *AAS2330
         FDP   AS58C2-3,2                                               *AAS2340
         STO   58YYAS+1                                                 *AAS2350
         CLA   58YYAS+1                                                 *AAS2360
         SXD   AS58V+1,0                                                *AAS2370
         TXH   AS58D-3,1,40            STORE IF , OR - OR +             *AAS2380
AS58W    LDQ   0,7                 NEXT IS E+L+A                        *AAS2390
         SLQ   AS58G+3             SET FIXED                            *AAS2400
         SLQ   AS58Y               SET POSITIVE                         *AAS2410
         TXH   AS58D1-1,1,92           NEXT CODE E                      *AAS2420
```

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         TZE    A559C-3,4,32       TO STORE IF PREV. CODE WAS         AAS2430
         TRL    A559D1-1,2,3       [illegible] OR E                   AAS2440
         TRL    A559C-3,4,2        TO STORE IF DIGITS HAVE BEEN       AAS2450
         TRL    A559D1-1,2,49TO64       READ WITH NO CODE              AAS2460
         TZE    A559G,2,1               ERROR                          AAS2470
A5599    PXC    **1,2                                                 AAS2480
         TRL    **3,4,5                                               AAS2490
         TRL    **2,1,14           SET NEGATIVE                       AAS2500
         STO    **4                                                   AAS2510
         LDC    A559F1,4,2                                            AAS2520
         TNZ    A559D1,3,1,48                                         AAS2530
         STO    A559G,3            SET FIXED                          AAS2540
A5599    NOP    **2                                                   AAS2550
         SSM                                                          AAS2560
         LDQ    SRTYAS                                                AAS2570
         DVP    SRDNE,4                                               AAS2580
         STO    SRTYAS                                                AAS2590
         LDQ    A559V,4                                               AAS2600
         TRL    **13,4,32                                             AAS2610
         STA    SRTYAS,2                                              AAS2620
         TZE    A559G,2,18              ERROR                          AAS2630
         TNZ    A559V,2                                               AAS2640
         LDQ    SRTYAS,1                                              AAS2650
         TRL    **4,2,9                                               AAS2660
         FMP    SRDNE,1                                               AAS2670
         STO    SRTYAS,1                                              AAS2680
         TXI    **6,2,9                                               AAS2690
         TRL    A559D,9,2,6                                           AAS2700
         FMP    A559C2,9,2                                            AAS2710
         STO    SRTYAS,1                                              AAS2720
         TRL    A559D,2,9,3                                           AAS2730
         CLA    SRTYAS                  1 OR 4                         AAS2740
         ADM    A559E,1                                               AAS2750
         TRL    **7,4,26                                              AAS2760
         ADM    A559B                                                 AAS2770
         STA    A559C              SET NEW STORAGE LOCATION           AAS2780
         TRL    A559D,1,32                                            AAS2790
         TRL    A559B,1,4C              ERROR                          AAS2800
         TRA    A559D,3                                               AAS2810
A559V1   PZE    2                                                     AAS2820
SRTYAS   EQU    COMMON                                                AAS2830
COMMON   BSS    32                                                    AAS2840
ZZZZZZ   PZE                                                          AAS2850
COMMON   CONTRL  COMMON,ZZZZZZ                                        AAS2860
         END                                                          AAS2870
```

```
$IBMAP *INTG   LIST,REF,DECK
*      SLAGZ - BOOLES INTEGRATION - SIMPSONS ERROR CONTROL (F,I,E,R)
       ENTRY   INTGR
       ENTRY   INTGS
INTGR  SAVE    1,2,4
       CLA*    4,4                     B
       SXA     IR4,4
       STO     B
       LDQ*    3,4                     A
       STQ     A
       FSB     A                       B-.
       STO     IVAL                    B-A IS INTERVAL
       CLA*    6,4                     NUMBER OF INTERVALS ESTIMATED
       LDQ     ZERO
       ALS     18
       STA     INT
       ANA     MASK                    MAKES MULTIPLE OF 4
       TZE     *+2
       CLA     FR                      4 IN DECREMENT
DBL    STD     DECA                    SETS DECREMENTS AT AP
       STD     DECB                                       AP
       STZ     INT                     ZERO OUT INTEGRAL AND
       STZ     ERR                           ERROR SUMS
       AXT     4,4
       SXA     I1,4                    PRESET IR1 AT 4
       PDX     0,4                     AP TO IR4
       TXI     *+1,4,1                 UP TO AP+1
       SXA     I2,4                    PRESET I2 TO AP+1
       ANA     MASK                    MASK OFF EVERYTHING EXCEPT DECREMENT
       ARS     18
       ADD     NAS                     ADD 233    FLOAT N TO GET NUMBER OF
       FAD     NAS                     NORMALIZE  INTERVALS
       STO     XN                      FLOATED NUMBER OF INTERVALS
       CLA     B
IR4    AXT     **,4
       STO*    5,4
       RETURN  INTGR                   EXIT WITH X
INTGS  SAVE    1,2,4
       SXA     IR1,1
       SXA     IR2,2
I1     AXT     **,1                    COEFFICIENT COUNTER
I2     AXT     **,2                    INTERVAL COUNTER
       LDQ     FRE
       TXL     *+3,2,1
DECA   TXH     *+2,2,**                SET AT AP
       LDQ     TABI+4,1
       FMP*    3,4                     F
       FAD     INT
       STO     INT                     NEW INTEGRAL SUM
       LDQ     ONE
       TXL     *+3,2,1
DECB   TXH     *+2,2,**                SET AT AP
       LDQ     TABE+4,1
       FMP*    3,4
       FAD     ERR
       STO     ERR                     NEW ERROR SUM
       TIX     *+2,1,1                 REDUCE IR1 BY 1
       AXT     4,1                     RESET IR1
       SXA     I1,1                    STORE COEFFICIENT COUNTER
IR1    AXT     **,1
       TIX     INC,2,1                 OUT TO GET NEW VALUE OF X
       FDP     INT                     ALL THROUGH SUMMING
       STO     TEMPA
       STQ     TEMPQ
       LDQ     TEMPA
       CLA     TEMPQ
       SSP
       SUB*    9,4                     MAXIMUM RELATIVE ERROR
       TMI     FIN                     OUT IF FINISHED
IRT    AXT     **,2
       TXI     *+1,2,1
       TXH     FIN,2,7
       SXA     IRT,2
       LXA     IR2,2
       CLA     DECA                    DOUBLE NUMBER
       ALS     1                          OF
       TPA     DBL                          INTERVALS
INC    SXA     I2,2                    STORE NEW INTERVAL COUNTER
       TXI     *+1,2,-1                REDUCE TO NUMBER OF INTERVALS
       PXA     0,2                     TO ACCUMULATOR
       ADD     NAS                     FLOAT
       FAD     NAS                       NUMBER
       FDP     XN                      /TOTAL NUMBER INTERVALS
       FMP     IVAL
       FAD     A                       NEW X
IR2    AXT     **,2                    RESTORE IR2
       TRA     IR4
FIN    CLA     INT
       FDP     XN                      IVAL/XN=H
       FMP     IVAL
       FDP     FRF
       STO*    4,4                     INTEGRAL
       STZ*    6,4
       CLA     DECA                    NUMBER OF
       ARS     18                            INTERVALS
       STA*    6,4
       LXA     IR2,2
       RETURN  INTGS
MASK   OCT     077774000000
FR     OCT     000004000000
NAS    OCT     233000000000
FRE    DEC     14.
TABI   DEC     28.,64.,24.,64.
ONE    DEC     1.
TABE   DEC     2.,-4.,6.,-4.
FRF    DEC     45.
A      BSS     1
B      BSS     1
ERR    BSS     1
INT    BSS     1
IVAL   BSS     1
XN     BSS     1
TEMPA  BSS     1
TEMPQ  BSS     1
ZERO   DEC     0
       END
```

```
$IBFTC *KDATE  SD,LIST,REF,DECK,M/94,RELMOD                                    *KDA
*                                                                              *KDA  10
*       DATE -- TODAY'S DATE IN THE FORM DD MMMM YYYY                          *KDA  20
*       CALL DATE (BCDATE), WHERE BCDATE IS 2 CELLS WHICH WILL CONTAIN         *KDA  30
*                          THE BCD FORM OF TODAY'S DATE                        *KDA  40
*                                                                              *KDA  50
       ENTRY  DATE                                                             *KDA  60
*SDAT  EQU    65                                                              *KDA  70
DATE   TXH    0,,0                                                            *KDA  80
       SXA    DATE1,1                                                         *KDA  90
       SXA    DATE4,4                                                         *KDA 100
       LXA    DATE,1                                                          *KDA 110
       TXH    *+1,1,0                                                         *KDA 120
PXA    PXA    ,,                      TSX ENTRY                               *KDA 130
       PAX    ,1                                                              *KDA 140
       TXI    **1,1,2                                                         *KDA 150
       SXA    DATE,1                  BUILD RETURN ADDRESS                    *KDA 160
       TRA    **4                                                             *KDA 170
TSL    TXI    **1,1,-1                TSL ENTRY                               *KDA 180
       PXA    ,1                                                              *KDA 190
       PAC    ,4                      LOAD UP XR4 FOR CALL SEQ.               *KDA 200
       CAL    3,4                                                             *KDA 210
       ADD    PAX                                                             *KDA 220
       STA    D1                                                              *KDA 230
       PXA    ,0                                                              *KDA 240
       LDQ    SYSDAT                  MMDDYY                                  *KDA 250
       LGL    12                      MM/DDYY00                               *KDA 260
PAX    PAX    1,1                                                             *KDA 270
       LGL    12                      00MMDD/YYOOOO                           *KDA 280
       ALS    24                      DDOOOO/YYOOOO                           *KDA 290
       SLW*   1,4                     DDOOOO/OOOOYY                           *KDA 300
       LGL    12                      OOO YY/OOOOOO                           *KDA 310
       ORA    D19                     0019YY/OOOOOO                           *KDA 320
D1     SLW    **                                                              *KDA 330
       TNX    **2,1,63                                                        *KDA 340
       TXI    **1,1,-9                                                        *KDA 350
       CAL    MOTABL-1,1                                                      *KDA 360
       LGR    12                      0/BAAA/ABOOOO                           *KDA 370
       ORA*   3,4                     DDOOOO+BAAA IN 3,4 (INDIRECT)           *KDA 380
       SLW*   3,4                                                             *KDA 390
       LGL    36                      ABOOOO/OOOOOO                           *KDA 400
       ORA*   D1                      ABOOOO+19YY                             *KDA 410
       SLW*   D1                                                              *KDA 420
DATE4  AXT    **,4                                                            *KDA 430
DATE1  AXT    **,1                                                            *KDA 440
       TRA*   DATE                    ESCAPE                                  *KDA 450
D19    BCI    1,001900                                                        *KDA 460
       BCI    9, DEC.  NOV.  OCT.  SEPT  AUG.  JULY  JUNE  MAY  APR.          *KDA 470
       BCI    2, MAR.  FEB.                                                   *KDA 480
MOTABL BCI    1, JAN.                                                         *KDA 490
       END                                                                     *KDA 500
```

```
$IBFTC *INT4    LIST,M94                                                       INT4
      SUBROUTINE INT4(X,Y,XI,YO)                                              INT4  10
      DIMENSION X(9),Y(9),XC(4),YC(4)                                         INT4  20
      EQUIVALENCE (XC(1),X1),(XC(2),X2),(XC(3),X3),(XC(4),X4),(YC(1),Y1)INT4  30
     1,(YC(2),Y2),(YC(3),Y3),(YC(4),Y4)                                       INT4  40
   10 ASSIGN 90 TO NA                                                         INT4  50
      J=2                                                                     INT4  60
      B=XI                                                                    INT4  70
   20 IF(X(J))30,40,30                                                        INT4  80
   30 GO TO NA,(90,160)                                                       INT4  90
   40 IF(Y(J))30,50,30                                                        INT4 100
   50 IF(J-2)60,60,70                                                         INT4 110
   60 YE=0.                                                                   INT4 120
      GO TO 180                                                               INT4 130
   70 ASSIGN 130 TO NA                                                        INT4 140
      J=J-1                                                                   INT4 150
   80 X1=X(J)                                                                 INT4 160
      X2=X(J-1)                                                               INT4 170
      X3=X(J-2)                                                               INT4 180
      Y1=Y(J)                                                                 INT4 190
      Y2=Y(J-1)                                                               INT4 200
      Y3=Y(J-2)                                                               INT4 210
      GO TO NA,(130,170)                                                      INT4 220
   90 IF(X(J)-B)120,100,130                                                   INT4 230
  100 IF(J-2)130,130,110                                                      INT4 240
  110 ASSIGN 160 TO NA                                                        INT4 250
  120 J=J+1                                                                   INT4 260
      GO TO 20                                                                INT4 270
  130 DO 140 J=1,3                                                            INT4 280
      XC(J)=X(J)                                                              INT4 290
  140 YC(J)=Y(J)                                                              INT4 300
  150 D=X2-X1                                                                 INT4 310
      A1=B-X1                                                                 INT4 320
      A2=B-X2                                                                 INT4 330
      YE=A1*A2/2.0/D*((Y3-Y2)/(X3-X2)-(Y2-Y1)/D)-A2/D*Y1+A1/D*Y2              INT4 340
      GO TO 180                                                               INT4 350
  160 ASSIGN 170 TO NA                                                        INT4 360
      GO TO 80                                                                INT4 370
  170 X4=X(J-3)                                                               INT4 380
      Y4=Y(J-3)                                                               INT4 390
      D=X3-X2                                                                 INT4 400
      A1=B-X2                                                                 INT4 410
      A2=B-X3                                                                 INT4 420
      XM12=(Y2-Y1)/(X2-X1)                                                    INT4 430
      XM23=(Y3-Y2)/D                                                          INT4 440
      XM34=(Y4-Y3)/(X4-X3)                                                    INT4 450
      YE=A1*A2**2/2.0/D**2*(XM12-XM23)+A2*A1**2/2.0/D**2*(XM34-XM23)-A2*INT4 460
     1Y2/D+A1*Y3/D                                                            INT4 470
  180 YO=YE                                                                   INT4 480
      RETURN                                                                  INT4 490
      END                                                                     INT4 500
```

```
$IBFTC INT4D   LIST,M94                                                      INT4D
      SUBROUTINE INT4D(X,Y,XI,YO,DY)                                         INT4D 10
      DIMENSION X(9),Y(9),XC(4),YC(4)                                        INT4D 20
      EQUIVALENCE (XC(1),X1),(XC(2),X2),(XC(3),X3),(XC(4),X4),(YC(1),Y1)INT4D 30
     1,(YC(2),Y2),(YC(3),Y3),(YC(4),Y4)                                      INT4D 40
   10 ASSIGN 90 TO NA                                                        INT4D 50
      J=2                                                                    INT4D 60
      B=XI                                                                   INT4D 70
   20 IF(X(J))30,40,30                                                       INT4D 80
   30 GO TO NA,(90,160)                                                      INT4D 90
   40 IF(Y(J))30,50,30                                                       INT4D100
```

```
    90 IF(J-2)160,60,70                                                 INT4D110
    60 YF=0.0                                                           INT4D120
       GO TO 180                                                        INT4D130
    70 ASSIGN 150 TO MB                                                 INT4D140
       J=J-1                                                            INT4D150
    80 X1=X(J)                                                          INT4D160
       X2=X(J-1)                                                        INT4D170
       X3=X(J-2)                                                        INT4D180
       Y1=Y(J)                                                          INT4D190
       Y2=Y(J-1)                                                        INT4D200
       Y3=Y(J-2)                                                        INT4D210
       GO TO MB,(150,170)                                               INT4D220
    90 IF(X(J)-81)120,100,100                                           INT4D230
   100 IF(J-2)130,130,110                                               INT4D240
   110 ASSIGN 160 TO MA                                                 INT4D250
   120 J=J-1                                                            INT4D260
       GO TO 20                                                         INT4D270
   130 DO 140 J=1,3                                                     INT4D280
       XC(J)=X(J)                                                       INT4D290
   140 YC(J)=Y(J)                                                       INT4D300
   150 D=X2-X1                                                          INT4D310
       A1=B-X1                                                          INT4D320
       A2=B-X2                                                          INT4D330
       XM23=(Y3-Y2)/(X3-X2)                                             INT4D340
       XM12=(Y2-Y1)/(X2-X1)                                             INT4D350
       XM2B=(XM23-XM12)/2.0/D                                           INT4D360
       YO=A1*A2*XM2B-A2*Y1/D+A1*Y2/D                                    INT4D370
       DY=XM2B*(A1+A21+XM12                                             INT4D380
       GO TO 180                                                        INT4D390
   160 ASSIGN 170 TO MB                                                 INT4D400
       GO TO 80                                                         INT4D410
   170 X4=X(J-3)                                                        INT4D420
       Y4=Y(J-3)                                                        INT4D430
       D=X3-X2                                                          INT4D440
       A1=B-X2                                                          INT4D450
       A2=B-X3                                                          INT4D460
       XM12=(Y2-Y1)/(X2-X1)                                             INT4D470
       XM23=(Y3-Y2)/D                                                   INT4D480
       XM34=(Y4-Y3)/(X4-X3)                                             INT4D490
       AM2=A2*(XM12-XM23)                                               INT4D500
       AM1=A1*(XM34-XM23)                                               INT4D510
       YO=(A1*A2/2.0/D*(AM2+AM1)-A2*Y2+A1*Y3)/D                         INT4D520
       DY=(AM2*(2.0*A1+A2)+AM1*(2.0*A2+A1))/2.0/D**2+XM23               INT4D530
   180 RETURN                                                           INT4D540
       END                                                              INT4D550
```

```
$IBFTC PAGER   LIST,M94                                                 PAGE
       SUBROUTINE PAGE(LINES)                                           PAGE  10
C                                                                       PAGE  20
C      HEAD MOVED TO /PROLOG/ AND PAGE MODIFIED TO PRINT HEAD 25JUL 67  PAGE  30
C                                                                       PAGE  40
       COMMON  /PROLOG/  LOGIK(38), HEAD(12), SL1, SL2, EORJ            PAGE  50
       DIMENSION  TODAY (2)                                             PAGE  60
       DATA  KPG / 0 /                                                  PAGE  70
C                                                                       PAGE  80
       IF(LINES-60)20,10,10                                             PAGE  90
    10 L=2                                                              PAGE 100
       GO TO 40                                                         PAGE 110
    20 K=L+LINES                                                        PAGE 120
       IF(K-60)30,30,50                                                 PAGE 130
    30 L=K                                                              PAGE 140
    40 RETURN                                                           PAGE 150
C                                                                       PAGE 160
    50 L=LINES+2                                                        PAGE 170
    60 IF ( KPG .EQ. 0 )   CALL  DATE (TODAY)                           PAGE 180
    70 KPG = KPG +                                                      PAGE 190
       WRITE (6,80)  TODAY, HEAD, KPG                                   PAGE 200
    80 FORMAT ( 1H1 51( 6HDATE   2A6, 12X 12A6, 11X 5HPAGE  I5 )        PAGE 210
       GO TO 40                                                         PAGE 220
       END                                                              PAGE 230
```

```
$ORIGIN        ALODE
$INCLUDE       ABCDF
$IBFTC CHAMR   LIST,M96                                                        CHAM
      SUBROUTINE  CHAMBR                                                       CHAM  10
C                                                                              CHAM  20
C           20 SEP 67  MODIFIED FOR TABULAR INJECTOR COEFFICIENTS              CHAM  30
C                                                                              CHAM  40
      LOGICAL  LOGIK, ARUN,BRUN,CRUN,DRUN,ERUN,FRUN,GRUN,HRUN,IRUN, JRUN       CHAM  50
      LOGICAL  SL1, SL2, EORJ                                                  CHAM  60
      REAL  MACH                                                               CHAM  70
      COMMON  / /                                                              CHAM  80
     1   GAM, RWI, WIT(30), AVN(30), BVN(30), CVNR(30), CVNI(30), EE,DSC      CHAM  90
      COMMON  /PROLOG/  LOGIK(38), HEAD(12), SL1, SL2, EORJ                    CHAM 100
      COMMON/ABCDF/ DINP,STOW                                                  CHAM 110
      DIMENSION  EXTRA(100),                    WC(75)                         CHAM 120
      DIMENSION DINP(6300),A(1),B(1),C(1),D(1)                                 CHAM 130
      DIMENSION  X(133),Y(133),Q(134),STOW(222),STODAT(4607)                   CHAM 140
      DIMENSION ZZ(209)                                                        CHAM 150
      DIMENSION G(1),DISTL(20),DISTM(20)                                       CHAM 160
      DIMENSION  AMIT(98)                                                      CHAM 170
      EQUIVALENCE ( EXTRA, DINP, STODAT )                                      CHAM 180
      EQUIVALENCE                                                              CHAM 190
     1   (LOGIK(1) , ARUN),   (LOGIK(2) , BRUN),   (LOGIK(3) , CRUN),        CHAM 200
     2   (LOGIK(4) , DRUN),   (LOGIK(5) , ERUN),   (LOGIK(6) , FRUN),        CHAM 210
     3   (LOGIK(7) , GRUN),   (LOGIK(8) , HRUN),   (LOGIK(9) , IRUN),        CHAM 220
     4   (LOGIK(10), JRUN)                                                   CHAM 230
      EQUIV LENCE (EXTRA(1),CA),(EXTRA(2),CB),(EXTRA(3),CC),(EXTRA(4),        CHAM 240
     1CD),(EXTRA(5),CE), EXTRA(6),CF),(EXTRA(7),CG),(EXTRA(8),CH)             CHAM 250
      EQUIVALENCE (EXTRA(9),C1)                                                CHAM 260
      EQUIVALENCE (DINP(1),A),(DINP(3001),B),(DINP(3401),D),                   CHAM 270
     1(DINP(3901),G),(DINP(5801),C),(EXTRA(21),WC) , (B(4),UE)                 CHAM 280
      EQUIVALENCE  (DINP(601),AMIT),(DINP(2013),Q),(DINP(3501),X),             CHAM 290
     1      (DINP(5685)),Y)                                                    CHAM 300
      EQUIVALENCE                                                              CHAM 310
     1  (STOW(1),ZZ), (STOW(213),YM)                                          CHAM 320
     2  ,  (STOW(214),J), (STOW(215),ME), (STOW(216),YL), (STOW(217),K1)CHAM 330
     3  ,  (STOW(218),N), (STOW(219),KER), (STOW(220),XM)                     CHAM 340
     4  ,  (STOW(221),RQUAD), (STOW(222),XL)                                  CHAM 350
     5   ,   (EXTRA(51), DISTL), (EXTRA(71), DISTM )                         CHAM 360
     6   ,  (EXTRA(101),CJ), (EXTRA(21),SNH ), (EXTRA(12), MACH )            CHAM 370
     7   ,   (DINP(107),D1BAR)                                               CHAM 380
C                                                                              CHAM 390
C*****************************************************************************CHAM 400
C                                                                              CHAM 410
   10 FORMAT(1H0,60H     A     B     C     D     E     F     G     H          CHAM 420
     1 I     J     // 3X,(10F6.0))                                            CHAM 430
   20 FORMAT(///,9X,108H********************** THE FOLLOWING MAIN CONTCHAM 440
     1ROL DATA WILL BE USED IN THIS CASE **********************  ,///,A5,     CHAM 450
     245X,33HRATIO OF SPECIFIC HEAT (GAMMA) = ,F7.4,//,45X,22HDESIRED MACHAM 460
     3CH NUMBER = ,E12.5,20H (=0 IF BEING CALCULATED) //45X,        17HCHCHAM 470
     5AMBER RADIUS = ,F7.3, 9H (INCHES)///,45X,17HCHAMBER LENGTH = ,F7.3CHAM 480
     6, 9H (INCHES)///,45X, 17HSPEED OF SOUND = ,F10.3,  9H (FT/SEC)///,CHAM 490
     745X, 27HCHAMBER MODE DESCRIPTION = ,F8.5, 20H (=0 FOR LONGITUDINALCHAM 500
     8 MODES)//)                                                             CHAM 510
   30 FORMAT(////,33X,48H********** CHAMBER FREQUENCIES (WC) **********      CHAM 520
     1   ///)                                                                CHAM 530
   40 FORMAT(5F20.9,/ )                                                      CHAM 540
   50 FORMAT(30X, 64H******* MACH DISTRIBUTION IN CHAMBER AS A FUNCTION OFCHAM 550
     1 LENGTH *****,//,11X,7HCHAMBER,15X,6HMACH,14X,7HCHAMBER,15X,6HMACHCHAM 560
     2,14X,7HCHAMBER,15X,6HMACH,/,12X,6HLENGTH,11X,12HDISTRIBUTION,11X, CHAM 570
     36HLENGTH,11X,12HDISTRIBUTION,11X,6HLENGTH,11X,12HDISTRIBUTION,/,)  CHAM 580
   60 FORMAT(6(10X,F10.5))                                                   CHAM 590
C*****************************************************************************CHAM 600
C*****************************************************************************CHAM 610
C                                                                              CHAM 620
      IF ( SL2 )              GO TO 170                                        CHAM 630
C                                                                              CHAM 640
      SL2 = .TRUE.                                                             CHAM 650
      DO 70 I = 1, 4300                                                        CHAM 660
   70    DINP (I) = 0.0                                                      CHAM 670
      GO TO 110                                                                CHAM 680
C                                                                              CHAM 690
C*****************************************************************************CHAM 700
C                                                                              CHAM 710
   80 WRITE (6,100)   NE                                                       CHAM 720
   90 CALL EXIT                                                               CHAM 730
  100 FORMAT (1H010X17HINPUT ERROR, NE = I3, 19H, HENCE TERMINATION )         CHAM 740
C                                                                              CHAM 750
C*****************************************************************************CHAM 760
C*****************************************************************************CHAM 770
C                                                                              CHAM 780
  110 KER = 0                                                                  CHAM 790
      CALL  DVCHK  (KCHK)                                                      CHAM 800
C                                                                              CHAM 810
      DO 120 I = 1, 10                                                         CHAM 820
  120    DINP(I) = 0.0                                                       CHAM 830
      CALL  AS13B  ( DINP(1), HEAD(1), NE )                                    CHAM 840
      IF ( NE .NE. 1 )   GO TO 80                                              CHAM 850
      ARUN = CA .NE. 0.0                                                       CHAM 860
      BRUN = CB .NE. 0.0                                                       CHAM 870
      CRUN = CC .NE. 0.0                                                       CHAM 880
      DRUN = CD .NE. 0.0                                                       CHAM 890
      ERUN = CE .NE. 0.0                                                       CHAM 900
      FRUN = CF .NE. 0.0                                                       CHAM 910
      IRUN = C1 .NE. 0.0                                                       CHAM 920
      JRUN = CJ .NE. 0.0                                                       CHAM 930
     GGRUN =       DINP(22) .LE. 0.0                                           CHAM 940
     1       .AND. ( ARUN .OR. BRUN .OR. CRUN .OR. IRUN )                      CHAM 950
C                                                                              CHAM 960
C     PRINT NEW MAIN CONTROL DATA                                              CHAM 970
C*****************************************************************************CHAM 980
      CALL  PAGE  ( 60 )                                                       CHAM 990
      WRITE (6,10)  (DINP(I), I=1,10)                                          CHAM1000
      WRITE (6,20)  DINP(11), MACH, DINP(14), DINP(15), DINP(16), SNH          CHAM1010
C*****************************************************************************CHAM1020
C     ARE FREQUENCIES TO BE CALCULATED... IF SO, CALCULATE AND PRINT.          CHAM1030
C*****************************************************************************CHAM1040
      IF ( .NOT. GRUN )        GO TO 130                                       CHAM1050
      CALL  GENMEG  ( WC(1) )                                                  CHAM1060
      IF ( BRUN .OR. ARUN )             CRUN = .TRUE.                          CHAM1070
      IF ( CRUN )     CC = CC + 11.0                                           CHAM1080
  130 JOMEGA=ABS(EXTRA(22))+22.0001                                            CHAM1090
      WRITE (6,30)                                                             CHAM1100
      WRITE (6,40)(EXTRA(I),I=23,JOMEGA)                                       CHAM1110
      WRITE (6,50)                                                             CHAM1120
      WRITE (6,60)( DISTL(I), DISTM(I), DISTL(I+7),          DISTM(I+7)),CHAM1130
     1, DISTL(I+14), DISTM(I+14), I=1,6 ), DISTL(7),         DISTM(7), CHAM1140
     2DISTL(16), DISTM(16)                                                     CHAM1150
C*****************************************************************************CHAM1160
C                                                                              CHAM1170
      EORJ = ERUN .OR. JRUN .OR. IRUN                                          CHAM1180
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      IF ( CRUN .OR. EORJ )   CALL  PAGE  ( 60 )                        CHAN1190
  140 IF ( .NOT. EORJ )        GO TO 200                                  CHAN1200
      WRITE (14)      STODAT                                             CHAN1210
      BACKSPACE  14                                                      CHAN1220
      EE  = CE                                                           CHAN1230
      DSC = CI                                                           CHAN1240
      GAM = DIMP(11)                                                     CHAN1250
      IF ( .NOT. IRUN )      GO TO 160                                   CHAN1260
      NWI = ( JOMEGA-22 )/2 +1                                           CHAN1270
      DO 150 I = 1, NWI                                                  CHAN1280
  150    WIT(I) = DIMP( 2*I+21 )                                         CHAN1290
      WIT(NWI) = DIMP( JOMEGA )                                          CHAN1300
C                                                                        CHAN1310
  160 RETURN                                                             CHAN1320
C     ******                                                             CHAN1330
C          PROGRAM RETURNS IF AND ONLY IF INJECTOR PROGRAM IS TO BE RUN  CHAN1340
C                                                                        CHAN1350
C*************************************************************************CHAN1360
C*************************************************************************CHAN1370
C                                                                        CHAN1380
C                                                                        CHAN1390
  170 READ (14)  STODAT                                                  CHAN1400
      BACKSPACE  14                                                      CHAN1410
      IF ( .NOT. ERUN )       GO TO 200                                  CHAN1420
C                                                                        CHAN1430
      DIMP(9400) = NWI                                                   CHAN1440
      DO 180 I = 1, NWI                                                  CHAN1450
         DIMP(I+4922) = WIT(I)                                           CHAN1460
         DIMP(I+4939) = AVR (I)                                          CHAN1470
         DIMP(I+4956) = BVR (I)                                          CHAN1480
         DIMP(I+4973) = CVNR(I)                                          CHAN1490
  180    DIMP(I+4990) = CVNI(I)                                          CHAN1500
      DO 190 I = NWI, 84, 17                                             CHAN1510
  190    DIMP(I+4923) = 0.0                                              CHAN1520
C                                                                        CHAN1530
C*************************************************************************CHAN1540
C                                                                        CHAN1550
  200 WC(2) = ABS( WC(2) )                                               CHAN1560
C*************************************************************************CHAN1570
C     FIX NUMBER OF FREQUENCIES AND TEST DESIRE FOR INTERNAL C FLAG      CHAN1580
C*************************************************************************CHAN1590
  210 NONEG=WC(2)+.0001                                                  CHAN1600
      IF(EXTRA(12))230,220,230                                           CHAN1610
  220 DIMP(9002)=9.0                                                     CHAN1620
      GO TO 240                                                          CHAN1630
  230 U1BAR = MACH                                                       CHAN1640
      UE = MACH                                                          CHAN1650
  240 IF ( .NOT. IRUN )              GO TO 390                           CHAN1660
C*************************************************************************CHAN1670
C     SET UP DATA FOR PROGRAM  C.                                        CHAN1680
C*************************************************************************CHAN1690
  250 DIMP(3001)=EXTRA(11)                                               CHAN1700
      NNMAP = NONEG/2 + 1                                                CHAN1710
      ZZ(1)=EXTRA(14)                                                    CHAN1720
      ZZ(2)=EXTRA(15)                                                    CHAN1730
      ZZ(3)=EXTRA(16)                                                    CHAN1740
       DIMP(3005) = EXTRA(14)                                            CHAN1750
      DIMP(3003)=NNMAP                                                   CHAN1760
      IF ( DIMP(3009) .EQ. 0.0 )        DIMP(3009) = 1C1.0               CHAN1770
      K = 0                                                              CHAN1780
      ZAVE=((EXTRA(11)+1.0)/2.0)*SQRT(DIMP(3006)*DIMP(3007))             CHAN1790
      IF(EXTRA(21))270,260,270                                           CHAN1800
  260 SNOZ = 0.0                                                         CHAN1810
C*************************************************************************CHAN1820
C     USING HALF OF CHAMBER FREQUENCIES, CALCULATE NOZZLE FREQUENCIES    CHAN1830
C       FOR USE IN PROG C.                                               CHAN1840
C*************************************************************************CHAN1850
      RORL = EXTRA(15)                                                   CHAN1860
      GO TO 280                                                          CHAN1870
  270 RORL = EXTRA(16)                                                   CHAN1880
      GRAD = SQRT((2.0/(EXTRA(11)+1.0))*(DIMP(3006)/DIMP(3007)))         CHAN1890
      SNOZ = SIN/GRAD                                                    CHAN1900
  280 DO 290 I=1,NNMAP                                                   CHAN1910
      KN=(2*I)+1                                                         CHAN1920
      NN=4210+K                                                          CHAN1930
      DIMP(NN) = ZAVE*WC(KN)/RORL                                        CHAN1940
      DIMP(NN+1) = SNOZ                                                  CHAN1950
      DIMP(NN+2) = MACH                                                  CHAN1960
      K=K+3                                                              CHAN1970
  290 CONTINUE                                                           CHAN1980
      DIMP(NN)=ZAVE*(WC(NONEG+2)/EXTRA(14))                              CHAN1990
  300 CALL CCC(C(1),ZZ(1),WC(1),CC,KER)                                  CHAN2000
C     SET UP NOZZ ADM FOR A,B                                            CHAN2010
      IF(KER) 310,330,310                                                CHAN2020
  310 WRITE (6,320)                                                      CHAN2030
  320 FORMAT (1HO 30X39H ERROR PROGRAM C.  ALL CASES TERMINATED )        CHAN2040
      CALL CORE(C(1),429,CC)                                             CHAN2050
      GO TO 90                                                           CHAN2060
  330 IF ( .NOT. ARUN )          GO TO 360                               CHAN2070
C*************************************************************************CHAN2080
C     MOVE OUTPUT FROM C INTO INPUT BLOCK TO A                           CHAN2090
C*************************************************************************CHAN2100
  340 NP = C(5)                                                          CHAN2110
      IWO = 0                                                            CHAN2120
      DO 350 I = 1, NP                                                   CHAN2130
         IWO = IWO + 2                                                   CHAN2140
         AMIT(I    ) = ZZ(IWO    )                                      CHAN2150
         AMIT(I+30) = ZZ(IWO+  1)                                        CHAN2160
         AMIT(I+60) = ZZ(IWO+101)                                        CHAN2170
  350    CONTINUE                                                        CHAN2180
C                     ZEROES TO END TABLES                               CHAN2190
      AMIT(NP+ 1) = 0.0                                                  CHAN2200
      AMIT(NP+31) = 0.0                                                  CHAN2210
      AMIT(NP+61) = 0.0                                                  CHAN2220
      IF ( MACH .LE. 0.0 )   U1BAR = ZZ(205)                             CHAN2230
      GO TO 410                                                          CHAN2240
C                                                                        CHAN2250
  360 IF ( .NOT. BRUN .AND. SNM .EQ. 0.0 )     GO TO 390                 CHAN2260
C*************************************************************************CHAN2270
C     MOVE OUTPUT FROM PROG C INTO INPUT BLOCK FOR PROG B.               CHAN2280
C*************************************************************************CHAN2290
  370 DO 380 I=10,200                                                    CHAN2300
  380 B(I)=ZZ(I)                                                         CHAN2310
      B(4)=ZZ(205)                                                       CHAN2320
C                                                                        CHAN2330
  390 CONTINUE                                                           CHAN2340
      HRUN = (CM.GT. 0.0) .OR. BRUN .AND.(UE.GE.0.1) .AND.(CM.EQ.0.0)    CHAN2350
C     NOZZLE ADMITTANCE IS INPUT TO PROGS A, B.                          CHAN2360
C*************************************************************************CHAN2370
C                                                                        CHAN2380
  400 IF ( .NOT. ARUN )            GO TO 490                             CHAN2390
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C                                                                       CHAM2400
  410 CALL  LONGL                                                       CHAM2410
C                                                                       CHAM2420
      IF(KER)420,440,420                                                CHAM2430
  420 WRITE (6,430)                                                     CHAM2440
  430 FORMAT(1H0,40X,18H ERROR PROGRAM A  )                             CHAM2450
      CALL  CORE  ( A(1), 700, CA )                                     CHAM2460
  440 CONTINUE                                                          CHAM2470
      GO TO 110                                                         CHAM2480
C*********************************************************************  CHAM2490
C     SET UP MAIN CONTROL DATA FOR USE IN B                             CHAM2500
C*********************************************************************  CHAM2510
  450 IF ( .NOT. BRUN )         GO TO 530                               CHAM2520
      B(1)=WC(1)                                                        CHAM2530
      B(2)=EXTRA(15)/EXTRA(14)                                          CHAM2540
      B(3)=EXTRA(11)                                                    CHAM2550
      B(5)=EXTRA(16)                                                    CHAM2560
      B(6) = DINP(17)                                                   CHAM2570
      B(7) = DINP(18)                                                   CHAM2580
      B(8) = DINP(19)                                                   CHAM2590
      B(101)=WC(2)                                                      CHAM2600
      DO 460 I=1,NOMEG                                                  CHAM2610
      B(I+1691)=WC(I+2)                                                 CHAM2620
  460 CONTINUE                                                          CHAM2630
      B(200) = DISTL(1) / DINP(14)                                      CHAM2640
      B(270) = DISTM(1)                                                 CHAM2650
      B(171) = 1.F                                                      CHAM2660
      DO 480 I = 2, 20                                                  CHAM2670
      IF(DISTM(I))490,490,470                                           CHAM2680
  470 B(I+199)=DISTL(I)/EXTRA(14)                                       CHAM2690
      B(I+219)=DISTM(I)                                                 CHAM2700
      B(171)=B(171)+1.0                                                 CHAM2710
  480 CONTINUE                                                          CHAM2720
  490 CONTINUE                                                          CHAM2730
      CALL  TRANS  ( B, X, CB, KER )                                    CHAM2740
      DO 500 I = 9, 100                                                 CHAM2750
  500    D(I) = X(I)                                                    CHAM2760
      IF(KER)590,510,590                                                CHAM2770
  510 WRITE (6,520)                                                     CHAM2780
  520 FORMAT (1H0,40X,18H ERROR PROGRAM B  )                            CHAM2790
      CALL CORE(B(1),600,CB)                                            CHAM2800
      GO TO 110                                                         CHAM2810
C*********************************************************************  CHAM2820
  590 IF ( .NOT. BRUN )       GO TO 620                                 CHAM2830
  600 DO 610 I=1,9                                                      CHAM2840
      X(I)=D(I)                                                         CHAM2850
  610 CONTINUE                                                          CHAM2860
      B(9)=EXTRA(11)                                                    CHAM2870
      DO 570 I = 9, 100                                                 CHAM2880
  570    X(I) = D(I)                                                    CHAM2890
      CALL  DDD  ( X(1), V(1), CD, KER, ERR )                           CHAM2900
      IF ( ERR )                  110,590,580                           CHAM2910
  580 IF ( KER )                  610,590,610                           CHAM2920
  590 WRITE (6,600)                                                     CHAM2930
  600 FORMAT (1H0,40X,18H ERROR PROGRAM D  )                            CHAM2940
      CALL CORE(X(1),100,CD)                                            CHAM2950
      GO TO 110                                                         CHAM2960
  610 CONTINUE                                                          CHAM2970
  620 IF ( .NOT. FRUN )       GO TO 670                                 CHAM2980
C*********************************************************************  CHAM2990
C     SET UP DATA FOR PROG F    (W, TAU )                               CHAM3000
C*********************************************************************  CHAM3010
  630 V(1)=EXTRA(16)                                                    CHAM3020
      B(101) = EXTRA(16)/V(1) * 12.0/6.2831853                          CHAM3030
  640 V(2)=EXTRA(18)                                                    CHAM3040
      CALL  FFF  ( V(1), B(1), CF, KER, WC(1) )                         CHAM3050
      IF ( KER )                  670,650,670                           CHAM3060
  650 WRITE (6,660)                                                     CHAM3070
  660 FORMAT (1H0,40X,18H ERROR PROGRAM F  )                            CHAM3080
      CALL CORE(V(1),100,CF)                                            CHAM3090
  670 GO TO 110                                                         CHAM3100
C                                                                       CHAM3110
C                                                                       CHAM3120
C*********************************************************************  CHAM3130
C*********************************************************************  CHAM3140
C*********************************************************************  CHAM3150
      END                                                               CHAM3160
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$IBFTC WGEN    LIST,...                                                 WGEN
      SUBROUTINE GENWG(W)                                               WGEN  10
C                                                                       WGEN  20
C*********************************************************************  WGEN  30
      DIMENSION W(1)                                                    WGEN  40
C                                                                       WGEN  50
C   LONGITUDINAL WILL HAVE WEG SUM UNION WILL BE SET TO ZERO BEFOR RETURWGEN  60
C  IF SUM 0 LONGITUDINAL AND GENERATE + OR - 10 PERCENT OF PIE          WGEN  70
C*********************************************************************  WGEN  80
      IF(W(1))40,50,10                                                  WGEN  90
C*********************************************************************  WGEN 100
C   FOR TRANSVERSE GENERATE 10 VALUES AROUND SUM 9 PERCEN. BELOW AND    WGEN 110
C   11 PERCENT ABOVE                                                    WGEN 120
C*********************************************************************  WGEN 130
   10 SUM=W(1)                                                          WGEN 140
   20 DELWEG=.1*SUM                                                     WGEN 150
      W(9)=SUM-DELWEG                                                   WGEN 160
      DELWEG=DELWEG/9.0                                                 WGEN 170
      W(9)=W(9)+DELWEG                                                  WGEN 180
      DO 30 I=10,12                                                     WGEN 190
      W(I)=W(I-1)+DELWEG                                                WGEN 200
   30 CONTINUE                                                          WGEN 210
C*********************************************************************  WGEN 220
C  NEGITIVE 10 INDICATES TO PROGRAM THAT FREQUENCES ARE GENERATED INTERWGEN 230
C*********************************************************************  WGEN 240
      W(2)=-10.0                                                        WGEN 250
      RETURN                                                            WGEN 260
C*********************************************************************  WGEN 270
C   IF WEG GENERATE + OR - 10 PERCENT OF POSITIVE INITIAL GUESS         WGEN 280
C*********************************************************************  WGEN 290
   40 SUM=-W(1)                                                         WGEN 300
      W(1)=0.0                                                          WGEN 310
      GO TO 20                                                          WGEN 320
   50 SUM=3.141592                                                      WGEN 330
      GO TO 20                                                          WGEN 340
      END                                                               WGEN 350
```

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$ORIGIN       BLCDE
$IBFTC HYMN    LIST,M94
      SUBROUTINE  TRANS  ( BIN, XOUT, CB, KER )
C
C     CALCULATES COMBUSTION PARAMETERS  MR, MI
C         PROGRAM BY  LW VERNON  FROM  11MAY67 ANALYSIS OF  AJ SMITH, JR
C             INCORPORATES CORRECTIONS TO ANALYSIS THRU  1 JUN 67
C             BOOLE INTEGRATION AS OF  12 JUNE 67
C             RHO, RHOL CONVENTIONS CORRECTED  22JUN 67
C             20 SEP 67  MODIFIED FOR TABULAR INJECTOR COEFFICIENTS
C
C*********************************************************************
C
      REAL  IAR, IAI, IBR, IBI
      LOGICAL  LOGIK, HRUN, CKOUT, SIMPL, KNOT, LIMIT, TABLR
C
      COMMON  /PROLOS/  LOGIK(30), HEAD(12), SL1, SL2, ECRJ
      COMMON  /ABCDF / DIN (4300)
     1  , SPACE(222), WIT(17), AVN(17), BVN(17), CVNR(17), CVNI(17)
      DIMENSION            B    ( 240 ) ,  GS    (  6, 102 ) ,
     1   ZZ    ( 102 ) ,  STAB ( 102 ) ,  GL    ( 12, 3 )    ,
     2   U     ( 102 ) ,  CTAB ( 102 ) ,  SLAM  ( 12 )       ,
     3   DU    ( 102 ) ,  D2U  ( 102 ) ,  ZAP   ( 12 )       ,
     4   UL    ( 102 ) ,  DUL  ( 102 ) ,  G     ( 12 )       ,
     5   RHO   ( 102 ) ,  DRHO ( 102 ) ,  OLD   ( 12 )       ,
     6   RHOL  ( 102 ) ,  DROL ( 102 ) ,  ZING  (  6 )       ,
     7   QBAR  ( 102 ) ,  DQ   ( 102 ) ,  SIMP  (  6 )       ,
     8   ZIP3  ( 102 ) ,  V1   ( 102 ) ,  ERRZ  (  6 )       ,
     9   ZIP5  ( 102 ) ,  V2   ( 102 ) ,  ZP    (  6 )
      DIMENSION
     1   THR  (  30 ) ,  THI  (  30 ) ,  THTR (  30 ) ,  THTI (  30 )
      DDIMENS'ON           AL   (  6 ) ,  DFEK  (  4 )     ,
     1   BIN  ( 240 ) ,  XOUT ( 100 ) ,  WC    ( 28 )      ,
     2   WET  (  30 ) ,  ERT  (  30 ) ,  EIT   ( 30 )      ,
     3   ZDIST(  20 ) ,  CRT  (  30 ) ,  CIT   ( 30 )      ,
     4   DISTH(  20 )
      EQUIVALENCE
     1   ( HRUN , LOGIK( 8)),( CKOUT, LOGIK(13)),( SIMPL, LOGIK(14)),
     2   ( KNOT , LOGIK(15)),( LIMIT, LOGIK(16)),( TABLR, LOGIK(17))
      EQUIVALENCE
     1   ( B(1) , SNM    ),( B( 10) , ZINC   ),( DIN( 14) , RCH    ),
     2   ( B(2) , ZE     ),( B( 18) , XNE    ),( UL(1)    , ULO    ),
     3   ( B(3) , GAM    ),( B( 19) , XNW    ),( RHOL(1)  , RHOLO  ),
     4   ( B(4) , UE     ),( B(170) , WC     ),( B(20)    , WET    ),
     5   ( B(5) , SOUND  ),( B(200) , ZDIST  ),( B(50)    , ERT    ),
     6   ( B(6) , ULN    ),( B(220) , DISTH  ),( B(80)    , EIT    ),
     7   ( B(7) , XK     ),( B(110) , CRT    ),
     8   ( B(8) , XCMPL  ),( B(140) , CIT    )
      EQUIVALENCE
     1   ( DIN(3406), RLON ),( DIN(3407), TLON )
      EQUIVALENCE
     1   ( A1R  , AL  ( 1) ),( A2R  , AL  ( 3) ),( A4R  , AL  ( 5) ),
     2   ( A1I  , AL  ( 2) ),( A2I  , AL  ( 4) ),( A4I  , AL  ( 6) ),
     3   ( G20R , SLAM( 9) ),( DG20R , SLAM(10) ),
     4   ( G20I , SLAM(11) ),( DG20I , SLAM(12) )
C*********************************************************************
C
   10 FORMAT ( / 65H TRANSVERSE STABILITY PROGRAM... CALCULATES  MR, MI
     1 OR  HTR, HTI )
   20 FORMAT ( // 11H INPUT DATA// 9X3HSNM12X2HZE10X5HGAMMA9X2HUE9X
     1    14HSOUND (FT/SEC) 2X13H ULN (FT/SEC) 5X 9HXK (DRAG)4X11HXCMPL
     2(IN)  //    F15.8, F14.8, F12.5, F14.8, F16.2, 2X 3F15.6    //
     3 5X10HINCREMENTS 8X4HLR/N 11X4HLT/N / 5XF8.1, 2F19.7 // )
   30 FORMAT ( // 25H NOZZLE ADMITTANCES INPUT//  15X9HOMEGA(CH) 12X
     1    5HERT 17X5HEIT 17X5HCRT 17X5HCIT // )
   40 FORMAT ( ////22H CALCULATED RESULTS... 10X 29HFIRST-ORDER SOLN ( UN
     1NIF INJ ) 15X21HSECOND-ORDER SOLUTION // 17X5HOMEGA 12X6HH REAL
     2 14X6HH IMAG 13X7HHT REAL 13X7HHT IMAG  )
   50 FORMAT ( 9XF15.7,2E20.8 )
   60 FORMAT ( 9XF15.7,4E20.8 )
   70 FORMAT ( // 31H INJECTOR COEFFICIENTS INPUT... // )
   80 FORMAT ( 11X3HANN ,7X3HBNN 16X6HCNN RE 14X6HCNN IM / 4E20.8 )
   90 FORMAT (10X5HOMEGA16X3HANN17X3HBNN16X6HCNN RE14X6HCNN IM/(5E20.8))
  100 FORMAT ( 12H0INTEGRALS   6E18.8 )
  110 FORMAT ( 6H ERROR 6X6E18.8 )
  120 FORMAT ( 29H0DUMP OF TABULAR FUNCTIONS... // 6X2HZZ12X1HU11X2HDU
     1    11X2HUL11X3HRHO9X4HRHOL9X4HQBAR9X4HZIP39X4HZIP5 // (1H 9E13.5))
  130 FORMAT ( 18H0TABLES FOR HIMACH//6X2HZZ11X3HD2U11X3HDUL9X4HDRHO9X
     1 4HDROL10X2HDQ11X2HV111X2HV2//)
  140 FORMAT ( 1H 8E13.5 )
  150 FORMAT (/10X1HW16X3HIAR15X3HIAI15X3HIBR15X3HIBI14X5HERCOX13X5HEICO
     1X/8X4HG20R14X4HG21R14X5HDG20R13X5HDG21R14X3HH1R15X3HH2R15X2HCR
     2 /8X4HG20I14X4HG21I14X5HDG20I13X5HDG21I14X3HH1I15X3HH2I15X2HCI//)
  160 FORMAT ( 7E18.8 )
C
C*********************************************************************
C*********************************************************************
      HRUN = DIN(8) .GE. 0.0
      CALL  DVCHK  ( KCHK )
      NWI = DIN(3408) + 0.01
      TABLR = NWI .GE. 3
      DO 170 I = 1, 240
  170    B(I) = BIN(I)
  180 IF ( CB-10.0 )           220,190,190
  190 CALL  PAGE  (  70 )
      KOUT = 2
      NET = XNE
      WRITE (6,10)
      IF ( CB-100.0 )          220,200,200
  200 WRITE (6,20)  ( B(I), I = 1, 8 ),  ZINC, RLON, TLON
      WRITE (6,30)
      WRITE (6,60)  ( WET(I), ERT(I),EIT(I), CRT(I),CIT(I), I=1,NET )
      CKOUT = ( CB .GT. 200.0 )
      IF ( .NOT. HRUN )       GO TO 220
      WRITE (6,70)
      IF ( TABLR )             GO TO 210
      WRITE (6,80)     AVN(1), BVN(1), CVNR(1), CVNI(1)
      GO TO 220
  210 WRITE (6,90)   ( WIT(I), AVN(I), BVN(I), CVNR(I), CVNI(I),
     1                 I = 1, NWI  )
C
C     GENERATE NORMALIZED DISTRIBUTION AND OTHER TABULAR FUNCTIONS
C
  220 ZC  = XCMPL / RCH
      ZC = ZE
      IDZ = ZINC + 0.001
      CALL  INT4  ( ZDIST, DISTH, ZC, UENRM )
      SCALE = UE / UENRM
      SIMPL = IDZ .LE. 0
      IF ( SIMPL )             GO TO 290
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      INT = 2                                                           MYMN1200
      IDZ = IDZ/4 * 4                                                   MYMN1210
C           MUST BE POSITIVE MULTIPLE OF FOUR.  LESS THAN  101          MYMN1220
      GO TO 240                                                         MYMN1230
C                                                                       MYMN1240
  230 INT = 1                                                           MYMN1250
      IDZ = -IDZ/2 * 2                                                  MYMN1260
C                                                                       MYMN1270
  240 IF ( ( IDZ .EQ. 0 ) .OR. ( IDZ .GT. 100 ) )  IDZ = 80             MYMN1280
C                                                                       MYMN1290
C          IDZ  IS NUMBER OF Z-INCREMENTS.                              MYMN1300
C                                                                       MYMN1310
      IDZP = IDZ + 1                                                    MYMN1320
      DZ  = ZC / FLOAT(IDZ)                                             MYMN1330
C                                                                       MYMN1340
      ZZ(1) = 0.0                                                       MYMN1350
      U(1)  = 1.0E-10                                                   MYMN1360
      DU(1) = 0.0                                                       MYMN1370
      RHO(1)= 1.0                                                       MYMN1380
      ULO   = ULM/SCUMD                                                 MYMN1390
      GF1 = -1.0 / (GAM-1.0)                                            MYMN1400
      GF2 = (GAM-1.0) / 2.0                                             MYMN1410
      RHOZE = ( 1.0 + GF2*UE*UE ) **GF1                                 MYMN1420
      RHOLO = RHOZE * UE / ULO                                          MYMN1430
      QBAR(1) = 0.0                                                     MYMN1440
      ZIP3(1) = 0.0                                                     MYMN1450
      ZIP5(1) = RHOLO                                                   MYMN1460
C                 ABOVE ARE FIRST TABULAR ENTRIES.                    MYMN1470
C                                                                       MYMN1480
      Z = 0.0                                                           MYMN1490
C                                                                       MYMN1500
      DO 250 IZ = 2, IDZP                                               MYMN1510
         Z = Z + DZ                                                     MYMN1520
         CALL  INT4D  ( ZDIST, DISTN, Z, U(IZ), DU(IZ) )                MYMN1530
         ZZ(IZ) = Z                                                     MYMN1540
         U (IZ) =  U(IZ)*SCALE                                          MYMN1550
         DU(IZ) = DU(IZ)*SCALE                                          MYMN1560
         UL(IZ) = UL(IZ-1) + XK*DZ*( U(IZ-1)-UL(IZ-1) )/UL(IZ-1)        MYMN1570
         TEMP = 1.0 + GAM*( U(IZ)-UL(IZ) )*U(IZ)                        MYMN1580
         RHO(IZ) = ( 1.0 + GF2*U(IZ)*U(IZ) ) **GF1                      MYMN1590
         RHOL(IZ) = ( RHOZE*UE - RHO(IZ)*U(IZ) ) / UL(IZ)               MYMN1600
     0   QBAR(IZ) = ( ( 1.0 - GAM*U(IZ)*U(IZ) )*RHO(IZ)*DU(IZ)         MYMN1610
     1              - GAM*U(IZ)*RHOL(IZ)*XK*( U(IZ)-UL(IZ) ) ) / TEMP   MYMN1620
         ZIP3(IZ) = DU(IZ) * DU(IZ)                                     MYMN1630
         ZIP5(IZ) = RHOL(IZ) / RHO(IZ)                                  MYMN1640
  250    CONTINUE                                                       MYMN1650
      ZZ(IDZP) = ZC                                                     MYMN1660
      U (IDZP) = UE                                                     MYMN1670
      DU(IDZP) = 0.0                                                    MYMN1680
      RHO(IDZP) = RHOZE                                                 MYMN1690
      RHOL(IDZP) = 0.0                                                  MYMN1700
      QBAR(IDZP) = 0.0                                                  MYMN1710
      ZIP3(IDZP) = 0.0                                                  MYMN1720
      ZIP5(IDZP) = 0.0                                                  MYMN1730
C                                                                       MYMN1740
C     QBAR, ZIP3, ZIP5  AS TABULATED ABOVE ARE FREQ-INDEPENDENT PARTS   MYMN1750
C        OF INTEGRANDS.                                                 MYMN1760
C                                                                       MYMN1770
C***********************************************************************MYMN1780
      IF ( .NOT. MRUN )        GO TO 270                                MYMN1790
C                                                                       MYMN1800
C          INITIAL VALUES FOR  HI-ORDER TABLES                          MYMN1810
      HDZ = 0.5 * DZ                                                    MYMN1820
      D2U (1) = 0.0                                                     MYMN1830
      DRHO(1) = 0.0                                                     MYMN1840
      DROL(1) = 0.0                                                     MYMN1850
      DQ  (1) = 0.0                                                     MYMN1860
      DUL (1) = -XK                                                     MYMN1870
      V1  (1) = 0.0                                                     MYMN1880
      V2  (1) = 1.0                                                     MYMN1890
C                                                                       MYMN1900
      HDZR = 0.5/DZ                                                     MYMN1910
      A1 = HDZ/ULO                                                      MYMN1920
C                              HI-ORDER TABLES                          MYMN1930
      DO 260 IZ = 2, IDZP                                               MYMN1940
         A2 = HDZ/UL(IZ)                                                MYMN1950
         V1(IZ) = V1(IZ-1) + A1 + A2                                    MYMN1960
         V2(IZ) = EXP( XK*V1(IZ) )                                      MYMN1970
         A1 = A2                                                        MYMN1980
         DUL (IZ) = ( UL  (IZ+1) - UL  (IZ-1) )*HDZR                    MYMN1990
         DRHO(IZ) = ( RHO (IZ+1) - RHO (IZ-1) )*HDZR                    MYMN2000
         DROL(IZ) = ( RHOL(IZ+1) - RHOL(IZ-1) )*HDZR                    MYMN2010
         DQ  (IZ) = ( QBAR(IZ+1) - QBAR(IZ-1) )*HDZR                    MYMN2020
         D2U (IZ) = ( DU  (IZ+1) - DU  (IZ-1) )*HDZR                    MYMN2030
  260    CONTINUE                                                       MYMN2040
C                    FINAL VALUES                                       MYMN2050
      DUL (IDZP) = XK*(UE-UL(IDZP))/UL(IDZP)                            MYMN2060
      DROL(IDZP) = 0.0                                                  MYMN2070
      DRHO(IDZP) = 0.0                                                  MYMN2080
      DQ  (IDZP) = 0.0                                                  MYMN2090
      D2U (IDZP) = 0.0                                                  MYMN2100
      D2U(2) = 0.5*D2U(3)                                               MYMN2110
      DQ (2) = 0.5*DQ (3)                                               MYMN2120
      D2U(IDZ) = 0.5*D2U(IDZ-1)                                         MYMN2130
      DQ (IDZ) = 0.5*DQ (IDZ-1)                                         MYMN2140
C                                                                       MYMN2150
      KNOT = XK .EQ. 0.0                                                MYMN2160
      XI2R = 0.0                                                        MYMN2170
      XI3R = 0.0                                                        MYMN2180
      XI4R = 0.0                                                        MYMN2190
      VK1 = 0.0                                                         MYMN2200
      VK2 = 0.0                                                         MYMN2210
      IF ( TABLR )             GO TO 270                                MYMN2220
      AMM  = AVM(1)                                                     MYMN2230
      BNM  = BVM (1) * PLOM                                             MYMN2240
      CMMR = CVMR(1) * TLOM                                             MYMN2250
      CMMI = CVMI(1) * TLOM                                             MYMN2260
C                                                                       MYMN2270
  270 CONTINUE                                                          MYMN2280
      NW  = NNW                                                         MYMN2290
C                                                                       MYMN2300
C***********************************************************************MYMN2310
C                                                                       MYMN2320
C     CALCULATIONS FOR EACH FREQUENCY, W                                MYMN2330
C                                                                       MYMN2340
C***********************************************************************MYMN2350
                                                                        MYMN2360
      DO 320 IW = 1, NW                                                 MYMN2370
         W = WC(IW)                                                     MYMN2380
         OMEG2 = SNH*SNH   W*W                                          MYMN2390
         OMEG = SQRT(ABS(OMEG2))                                        MYMN2400
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      LIMIT = .FALSE.                                                   HYMN2410
C                                                                       HYMN2420
      CALL  INT4  ( WET, ERT, W, ER )                                   HYMN2430
      CALL  INT4  ( WET, EIT, W, EI )                                   HYMN2440
      IF ( OMEG2 )          280,290,300                                 HYMN2450
280   IM = 1                                                            HYMN2460
      GO TO 310                                                         HYMN2470
C                                                                       HYMN2480
290   IM = 2                                                            HYMN2490
      OMEG = 0.5E-10                                                    HYMN2500
      OMEG2 = 0.25E-20                                                  HYMN2510
C                                                                       HYMN2520
300   IM = 3                                                            HYMN2530
C                                                                       HYMN2540
C    EVALUATION OF SIX INTEGRALS BY  BOOLE  FORMULA  ( OR SIMPSON )     HYMN2550
C     BOOLE INTEGRATION IF  ZINC INPUT POSITIVE.  ELSE SIMPSON RULE     HYMN2560
C        ( BOOLE IS SIMPSON RULE WITH ERROR FORMULA )                   HYMN2570
C                                                                       HYMN2580
C       IM  IS  ( 1, 2, 3 )  AS  OMEG2  IS  ( -, 0, + ),                HYMN2590
C       THEN USE  ( CIRCULAR, LIMIT, HYPERBOLIC )  FUNCTIONS            HYMN2600
C                                                                       HYMN2610
310   DO 320 I = 1, 6                                                   HYMN2620
320      ZING(I) = 0.0                                                  HYMN2630
      NOD = 3                                                           HYMN2640
      DO 430 IZ = 1, IDZP, INT                                          HYMN2650
         Z = ZZ(IZ)                                                     HYMN2660
         GO TO (350,340,330), NOD                                       HYMN2670
C                                                                       HYMN2680
330      WT = 1.0                                                       HYMN2690
         NOD = 1                                                        HYMN2700
         GO  TO 360                                                     HYMN2710
C                                                                       HYMN2720
340      WT = 2.0                                                       HYMN2730
         IF ( IZ .EQ. IDZP )   GO TO 350                                HYMN2740
         NOD = 1                                                        HYMN2750
         GO TO 360                                                      HYMN2760
C                                                                       HYMN2770
350      WT = 4.0                                                       HYMN2780
         NOD = 2                                                        HYMN2790
C                                                                       HYMN2800
360      PSI = OMEG * (ZE-Z)                                            HYMN2810
         GO TO (390,370,380), IM                                        HYMN2820
C                                                                       HYMN2830
370      ZEZ = ZE - Z                                                   HYMN2840
         ZF(1) = QBAR(IZ) * ZEZ                                         HYMN2850
         ZF(2) = QBAR(IZ)                                               HYMN2860
         ZF(3) = ZIPS(IZ) * ZEZ                                         HYMN2870
         ZF(4) = ZIPS(IZ)                                               HYMN2880
         ZF(5) = ZIPS(IZ) * ZEZ                                         HYMN2890
         ZF(6) = ZIPS(IZ)                                               HYMN2900
         GO TO 410                                                      HYMN2910
C                                                                       HYMN2920
380      CF = COSH(PSI)                                                 HYMN2930
         SF = SINH(PSI)                                                 HYMN2940
         GO TO 400                                                      HYMN2950
C                                                                       HYMN2960
390      CF = COS (PSI)                                                 HYMN2970
         SF = SIN (PSI)                                                 HYMN2980
C                                                                       HYMN2990
400      ZF(1) = QBAR(IZ) * SF                                          HYMN3000
         ZF(2) = QBAR(IZ) * CF                                          HYMN3010
         ZF(3) = ZIPS(IZ) * SF                                          HYMN3020
         ZF(4) = ZIPS(IZ) * CF                                          HYMN3030
         ZF(5) = ZIPS(IZ) * SF                                          HYMN3040
         ZF(6) = ZIPS(IZ) * CF                                          HYMN3050
C       ZF ARE COMPLETE INTEGRANDS                                      HYMN3060
C                                                                       HYMN3070
410      DO 420 I = 1, 6                                                HYMN3080
            ZING(I) = ZING(I) + WT*ZF(I)                                HYMN3090
420         CONTINUE                                                    HYMN3100
430      CONTINUE                                                       HYMN3110
C                                                                       HYMN3120
      GO TO (460,440), INT                                              HYMN3130
C                                                                       HYMN3140
440   INT = 1                                                           HYMN3150
      DO 450 I = 1, 6                                                   HYMN3160
450      SIMP(I) = ZING(I)*DZ/1.5                                       HYMN3170
C           SIMP IS SIMPSON INTEGRAL FOR IDZ/2 INCREMENTS               HYMN3180
      GO TO 310                                                         HYMN3190
C                                                                       HYMN3200
460   DO 470 I = 1, 6                                                   HYMN3210
470      ZING(I) = ZING(I)*DZ/3.0                                       HYMN3220
C           ZING IS SIMPSON INTEGRAL FOR  IDZ  INCREMENTS               HYMN3230
C                                                                       HYMN3240
      IF ( SIMPL )          GO TO 490                                   HYMN3250
   INT = 2                                                              HYMN3260
      DO 480 I = 1, 6                                                   HYMN3270
         ERRZ(I) = ( ZING(I)-SIMP(I) ) / 15.0                           HYMN3280
         IF ( ABS(ERRZ(I)/ZING(I) ) .GT. 0.05 )  CKOUT = .TRUE.         HYMN3290
C    ZING, SIMP ARE SIMPSON INTEGRALS WITH  IDZ, IDZ/2  INCREMENTS      HYMN3300
         ZING(I) = ZING(I) + ERRZ(I)                                    HYMN3310
C    CORRECTED  ZING  IS NOW  BOOLE INTEGRAL                            HYMN3320
480      CONTINUE                                                       HYMN3330
C                                                                       HYMN3340
C       ABOVE  ZING(I)  ARE THE REQUIRED INTEGRALS                      HYMN3350
C                                                                       HYMN3360
490   IF ( .NOT. CKOUT )    GO TO 500                                   HYMN3370
      WRITE (6,100)  ZING                                               HYMN3380
      IF ( .NOT. SIMPL )    WRITE (6,110)  ERRZ                         HYMN3390
C                                                                       HYMN3400
500   OZE = OMEG * ZE                                                  HYMN3410
      WK5Q = XK*XK + W*W                                                HYMN3420
      T1 = XI*W / WK5Q                                                  HYMN3430
      T2 = W*W / WK5Q                                                   HYMN3440
C                                                                       HYMN3450
      Y1R = GAM*ZING(2)-ZING(2) + ZING(4) + W*T1*ZING(6)                HYMN3460
      Y1I = XK*T1*ZING(6)                                               HYMN3470
C                                                                       HYMN3480
      GO TO (530,510,520), IM                                           HYMN3490
C                                                                       HYMN3500
510   Y2R = -SNH*ER/W                                                   HYMN3510
      Y2I = -SNH*EI/W                                                   HYMN3520
      ERCOM = SNH*ER                                                    HYMN3530
      EICOM = SNH*EI                                                    HYMN3540
      GO TO 550                                                         HYMN3550
C                                                                       HYMN3560
520   COZE = COSH(OZE)                                                  HYMN3570
      SOZE = SINH(OZE)                                                  HYMN3580
      GO TO 540                                                         HYMN3590
C                                                                       HYMN3600
530   COZE =  COS(OZE)                                                  HYMN3610
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      SOZE = -SIN(OZE)                                                  HYMN3620
C                                                                       HYMN3630
  540 ERCON = SNH*ER/OMEG                                               HYMN3640
      EICON = SNH*EI/OMEG                                               HYMN3650
      Y2R = -SNH*ER/W*COZE                                              HYMN3660
      Y2I = -SNH*EI/W*COZE - OMEG/W*SOZE                                HYMN3670
C                                                                       HYMN3680
  550 TEMP = GAM*ZING(1)-ZING(1) + ZING(3) + W*T1*ZING(5)               HYMN3690
      Y3R = ERCON*XK*T1*ZING(5) + EICON*TEMP                            HYMN3700
      Y3I = EICON*XK*T1*ZING(5) - ERCON*TEMP                            HYMN3710
      Y6R =  EICON*ZING(1) + ZING(2)                                    HYMN3720
      Y6I = -ERCON*ZING(1)                                              HYMN3730
C                                                                       HYMN3740
C                                                                       HYMN3750
C***********************************************************************HYMN3760
C                                                                       HYMN3770
C****   CALCULATION OF FIRST-ORDER SOLUTION...                          HYMN3780
C                                                                       HYMN3790
C                                                                       HYMN3800
C                                                                       HYMN3810
  560 M1R = ( Y1R+Y2R+Y3R )/GAM                                         HYMN3820
      M1I = ( Y1I+Y2I+Y3I )/GAM                                         HYMN3830
      MD = Y6R*Y6R + Y6I*Y6I                                            HYMN3840
C                                                                       HYMN3850
      MR = ( M1R*Y6R + M1I*Y6I ) / MD                                   HYMN3860
      MI = ( M1I*Y6R - M1R*Y6I ) / MD                                   HYMN3870
C                                                                       HYMN3880
      THR(IW) = MR                                                      HYMN3890
      THI(IW) = MI                                                      HYMN3900
C                                                                       HYMN3910
      IF ( .NOT. HRUN )     GO TO 820                                   HYMN3920
C                                                                       HYMN3930
C***********************************************************************HYMN3940
C                                                                       HYMN3950
C     TERMS FROM HIGH-ORDER ANALYSIS   ( STILL IN  W-LOOP )             HYMN3960
C        INITIALIZE  INTEGRALS, INTEGRANDS FOR  Z=0.0                   HYMN3970
C                                                                       HYMN3980
      DO 570 I = 1, 6                                                   HYMN3990
         AL(I) = 0.0                                                    HYMN4000
         DO 570 IZ = 1, IDZP                                            HYMN4010
  570       GS(I,IZ) = 0.0                                              HYMN4020
      DO 580 I = 1, 12                                                  HYMN4030
         QLD(I) = 0.0                                                   HYMN4040
         ZAP(I) = 0.0                                                   HYMN4050
         GL(I,1) = 0.0                                                  HYMN4060
  580    SLAM(I) = 0.0                                                  HYMN4070
      QLD(3) = -XK*OMEG2                                                HYMN4080
      IF ( IM .EQ. 1 )     SOZE = -SOZE                                 HYMN4090
      NOD = 1                                                           HYMN4100
      TEMP = -T1*RHOLO                                                  HYMN4110
      GL( 9,1) = TEMP*XK*W*SOZE                                         HYMN4120
      GL(10,1) = TEMP*XK*W*COZE                                         HYMN4130
      GL(11,1) = TEMP*OMEG2*SOZE                                        HYMN4140
      GL(12,1) = TEMP*OMEG2*COZE                                        HYMN4150
C                                                                       HYMN4160
      IF ( .NOT. TABLR )   GO TO 585                                    HYMN4161
      CALL  INT4  ( WIT, AVN , W, ANH  )                                HYMN4162
      CALL  INT4  ( WIT, BVN , W, BNH  )                                HYMN4163
      CALL  INT4  ( WIT, CVNR, W, CNHR )                                HYMN4164
      CALL  INT4  ( WIT, CVNI, W, CNHI )                                HYMN4165
C                                                                       HYMN4166
      BNH  = RLON * BNH                                                 HYMN4167
      CNHR = TLON * CNHR                                                HYMN4168
      CNHI = TLON * CNHI                                                HYMN4169
C                                                                       HYMN4170
  585 YE = ANH - CNHI/(W*GAM)                                           HYMN4171
      YF = ( BNH + CNHR ) / (W*GAM)                                     HYMN4180
      H2? = Y6R*YE - Y6I*YF                                             HYMN4190
      H2I = Y6R*YF + Y6I*YE                                             HYMN4200
      HSSQ = H2R*H2R + H2I*H2I                                          HYMN4210
      HA = ( H1R*H2R + H1I*H2I ) / HSSQ                                 HYMN4220
      HB = ( H1I*H2R - H1R*H2I ) / HSSQ                                 HYMN4230
C                                                                       HYMN4240
      CALL  INT4  ( WET, CRT, W, CR )                                   HYMN4250
      CALL  INT4  ( WET, CIT, W, CI )                                   HYMN4260
C                                                                       HYMN4270
      GO TO (590,610,630),  IM                                          HYMN4280
  590 DO 600 IZ = 1, IDZP                                               HYMN4290
         ARG = OMEG*ZZ(IZ)                                              HYMN4300
         STAB(IZ) = SIN (ARG)                                           HYMN4310
  600    CTAB(IZ) = COS (ARG)                                           HYMN4320
      SIGN = -1.0                                                       HYMN4330
      GO TO 650                                                         HYMN4340
C                                                                       HYMN4350
  610 DO 620 IZ = 1, IDZP                                               HYMN4360
         STAB(IZ) = ZZ(IZ)                                              HYMN4370
  620    CTAB(IZ) = 1.0                                                 HYMN4380
      GL(11,1) = TEMP * ZE                                              HYMN4390
      GL(12,1) = TEMP                                                   HYMN4400
      GO TO 650                                                         HYMN4410
C                                                                       HYMN4420
  630 DO 640 IZ = 1, IDZP                                               HYMN4430
         ARG = OMEG*ZZ(IZ)                                              HYMN4440
         STAB(IZ) = SINH(ARG)                                           HYMN4450
  640    CTAB(IZ) = COSH(ARG)                                           HYMN4460
      SIGN = 1.0                                                        HYMN4470
C                                                                       HYMN4480
C                                                                       HYMN4490
  650 DO 780 IZ = 2, IDZP                                               HYMN4500
         NOD = NOD + 1                                                  HYMN4510
         V3 = XK*RHOL(IZ)/RHO(IZ)                                       HYMN4520
         V4 = DU(IZ) + V3                                               HYMN4530
         V5 = QBAR(IZ)*V4 + RHO(IZ)*U(IZ)*DQ(IZ)                        HYMN4540
         V6 = ( RHOL(IZ)/UL(IZ)*DUL(IZ) - DROL(IZ) ) / RHO(IZ)          HYMN4550
         V7 = ( 2.0*(D2U(IZ)-DU(IZ)) + V3 - XK*V6 )                     HYMN4560
         V8 = XK*ZIPS(IZ) - U(IZ) - 3.0*DU(IZ)                          HYMN4570
     0   V9 = V3*( DU(IZ) - DUL(IZ) - UL(IZ)/RHOL(IZ)*DROL(IZ) )        HYMN4580
     1        + DU(IZ)*DU(IZ)                                           HYMN4590
     0   V10 = ( GAM*DQ(IZ) - DQ(IZ) + RHO(IZ)*D2U(IZ) + D2U(IZ) )      HYMN4600
     1         * U(IZ)/RHO(IZ)                                         HYMN4610
         V11 = U(IZ)/RHO(IZ)*DROL(IZ)/RHO(IZ)                           HYMN4620
         V12 = ( GAM*QBAR(IZ) - QBAR(IZ) )*DU(IZ)                       HYMN4630
         V13 = ( V12 + D2U(IZ) )/RHO(IZ)                                HYMN4640
         V16 = QBAR(IZ)/RHO(IZ)                                         HYMN4650
         V17 = (GAM-1.0) * ( V16*V16 + U(IZ)/RHO(IZ)*DQ(IZ) )           HYMN4660
     0   V18 = (U(IZ)-UL(IZ))*DQ(IZ) + QBAR(IZ)*(DU(IZ)-DUL(IZ))       HYMN4670
     1         * RHO(IZ)                                               HYMN4680
         V19 = ( UL(IZ)-XK-DUL(IZ) ) / ( UL(IZ)*UL(IZ) ) * RHOL(IZ)     HYMN4690
         V20 = V19 + DROL(IZ)/UL(IZ)                                    HYMN4700
         V21 = V16 - GAM*V16 - DU(IZ) - DU(IZ)/RHO(IZ)                  HYMN4710
            V22 = GAM - 1.0                                             HYMN4720
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            V23 = RHO(IZ) + 1.0                                                 HYMNA730
            V24 = RHO(IZ) - 1.0                                                 HYMNA740
            V25 = V22 * (QBAR(IZ)*DU(IZ) + U(IZ)*DQ(IZ))                       HYMNA750
            V26 = DU(IZ) * (V22*QBAR(I7) + (GAM + V23)*DU(IZ))                  HYMNA760
            V27 = RHO(IZ)*W10/T2                                                HYMNA770
     0      V28 = V22 * (QBAR(IZ)*(QBAR(IZ)/RHO(IZ) + DU(IZ))                  HYMNA780
     1                 + 2.0*U(IZ)*DQ(IZ))                                      HYMNA790
     0      V29 = RHO(IZ) * (D2U(IZ)*(U(IZ  - UL(IZ))                          HYMNA800
     1                    + DU(IZ)*(DU(IZ) - DUL(IZ)))                         HYMNA810
            V30 = U(IZ)*D2U(IZ)                                                 HYMNA820
C                                                                               HYMNA830
C     THE FUNCTIONS  V1 ... V20  ARE INDEPENDENT OF W.  HENCE WE COULD          HYMNA840
C        TRADE CORE FOR TIME BY TAKING ALL OR SOME OUT OF W-LOOP AS             HYMNA850
C        SUBSCRIPTED VARIABLES.  LET S SEE FIRST WHAT CORE WE HAVE.             HYMNA860
C                                                                               HYMNA870
            ARG = W * V1(IZ)                                                    HYMNA880
            CWV = COS(ARG)                                                      HYMNA890
            SWV = SIN(ARG)                                                      HYMNA900
            XI10R = CWV*V2(IZ)/RHO(IZ)                                          HYMNA910
            XI10I = SWV*V2(IZ)/RHO(IZ)                                          HYMNA920
            ZETAR = CWV/V2(IZ)                                                  HYMNA930
            ZETAI = SWV/V2(IZ)                                                  HYMNA940
            XI14R = XI10R*DUL(IZ)                                               HYMNA950
            XI14I = XI10I*DUL(IZ)                                               HYMNA960
            OZEZ = OMEG * ( ZE-ZZ(IZ) )                                         HYMNA970
            GO TO (660,670,680), IM                                             HYMNA980
C                                                                               HYMNA990
  660       PO  = CTAB(IZ)                                                      HYMN5000
            PPO = -OMEG*STAB(IZ)                                                HYMN5010
            ST = SIN ( OZEZ )                                                   HYMN5020
            CT = COS ( OZEZ )                                                   HYMN5030
            GO TO 690                                                           HYMN5040
C                                                                               HYMN5050
  670       PO  = 1.0                                                           HYMN5060
            PPO = 0.0                                                           HYMN5070
            ST = ZE-ZZ(IZ)                                                      HYMN5080
            CT = 1.0                                                            HYMN5090
            GO TO 690                                                           HYMN5100
C                                                                               HYMN5110
  680       PO  = CTAB(IZ)                                                      HYMN5120
            PPO = OMEG*STAB(IZ)                                                 HYMN5130
            ST = SINH( OZEZ )                                                   HYMN5140
            CT = COSH( OZEZ )                                                   HYMN5150
C                                                                               HYMN5160
  690        IJK = 0                                                           HYMN5170
            DO 700 JZ = IZ, IDZP                                                HYMN5180
               IJK = IJK + 1                                                    HYMN5190
     0         GS(1,JZ) = (QBAR(IZ)*STAB(IJK)+QBAR(IZ-1)*STAB(IJK+1))         HYMN5200
     1                    * HDZ + GS(1,JZ)                                    HYMN5210
     0         GS(2,JZ) = (QBAR(IZ)*CTAB(IJK)+QBAR(IZ-1)*CTAB(IJK+1))         HYMN5220
     1                    * HDZ + GS(2,JZ)                                    HYMN523C
     0         GS(3,JZ) = (ZIP3(IZ)*STAB(IJK)+ZIP3(IZ-1)*STAB(IJK+1))         HYMN5240
     1                    * HDZ + GS(3,JZ)                                    HYMN5250
     0         GS(4,JZ) = (ZIP3(IZ)*CTAB(IJK)+ZIP3(IZ-1)*CTAB(IJK+1))         HYMN5260
     1                    * HDZ + GS(4,JZ)                                    HYMN5270
     0         GS(5,JZ) = (ZIP5(IZ)*STAB(IJK)+ZIP5(IZ-1)*STAB(IJK+1))         HYMN5280
     1                    * HDZ + GS(5,JZ)                                    HYMN5290
     0         GS(6,JZ) = (ZIP5(IZ)*CTAB(IJK)+ZIP5(IZ-1)*CTAB(IJK+1))         HYMN5300
     1                    * HDZ + GS(6,JZ)                                    HYMN5310
C                                                                               HYMN5320
  700           CONTINUE                                                      HYMN5330
C                                                                               HYMN5340
            P10R = -XK*W*GS(5,IZ) * T1                                          HYMN5350
            P10I = ( GAM*GS(1,IZ)-GS(1,IZ)+GS(3,IZ)+W*T1*GS(3,IZ) ) * W         HYMN5360
C         ( P11R = 0.0 )                                                        HYMN5370
            P11I = -W*GS(1,IZ)                                                  HYMN5380
            IF ( LIMIT )       GO TO 710                                        HYMN5390
            P10R = P10R/OMEG                                                    HYMN5400
            P10I = P10I/OMEG                                                    HYMN5410
            P11I = P11I/OMEG                                                    HYMN5420
  710       PP10R = -W*XK*T1 * GS(6,IZ)                                         HYMN5430
     0      PP10I = (GAM*GS(2,IZ) - GS(2,IZ) + GS(4,IZ)                         HYMN5440
     1                                       + W*T1*GS(6,IZ) ) * W              HYMN5450
C         ( PP11R = 0.0 )                                                       HYMN5460
            PP11I = -W*GS(2,IZ)                                                 HYMN5470
C                                                                               HYMN5480
            IF ( KNOT )        GO TO 730                                        HYMN5490
C             EVALUATE INTEGRALS IN EXPRESSIONS FOR LAMDAS  ( AL(I) )           HYMN5500
            XI16R = ( W*RHOL(IZ)*ZETAR - V19*ZETAI ) * T1                       HYMN5510
            XI16I = ( W*RHOL(IZ)*ZETAI - V19*ZETAR ) * T1                       HYMN5520
            T3 = ( W*T1*DROL(IZ)/RHO(IZ) + D2U(IZ) ) * PO                       HYMN5530
            G(1) = T3 + XI10R                                                   HYMN5540
            G(2) = T3 + XI10I                                                   HYMN5550
            T4 = OMEG2*PO + PPO                                                 HYMN5560
            G(3) = XI14R * T4                                                   HYMN5570
            G(4) = XI14I * T4                                                   HYMN5580
            G(5) = PPO * XI10R                                                  HYMN5590
            G(6) = PPO * XI10I                                                  HYMN5600
            G( 7) = XI14R * PP11I                                               HYMN5610
            G( 8) = XI14I * PP11I                                               HYMN5620
            G( 9) = XI14R * PP10R                                               HYMN5630
            G(10) = XI14I * PP10R                                               HYMN5640
            G(11) = XI14R * PP10I                                               HYMN5650
            G(12) = XI14I * PP10I                                               HYMN5660
C                                                                               HYMN5670
            DO 720 I = 1, 12                                                    HYMN5680
               ZAP(I) = ( G(I) + OLD(I) )*HDZ + ZAP(I)                          HYMN5690
  720          OLD(I) = G(I)                                                   HYMN5700
C                    ( TRAPEZOIDAL RULE )                                       HYMN5710
     0         VK1 = XK * (  T2*RHOL(IZ)/RHO(IZ)*(V24*DU(IZ) - V3)             HYMN5720
     1                     + RHOL(IZ) * (W*T1*RHOL(IZ)/RHO(IZ)+DU(IZ)          HYMN5730
     2                                   - DUL(IZ) - XK*ZETAR)                  HYMN5740
     3                     - UL(IZ)*DROL(IZ) - U(IZ)/RHO(IZ)*DROL(IZ)         HYMN5750
     4                - RHOL(IZ)/RHO(IZ)*(V22*QBAR(IZ) + V23*DU(IZ)))        HYMN5760
     0         VK2 = XK * (  T2*U(IZ)/RHO(IZ  *DROL(IZ)                       HYMN5770
     1                     + XK*GAM*RHOL(IZ)*ZETAI/W)                         HYMN5780
C                                                                               HYMN5790
  730       XI1R = T2/RHO(IZ) * (V25 - V26 - V27 - V28 + V29 + VK1)             HYMN5800
            XI1I = T2 * (VK2 + V30)                                             HYMN5810
            XI2I = ( GAM*V16 - V16 + DU(IZ) + T2*V4 )*W                         HYMN4820
            XI9I = W*U(IZ) - T2/W*V7                                            HYMN5830
            XI4I = T1*V6 + 2.0*W*U(IZ)                                          HYMN5840
            XI5I = ( T2*V8 + DU(IZ)/RHO(IZ) )/W                                 HYMN5850
C           XI2R = XI3R = XI4R = XI5R = 0                                        HYMN5860
C                                                                               HYMN5870
C                                                                               HYMN5880
C                                                                               HYMN5890
            IF ( KNOT )        GO TO 740                                        HYMN5900
            A1R = -XI16R*ZAP(8) - XI16I*ZAP(7)                                  HYMN5910
            A1I =  XI16R*ZAP(7) - XI16I*ZAP(8) + GAM*PO*V5*T1                   HYMN5920
            A2R = T1/W*(V16*V5-V5/RHO(IZ))*PO                                   HYMN5930
```

```
      T5 = [illegible]
      T6 = AI*ZETAI - T9*ZETAR
      T7 = [illegible]*ZETAR - T*ZETAI
      T8 = [illegible]
C
      AAR = T1 * ( T8*( ZETAI*ZAP(5) + ZETAR*ZAP(6) )
     1          - [illegible]*( ZETAR*ZAP(1) + ZETAI*ZAP(2) )
     2          - T6*ZAP(3) + T7*ZAP(4) )
     3    + [illegible]
C
      AAI = T1 * ( T8*( ZETAI*ZAP(6) - ZETAR*ZAP(5) )
     1          - [illegible]*( ZETAR*ZAP(2) - ZETAI*ZAP(1) )
     2          + T7*ZAP(3) - T6*ZAP(4) )
     3    + [illegible]
C
 767  T9  = [illegible] * P111
      T10 = [illegible] * P111
      TEMP = -[illegible]
      A10 = A10 + TEMP*(T9-P10I) + [illegible]
     1          + [illegible]
      A11 = A11 - TEMP*(T10-P10R)
      A20 = A20 + [illegible]
      A21 = [illegible]
     1      [illegible]
      AAR = AAR + [illegible]
      AAI = AAI + [illegible]
     1          - [illegible]
C
C*************************************************************************
C
C     SET UP INTEGRANDS  ( SIMPSON RULE HERE  )
      DO 750 I = 1, 6
         SL(2*I-1,NDD) = AL(I)*ST
         GL(2*I ,NDD) = AL(I)*CT
         AL(I) = 0.0
 750     CONTINUE
C
      GO TO (780,785,760), NDD
C
 760  DO 775 I = 1, 12
         SLAM(I) = SLAM(I) + GL(I,1) + 4.0*GL(I,2) + GL(I,3)
C                          WEIGHTED SUM FOR THREE ORDINATES
         GL(I,1) = GL(I,3)
 775     CONTINUE
      NDD = 2
C
 785  CONTINUE
C
C*********************  ENDS  PRINCIPAL  Z-LOOP  ***********************
C                        STILL DOING FOR  IW
C
C*************************************************************************
C
C     COMPLETE INTEGRATION
      DO 790 I = 1, 12
         SLAM(I) = SLAM(I) * DZ/3.0
 790     CONTINUE
      IF ( LIMIT )             GO TO 800
C     CALCULATE DEFECT  ( CON  IBUTION OF INTEGRALS FROM  Z=ZC TO Z=ZE )
      TEMP = 2.0*VUE
      SLAM( 1) = SLAM( 1) + TEMP*P11I*(CF-1.0)/OMEG2
      SLAM( 2) = SLAM( 2) + TEMP*P11I*SF/OMEG
      SLAM( 9) = SLAM( 9) + TEMP*P10I*(CF-1.0)/OMEG2
      SLAM(10) = SLAM(10) + TEMP*P10I*SF/OMEG
      SLAM(11) = SLAM(11) - TEMP*P10R*(CF-1.0)/OMEG2
     1         -0.5*VUE*( PSI*COZE-CTAB(IDZP)*SF )/OMEG
     2         + 0.5*T2/VUE*( PSI*SOZE-STAB(IDZP)*SF )*SIGN
      SLAM(12) = SLAM(12) - TEMP*P10R*SF/OMEG
     1         - 0.5*VUE*( PSI*SOZE-STAB(IDZP)*SF )*SIGN
     2         + 0.5*T2/VUE*( PSI*COZE+CTAB(IDZP)*SF )*OMEG*SIGN
C
 800  G21R  = ANN*SLAM(1) + BNN*SLAM(5) + CNNR*SLAM(5) - CNNI*SLAM(7)
      G21I  = ANN*SLAM(3) + BNN*SLAM(7) + CNNR*SLAM(7) + CNNI*SLAM(5)
      DG21R = ANN*SLAM(2) + BNN*SLAM(6) + CNNR*SLAM(6) - CNNI*SLAM(8)
      DG21I = ANN*SLAM(4) + BNN*SLAM(8) + CNNR*SLAM(8) + CNNI*SLAM(6)
C
C      THE FOLLOWING AVAILABLE BY EQUIVALENCE...
C     G20R     IS  SLAM ( 9)
C     G20I     IS  SLAM (11)
C     DG20R    IS  SLAM (10)
C     DG20I    IS  SLAM (12)
C
C     FOR NONZERO OMEG, DIVISION BY OMEG IS IMPLICIT IN ERCON, EICON,
C     IAR, IAI, IBR, IBI  ARE TYPE REAL.
      TEMP = UE * W * ZING(2)
C     IAR = H1R - DG20R - ERCON*G20I - EICON*G20R
C    1           + ( ( CI*Y1I - CR*Y1R )*W - CR*Y1I + CI*Y1R )*W*UE
C     IAI = H1I - DG20I + ERCON*G20R - EICON*G20I
C    1           - ( ( CR*Y1I + CI*Y1R )*W + CR*Y1R - CI*Y1I )*W*UE
      IBR = H2R + DG21R + ERCON*G21I + EICON*G21R + TEMP*( CI-W*CR )
      IBI = H2I + DG21I - ERCON*G21R + EICON*G21I - TEMP*( CR+W*CI )
C
      HTD = IBR*IBR + IBI*IBI
      HTR = ( IAR*IBR + IAI*IBI ) / HTD
      HTI = ( IAI*IBR - IAR*IBI ) / HTD
C
      THTR(IW) = HTR
      THTI(IW) = HTI
C
      IF ( .NOT. CKOUT )     GO TO 820
      WRITE (6,150)
      WRITE (6,160)  W  ,  IAR,  IAI ,  IBR ,  IBI , ERCON, EICON,
     1               G20R, G21R, DG20R, DG21R,  H1R ,  H2R ,  CR  ,
     2               G20I, G21I, DG20I, DG21I,  H1I ,  H2I ,  CI
C
 820  CONTINUE
C                          END  OF  W-LOOP
C*************************************************************************
C
      KEP = NW
      KOUT(9) = INW
C
      IF ( NR M .     GO TO 850
C
      DO 830 IW = 1, NW
         KOUT(IW+ 9) = WC (IW)
         KOUT(IW+39) = THR(IW)
         KOUT(IW+69) = THI(IW)
 830     CONTINUE
      GO TO (880,840),  KOUT
 840  IF ( CKOUT )      CALL PAGE  ( 70 )
```

```
      WRITE (6,40)
      WRITE (6,50)  ( WC(I), THR(I), THI(I),  I = 1, NW  )
      GO TO 890
C
  850 DO 860 IW = 1, NW
          XOUT(IW+ 9) = WC (IW)
          XOUT(IW+39) = THTR(IW)
          XOUT(IW+69) = THTI(IW)
  860     CONTINUE
      GO TO (880,870), KOUT
  870 IF ( CKOUT )      CALL PAGE  ( 70 )
      WRITE (6,40)
      WRITE (6,60)  ( WC(I), THR(I), THI(I), THTR(I), THTI(I),
     1                 I = 1, NW  )
C
  880 IF ( .NOT. CKOUT )       GO TO 890
      CALL  PAGE ( 70 )
      WRITE (6,120)  ( ZZ(I), U(I), BU(I), UL(I), RHO(I), RHOL(I),
     1  XBAR(I), ZIPS(I), ZIPS(I),  I = 1, IBZP )
      IF  ( .NOT. HRUN )      GO TO 890
      CALL  PAGE ( 70 )
      WRITE (6,130)
      WRITE (6,140)  ( ZZ(I),DZU(I),DUL(I),DRHO(I),DRHOL(I),DO(I),V1(I),
     1    V2(I),  I = 1, IBZP )
C
C
C
C     I.E.  HTR, HTI  ARE FINAL RESULTS OF THIS SUBROUTINE WHEN PLACED
C           IN XOUT.   HTR, HTI INCLUDE INJECTOR EFFECTS, WHILE  HR, HI
C           DO NOT.  HENCE IF SUBROUTINE  DBD  IS ENTERED WITH HTR, HTI,
C           DBD  WILL EXPAND TABLE (BY INTERPOLATION), PRINT,
C           AND RETURN.
C
C
C
  890 RETURN
          END
```

```
$IBFTC HTINT   LIST,M94
      SUBROUTINE DOD(DIN,DOUT,CD,NER,ERR)
C
C     PROGRAM  D  COMPUTE HTR,HTI + INTERPOLATE 40 POINTS
C            20 SEP 67  MODIFIED FOR TABULAR INJECTOR COEFFICIENTS
C
      LOGICAL LOGIK,HRUN,TABLR
      COMMON /PROLOG/ LOGIK(50)
      COMMON  /ABCOF /  EXTRA(100),  ABLOK(600), A   , B , SPACE(3556),
     1          WIT(17), AVN(17), BVN(17),CVNR(17), CVNI(17)
      DIMENSION DIN(1),DOUT(1),A(133),B(133),OMEGA(1),HR(1),HI(1)
     1,HTR(30),HTI(30),HTRINT(1),HTIINT(1), OMGA(1)
     2,DOM(30)
      EQUIVALENCE (LOGIK(8),HRUN),(LOGIK(17),TABLR)
      EQUIVALENCE (A(1),ANH),(A(2),BNH),(A(3),CNHRE),(A(4),CNHIM),
     1(A(5),GAMMA),(A(6),XLRN),(A(7),XLON),(A(9),XNW),(A(10),OMEGA),
     2(A(40),HR),(A(70),HI),(B(9),ONW),(B(10),OMGA),(B(51),HTRINT),
     3(B(92),HTIINT) ,  ( OMEGA, DOM )
C
   10 FORMAT ( 21H0 INPUT TO PROGRAM  D // 10X8H GAMMA = F8.4,5X6HLR/N =
     1  F12.8, 5X6HLT/N = F12.8 )
   20 FORMAT ( 10X3HANH12X3HBNH11X6HCNH RE 9X6HCNH IN // 9X 4F15.7 // )
   30 FORMAT ( // 38H INJECTOR DISTRIBUTION COEFFICIENTS... //
     117X5HOMEGA 11X3HANH 12X3HBNH 11X6HCNH RE 9X6HCNH IN // (9X5F15.7))
   40 FORMAT (1H0, 19X,8HOMEGA(C),9X3H HR,13X3H HI   )
   50 FORMAT (1H0,19X, 8HOMEGA(C),9X3HHTR 13X3HHTI )
   60 FORMAT(1H ,10X,3F16.6)
   70 FORMAT (1H0 ,20H PROGRAM  D  OUTPUT  // 19X,8HOMEGA(C) 9X
     16H   HTR ,10X,6H   HTI  // )
   80 FORMAT (91H0ALL VALUES OF HTR ARE NEGATIVE- ( I.E. OUT OF RANGE OF
     1INTEREST- WILL PROCEED TO NEXT CASE))
   90 FORMAT(//,30X,69H   FOLLOWING WILL BE INTERPOLATION WITHIN HTR HTI
     1 TABLE GIVEN ABOVE    )
  100 FORMAT (19X,8H OMEGA   ,9X6HHTRINT,10X,6HHTIINT   )
  110 FORMAT (11X,F10.5,10X,F10.5,10X,F10.5)
C
      ERR=0.0
      C=0.0
      CALL DVCHK (K000FX)
  120 DO 130 I=1,133
      A(I)= DIN(I)
  130 B(I)=0.0
      NER=IFIX(XNW)
      IF(NER)140,140,160
  140 WRITE (6,150)NER
  150 FORMAT (1H0,10X,31H NUMBER OF OMEGAS IN ERROR    ,3X,I4    )
      GO TO 510
  160 IF(NER-29)170,170,140
  170 ONW = 40.0
      IF ( HRUN )              GO TO 190
      NWI = A(8) + 0.01
      IF ( NWI .GT. 2 )        GO TO 180
      ASSIGN 280 TO  NT
      TABLR = .FALSE.
      ANH = AVN (1)
      BNH = BVN (1)
      CNHRE = CVNR(1)
      CNHIM = CVNI(1)
      GO TO 190
  180 ASSIGN 270 TO  NT
      TABLR = .TRUE.
  190 IF(CD-99.0)260,260,200
  200 CALL  PAGE  ( 60 )
      WRITE (6,10)  GAMMA, XLRN, XLON
      IF ( HRUN  )             GO TO 230
      IF ( TABLR )             GO TO 210
      WRITE (6,20)  ANH, BNH, CNHRE, CNHIM
      GO TO 220
  210 WRITE (6,30)  ( WIT(I), AVN(I), BVN(I), CVNR(I), CVNI(I),
     1                I = 1, NWI )
  220 WRITE (6,40)
      GO TO 240
  230 WRITE (6,50)
  240 DO 250 I = 1,NER
  250 WRITE (6,60)OMEGA(I),HR(I),HI(I),
C
  260 IF ( HRUN )              GO TO 350
      DO 340 I=1,NER
      W = OMEGA(I)
      GO TO NT,(270,280)
  270 CALL   INT4  ( WIT, AVN , W, ANH    )
      CALL   INT4  ( WIT, BVN , W, BNH    )
      CALL   INT4  ( WIT, CVNR, W, CNHRE )
      CALL   INT4  ( WIT, CVNI, W, CNHIM )
  280 DEN = GAMMA*W
      X = ANH - CNHIM/DEN*XLON
      Y = BNH / DEN * XLRN + CNHRE * XLON / DEN
      SQD = X * X + Y * Y
      HTR(I) = (X * HR(I) + Y * HI(I) ) /SQD
      HTI(I) = (X * HI(I) - Y * HR(I) ) / SQD
      CALL DVCHK (K000FX)
       GO TO (310,290),K000FX
  290 IF (CD-10.0) 340,300,300
  300 IF (I-1) 330,320,330
  310 C=10.0
  320 LIN=NER+6
      CALL PAGE (LIN)
      WRITE (6,70)
  330 WRITE (6,60)DOM(I),HTR(I),HTI(I)
  340 CONTINUE
      GO TO 370
C
  350 DO 360 I = 1,NER
      HTI(I) = HI(I)
  360 HTR(I) = HR(I)
  370 JOMEG1 = 0
      JOMEG2=0
      IF ( CD .LE. 99.0 )      CALL  PAGE  (60)
      DO 390 I =1,NER
      IF (HTR(I)) 390,390,380
  380 JOMEG1 = I
      GO TO 410
  390 CONTINUE
      IF (JOMEG1)400,400,410
  400 WRITE (6,80)
      ERR= -1.0
      GO TO 520
  410 DO 430 J =I,NER
      IF (HTR(J)) 420,430,430
  420 JOMEG2 = J
      GO TO 440
```

```
430 CONTINUE                                                        MTRT1200
    JOME62 =NER                                                     MTRT1210
440 DLTME6 = (DOM(JOME62) -DOM(JOME61))/ 59.0                       MTRT1220
    L=NER+1                                                         MTRT1230
    MTI(L)=0.0                                                      MTRT1240
    MTR(L)=0.0                                                      MTRT1250
    DOM(L)=0.0                                                      MTRT1260
    OMGA(1) =DOM(JOME61)                                            MTRT1270
    DO 490 I=1,40                                                   MTRT1280
    CALL INTA (DOM(1),MTR(1),OMGA(1),MTRINT(1) )                    MTRT1290
    CALL INTA (DOM(1) MTI(1),OMGA(1),MTIINT(1) )                    MTRT1300
    IF (CD-10.6)480,4,3.450                                         MTRT1310
450 IF ( I-1 )   470,460,470                                        MTRT1320
460 IF ( .NOT. NRUN )    CALL  PAGE  ( 60 )                         MTRT1330
    WRITE (6,90)                                                    MTRT1340
    WRITE (6,100)                                                   MTRT1350
470 WRITE (6,60) OMGA(I),MTRINT(I),MTIINT(I)                        MTRT1360
480 OMGA(I+1) = OMGA(I) + DLTME6                                    MTRT1370
490 CONTINUE                                                        MTRT1380
    DO 900 I=1,199                                                  MTRT1390
900 DOUT (I) = B(I)                                                 MTRT1400
    IF(C) 910,920,910                                               MTRT1410
910 NER=6                                                           MTRT1420
920 RETURN                                                          MTRT1430
    END                                                             MTRT1440
```

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*[illegible] ADMIN                                                     *ADM0010
* SLALZ - ADAMS METHOD OF INTEGRATION                                  *ADM0020
* FAP TO MAP CONVERSION MSZLE[illegible] DEC 1963 . FORTRAN & PATTERSON JULY 64 *ADM0030
        ENTRY   ADMSET                                                 *ADM0040
        ENTRY   ADMINT                                                 *ADM0050
        ENTRY   ADMCOR                                                 *ADM0060
        ENTRY   ADMPAR                                                 *ADM0070
        ENTRY   ADMRES                                                 *ADM0080
ADMSET  SAVE    1                                                      *ADM0090
        CLA     3,4                                                    *ADM0100
        STA     RZ                   N TO ADD  OF RZ                   *ADM0110
        ALS     2                    4N                                *ADM0120
        STA     BP18      SAVE 4N,   SET FLAG FOR RETURN               *ADM0130
        ADD*    3,4                  4N                                *ADM0140
        STA     CF                   5N                                *ADM0150
        ADD     7,4                     PUT IN                         *ADM0160
        ADD     BP18          +4N                                      *ADM0170
        STA     CC                      PUT IN    DIFF TABLE LOC       *ADM0180
        CLA     4,4                  FUNCTION LOCATION                 *ADM0190
        ADD*    3,4                  4N                                *ADM0200
        STA     LF                   FUNCTION VALUE LOC                *ADM0210
        CLA     5,4                  DERIV LOC                         *ADM0220
        ADD*    3,4                  4N                                *ADM0230
        STA     LD                   DERIV VALUE LOC                   *ADM0240
        CLA     6,4                  PARTIAL STEP LOC                  *ADM0250
        ADD*    3,4                  4N                                *ADM0260
        STA     CP                   PARTIAL STEP LOC                  *ADM0270
        CLA     7,4                                                    *ADM0280
        ADD*    3,4                  4N                                *ADM0290
        STA     LG                   TEST VALUE LOC.     7,4 WAS PUT IN *ADM0300
        ADD*    3,4                  4N                                *ADM0310
        STA     CA                   ACCURACY EXPONENT LOC             *ADM0320
        ADD*    3,4                  4N                                *ADM0330
        STA     CK                   OLD FCN. LOC.                     *ADM0340
        ADD*    3,4                                                    *ADM0350
        STA     CO                                                     *ADM0360
        CLA     8,4                                                    *ADM0370
        STA     CX                   X LOC                             *ADM0380
        CLA     9,4                                                    *ADM0390
        STA     CH                   H LOC                             *ADM0400
        CLA     10,4                                                   *ADM0410
        ADD*    3,4                  4N                                *ADM0420
        STA     CD                   ACCURACY INPUT TABLE              *ADM0430
        TRA     BP20                                                   *ADM0440
ADMRES  SAVE    1                                                      *ADM0450
        STZ     BP18                                                   *ADM0460
BP20    STZ     FLAG                                                   *ADM0470
        LXA     RZ,4                 4N                                *ADM0480
CD      CAL     **,4                 ACCURACY INPUT,4                  *ADM0490
        ANA     =0377000000000                                         *ADM0500
        TNZ     *+2                  TEST FOR 0 ACCURACY INPUT         *ADM0510
        CLA     =0152000000000       ACCURACY SET= +152                *ADM0520
        ADD     =0022000000000                                         *ADM0530
CA      STO     **,4                 ACCURACY EXPONET,4                *ADM0540
        TIX     CD,4,1                                                 *ADM0550
        LXA     CF,1                 +5N                               *ADM0560
BP      STZ*    CC                   DIFF TABLE,1                      *ADM0570
        TIX     BP,1,1                                                 *ADM0580
        AXT     5,1                                                    *ADM0590
        SXD     CNT,1                                                  *ADM0600
        CLA     BP18                                                   *ADM0610
        TNZ     BP19                                                   *ADM0620
        RETURN  ADMRES                                                 *ADM0630
BP19    RETURN  ADMSET                                                 *ADM0640
BP18    PZE                                                            *ADM0650
ADMINT  SAVE                                                           *ADM0660
        CLA     FLAG                                                   *ADM0670
        TNZ     RZ                                                     *ADM0680
        RETURN  ADMINT                                                 *ADM0690
RZ      AXT     **,4                 4N                                *ADM0700
BP2     CLA*    LF                   FUNCTION,4                        *ADM0710
CK      STO     **,4                 OLD FUNCTION,4                    *ADM0720
        TIX     BP2,4,1                                                *ADM0730
RF      AXT     COEFP,4              PRED TABLE LOC                    *ADM0740
        SXA     CO,4                                                   *ADM0750
        TSX     COMP,4                                                 *ADM0760
CX      CLA     *                    X                                 *ADM0770
CH      FAD     *                    H                                 *ADM0780
        STO*    CX                   STORE IN X                        *ADM0790
        RETURN  ADMINT                                                 *ADM0800
COMP    SXA     IR1,1                                                  *ADM0810
        SXA     IR2,2                                                  *ADM0820
        SXA     IR4,4                                                  *ADM0830
        LXA     RZ,4                 N TO IN 4                         *ADM0840
CF      AXT     **,1                 5N   IN 1                         *ADM0850
CR      AXT     5,2                                                    *ADM0860
        STZ     TEMP                                                   *ADM0870
CC      LDQ     **,1                 DIFF TABLE,1                      *ADM0880
CO      FMP     **,2                 COEF,2                            *ADM0890
        FAD     TEMP                                                   *ADM0900
        STO     TEMP                                                   *ADM0910
        TXI     BP3,1,-1             NEXT DIFF                         *ADM0920
BP3     TIX     CC,2,1               NEXT COEF                         *ADM0930
        AXT     5,2                                                    *ADM0940
LD      LDQ     **,4                 DERIV,4                           *ADM0950
        FMP*    CO                   COEF,2                            *ADM0960
        FAD     TEMP                                                   *ADM0970
        LRS     35                                                     *ADM0980
        FMP*    CH                   H                                 *ADM0990
LG      STO     **,4                 TEST VALUE                        *ADM1000
ICM     FAD*    CK                   OLD FUNCTION                      *ADM1010
CM      STO*    LF                   FUNCTION,4                        *ADM1020
        TIX     CR,4,1               NEXT EQUATION                     *ADM1030
IR4     AXT     **,4                                                   *ADM1040
IR2     AXT     **,2                                                   *ADM1050
IR1     AXT     **,1                                                   *ADM1060
        TRA     1,4                                                    *ADM1070
ADMCOR  SAVE    1,2                                                    *ADM1080
        CLA     FLAG                                                   *ADM1090
        TZE     FIRST                                                  *ADM1100
        STD     TT                   0 TO DECR TT                      *ADM1110
        LXA     RZ,4                 N IN 4                            *ADM1120
DA      CLA*    LG                   TEST VALUE,4                      *ADM1130
CQ      STO     **,4                 PREDICTOR TEST VALUE,4            *ADM1140
        TIX     DA,4,1                                                 *ADM1150
        AXT     COEFC,4              CORRECTOR TABLE LOC               *ADM1160
        SXA     CO,4                                                   *ADM1170
        TSX     COMP,4                                                 *ADM1180
        LXA     RZ,4                 N TO IN 4                         *ADM1190
LF      CAL     **,4                 FUNCTION,4                        *ADM1200
        ANA     =0377000000000       KEEP EXP ONLY                     *ADM1210
```

```
         SUB     -0002000000000          SHIFT EXP                          *ADM1220
         UFA*    L6                      TEST VALUE,4                       *ADM1230
         UFS*    CB                      DEL YC - DEL YP                    *ADM1240
         SSP                                                                *ADM1250
         UFA*    CA                                                         *ADM1260
         ANA     =0000777777776          DOUBLING TEST 0 DOUBLE             *ADM1270
         TZE     BP4                                                        *ADM1280
         SXD     TT,4                    NO DOUBLE FLAG OVER 0              *ADM1290
BP4      ANA     =0000777777600          HALVING TEST 0 NO HALVE            *ADM1300
         TNZ     HALV                    NO ZERO HALVE                      *ADM1310
BZ       TIX     LF,4,1                                                     *ADM1320
         LXA     BZ,4                    +N                                 *ADM1330
         LXD     CNT,1                                                      *ADM1340
         TXL     BP5,1,0                                                    *ADM1350
         TXI     BP6,1,-1                REDUCE CNT BY 1                    *ADM1360
BP6      SXD     CNT,1                                                      *ADM1370
BP5      LXA     CF,1                    SN                                 *ADM1380
LP       AXT     5,2                                                        *ADM1390
         LDQ*    LD                      DERIV,4                            *ADM1400
CPR      CLS*    CC                      DIFF TABLE,1                       *ADM1410
         STO*    CC                      DIFF TABLE,1                       *ADM1420
         FAD*    CC                                                         *ADM1430
         LRS     35                                                         *ADM1440
CNT      TXH     BP7,2,*                                                    *ADM1450
         LDQ     COEFP                   0.                                 *ADM1460
BP7      TXI     BP8,1,-1                NEXT DIFF                          *ADM1470
BP8      TIX     CPR,2,1                                                    *ADM1480
         TIX     LP,4,1                                                     *ADM1490
TT       TXL     OUT,4,*                 ** BZERO DOUBLE                    *ADM1500
         AXT     TDBL,4                                                     *ADM1510
         SXA     TV,4                                                       *ADM1520
         TSX     MAT,4                                                      *ADM1530
         LDQ*    CH                      H                                  *ADM1540
         FMP     THAL,1                  2.0                                *ADM1550
         STO*    CH                      H                                  *ADM1560
OUT      RETURN  ADMCOR                                                     *ADM1576
HALV     AXT     THAL,4                  HALVING TABLE                      *ADM1580
         SXA     TV,4                                                       *ADM1590
         TSX     MAT,4                                                      *ADM1600
         CLA*    CX                      X                                  *ADM1610
         FSB*    CH                      H                                  *ADM1620
         STO*    CX                      X BACKED UP                        *ADM1630
         LDQ*    CH                      H                                  *ADM1640
         FMP     TPBL                    .5                                 *ADM1650
         STO*    CH                      NEW H                              *ADM1660
         TSX     IR2,4                   RESTORE IR1,IR2 DESTROYED BY MAT   *ADM1670
         TRA     BF                                                         *ADM1680
FIRST    STL     FLAG                    FLAG NOT = ZERO                    *ADM1690
         SXA     IR1F,1                                                     *ADM1700
         LXA     BZ,4                    N                                  *ADM1710
         LXA     CF,1                    SN                                 *ADM1720
BP10     CLA*    LD                      DERIV,4                            *ADM1730
         STO*    CC                      DIFF TABLE,1                       *ADM1740
         TXI     *+1,1,-5                                                   *ADM1750
BP9      TIX     BP10,4,1                                                   *ADM1760
IR1F     AXT     *,1                                                        *ADM1770
         TRA     BZ                                                         *ADM1780
MAT      LXA     CF,1                    SN                                 *ADM1790
         SXA     IR4M,4                                                     *ADM1800
TW       AXT     4,4                     4                                  *ADM1810
         AXT     9,2                     9                                  *ADM1820
TV       SXD     TU,4                    STORE IR4 INSHIFT LOC              *ADM1830
         TXI     BP11,1,-1               MOVE PAST Y OR PAST DIFF.          *ADM1840
BP11     STZ     TEMP                                                       *ADM1850
TX       LDQ*    CC                      DIFF TABLE,1                       *ADM1860
TY       FMP     *,2                     MAT COEF,2                         *ADM1870
         FAD     TEMP                                                       *ADM1880
         STO     TEMP                                                       *ADM1890
         TXI     BP12,1,-1               MOVE TO NEXT DIFF                  *ADM1900
BP12     TXI     BP14,2,-1               MOVE TO NEXT COEF                  *ADM1910
BP14     TIX     TX,4,1                  GO FOR MORE TERMS                  *ADM1920
TU       TXI     TZ,1,*                  MOVE BACK TO ORIG DIFF             *ADM1930
TZ       STO*    CC                      DIFF TABLE,1                       *ADM1940
         LXD     TU,4                                                       *ADM1950
         TIX     TV,4,1                                                     *ADM1960
         TIX     TW,1,1                  MOVE TO Y TERM OR ALL THROUGH      *ADM1970
IR4M     AXT     *,4                                                        *ADM1980
         TRA     1,4                                                        *ADM1990
ADMPAR   SAVE                                                               *ADM2000
         SXA     IR2,2                                                      *ADM2010
         SXA     IR1,1                                                      *ADM2020
         CLA*    3,4                                                        *ADM2030
         FSB*    CX                      XP-X                               *ADM2040
         FDP*    CH                      XP-X /H =P                         *ADM2050
         STQ     TEMPA-5                 P TO TEMPA-5                       *ADM2060
         STZ     TEMPA                                                      *ADM2070
         AXT     -4,4                    GENERATE POWERS OF P               *ADM2080
BP16     FMP     TEMPA-5                                                    *ADM2090
         STO     TEMPB-4,4                                                  *ADM2100
         LRS     35                                                         *ADM2110
         TXI     BP15,4,1                                                   *ADM2120
BP15     TXH     BP16,4,0                                                   *ADM2130
         AXT     5,1                                                        *ADM2140
         AXT     CPP,4                                                      *ADM2150
         SXA     TX,4                                                       *ADM2160
         SXA     TZ,4                                                       *ADM2170
         AXT     TPBL,4                                                     *ADM2180
         SXA     TY,4                                                       *ADM2190
         TSX     MAT+1,4                 AVOIDS SN TO IN1                   *ADM2200
         AXT     CC,4                                                       *ADM2210
         SXA     TX,4                                                       *ADM2220
         SXA     TZ,4                                                       *ADM2230
         AXT     1,1                                                        *ADM2240
         AXT     4,2                                                        *ADM2250
CPP      CLA     TEMPB+1,1                                                  *ADM2260
         STO     TEMPA,2                                                    *ADM2270
         TXI     BP17,1,1                                                   *ADM2280
BP17     TIX     CPP,2,1                                                    *ADM2290
         AXT     TEMPA,4                                                    *ADM2300
         SXA     CO,4                                                       *ADM2310
         AXT     LF,4                                                       *ADM2320
         SXA     CCM,4                                                      *ADM2330
         AXT     CP,4                                                       *ADM2340
         SXA     CM,4                                                       *ADM2350
         TSX     COMP+2,4                                                   *ADM2360
         AXT     LP,4                                                       *ADM2370
         SXA     CM,4                                                       *ADM2380
         AXT     CK,4                                                       *ADM2390
         SXA     CCM,4                                                      *ADM2400
         RETURN  ADMPAR                                                     *ADM2410
CP       PZE     0,4                                                        *ADM2420
```

```
[illegible]  [illegible]                                                *ADM2630
       [illegible]  1.                  1                               *ADM2640
       [illegible]  .5                  1/2                             *ADM2650
       [illegible]  [illegible]         .41666666667   5/12             *ADM2660
       DEC    .375                 3/8                                  *ADM2670
       DEC    [illegible]          .34861111111   251/720               *ADM2680
[illegible] DEC  [illegible]                                            *ADM2690
       [illegible]  [illegible]         .65138888889   469/720          *ADM2500
       [illegible]  [illegible]         .15138888889   [illegible]/720  *ADM2510
       [illegible]  [illegible]                        [illegible]      *ADM2520
       [illegible]  [illegible]         .02638888889   19/720           *ADM2530
       DEC    [illegible]          .00                                  *ADM2540
[illegible] DEC  [illegible]       .34861111111   251/720               *ADM2550
       DEC    .50833333333                        6/720                 *ADM2560
       DEC    .0625                               65/720 [illegible]    *ADM2570
       DEC    .15277777778                        110/720               *ADM2580
       DEC    .125                                90/720 [illegible]    *ADM2590
       DEC    .041666667                          1/24                  *ADM2600
       DEC    .16666667                           1/6                   *ADM2610
       DEC    .16666667                           1/6                   *ADM2620
       DEC    .16666667                           1/6                   *ADM2630
       DEC    .25                                 1/6                   *ADM2640
[illegible] DEC  .5                                                     *ADM2650
       DEC    .125                                                      *ADM2660
       DEC    .5625                                                     *ADM2670
       DEC    .0390625                                                  *ADM2680
       DEC    .25                                                       *ADM2690
       DEC    .125                                                      *ADM2700
       DEC    .078125                                                   *ADM2710
       DEC    .375                                                      *ADM2720
       DEC    .59375                                                    *ADM2730
[illegible] DEC  .5625                                                  *ADM2740
       DEC    2.                                                        *ADM2750
       DEC    -1.                                                       *ADM2760
       DEC    0                                                         *ADM2770
       DEC    0                                                         *ADM2780
       DEC    4.                                                        *ADM2790
       DEC    -4.                                                       *ADM2800
       DEC    1.                                                        *ADM2810
       DEC    8.                                                        *ADM2820
       DEC    -12.                                                      *ADM2830
[illegible] DEC  16.                                                    *ADM2840
TEMP   BSS    11                                                        *ADM2850
TEMPA  SYN    TEMP+6                                                    *ADM2860
TEMPB  SYN    TEMP+10                                                   *ADM2870
       END                                                              *ADM2880
```

```
$IBFTC NOZWIT  LIST,M94
      SUBROUTINE CCC(DIN,DOUT,WC,CODE,NER)
C*********************************************************************
C***** THIS PROGRAM WAS WRITTEN FROM A REPORT ON NOZZLE ADMITTANCE*****
C***** THEORY FROM PRINCETON UNIVERSITY.  THE ANALYSIS WAS DONE BY*****
C***** CARL LUNDELIUS AND THE PROGRAMMING BY JERRY HOWARD.JOB 8052*****
C************
C     NOZWIT MODIFIED 25 JUL 67  TO SUPPLY CR1,CI1 IN PLACE OF BR1,BI1.
C*********************************************************************
C
      LOGICAL  LOGIK,  SL1,  SL2,  EORJ
      COMMON  /ABCDF/  EXTRA(100),  ABLOK(600)
     1      , XX     , U2TBL  , DESIRE , RAT    , RAC    , RCC
     2      , RCT    , ALFA   , G      , KN     , Y      , YP
     3      , YOUT   , TEMP   , E      , XTABLE , YTABLE , A
     4      , R      , AM     , AP     , AMP    , ZZ     , AMM
     5      , AMP2   , CALFA  , CTALFA , DELAM  - DELTZ  , FKN
     6      , G1     , G2     , G3     , G4     , JPLAG1 , KNN1
     7      , K      , NN     , PI     , PROD   , RSTA1  , RSTA2
     8      , SALFA  , T1     , T2     , T3     , XINT   , XK
     9      , ZZ1    , ZZ2    , ZZ3    , A1     , ABC    , ABD
      COMMON  /ABCDF/
     1        AI1    , ALPHAI , ALPHAR , AR1    , B101   , B102
     2      , B10    , B1     , B2     , B3     , B4     , B5
     3      , B6     , B7     , B8     , B91    , B92    , B9
     4      , BI1    , BR1    , C2     , C3     , CHII   , CHIR
     5      , CI1    , CR1    , C      , D10    , D11    , D1
     6      , D2     , D3     , D4     , D5     , D6     , D7
     7      , D8     , D9     , DC2    , D      , DU2    , EI
     8      , ER     , F31    , F3R    , FI     , FR     , HI
     9      , H      , I      , IWO    , IW     , IWW    , J
      COMMON  /ABCDF/
     1        MDESIR , NK     , NP     , S2     , S      , TT
     2      , U2     , U      , W2     , W      , XI0I   , XI0R
     3      , XI2I   , XI2R   , XI     , XJI    , XJR    , XNNEW
     4      , XNOLD  , XNEW   , XOLD   , XPT    , X      , ZI
     5      , ZR
      COMMON  /PROLOG/  LOGIK(50), SL1, SL2, EORJ
C
      DIMENSION XX(200),U2TBL(200),XTABLE(200),YTABLE(200),ZZ(200)
      DIMENSION  Y(8),YP(8),YOUT(8),TEMP(72),E(8)
      DIMENSION A(200),R(200),AM(200),AP(200),AMP(200)
      DIMENSION   DIN(1), DOUT(1),WC(1)
C
C********************************************************************
C
C
      NER  =  0
C ***********
C READ INPUT*
C ***********
      G  =  DIN(1)
      NOMEG=WC(2)+2.0001
      MDESIR  =  DIN(2)  +  .0001
      GEO=.5*(G+1.0)*SQRT(DIN(4)*DIN(7))
      IF  (CODE)   10,20,30
   10 NER =  1
   20 RETURN
   30 IF(WC(1))40,50,40
   40 WCONST=DOUT(3)/(6.2831853*DOUT(1))
      GEO=GEO/DOUT(1)
      GO TO 60
   50 WCONST=DOUT(3)/(6.2831853*DOUT(2))
      GEO=GEO/DOUT(2)
   60 IF(CODE-99.0)100,100,70
C ****************
C PRINT OUT INPUT*
C ****************
   70 CALL PAGE(5)
      WRITE (6,80)
   80 FORMAT (1H0,75H PROGRAM  C  INPUT - CALCULATES NOZZLE ADMITTANCE
     1COEFFICIENTS USING 8052    )
      WRITE (6,90)G,  MDESIR
   90 FORMAT (1H0,5X,3HG =,F9.3,11H , MDESIR =,I2   )
  100 CONTINUE
C ******************************************************************
C MDESIR=1,INPUT TABLE,INPUT DESIRE  MDESIR=2,CALCULATE TABLE,INPUT*
C DESIRE  MDESIR=3,CALCULATE TABLE,CALCULATE DESIRE (AT LAST POINT)*
C ******************************************************************
      GO TO (150,110,110),MDESIR
  110 RAT   =  DIN(4)
      RAC   =  DIN(5)
      RCC   =  DIN(6)
      RCT   =  DIN(7)
      ALFA  =  DIN(8)
      KN    =  DIN(9)  +  .0001
      IF   (CODE  -  99.0)   140,140,120
  120 CALL  PAGE (1)
      WRITE (6,130)RAT, RAC, RCC, RCT, ALFA, KN
  130 FORMAT  (1H ,5X5HRAT =,F7.3,6H,RAC =,F7.3,6H,RCC =,F7.3,6H,RCT =,
     1   F7.3, 7H,ALFA = F7.3,5H,KN = I4    )
  140 CONTINUE
      CALL TBLCAL
      KN = KN/2 + 1
      GO TO 190
C ************************************************
C READ VELOCITY POTENTIAL TABLE, FIRST POINT IS (0,1)*
C ************************************************
  150 J = 10
      DO 170 I = 1,200
      I = I
      XX(I) =  DIN(J)
      U2TBL(I)  =  DIN(J+1)
      J = J+2
      IF (I)  170,170,160
  160 IF ( XX(I) )   170,180,180
  170 CONTINUE
C ***********************************************
C KN = COUNT OF TOTAL NO. OF POINTS IN THE TABLE.*
C ***********************************************
  180 KN = I - 1
  190 IF(CODE-199.0)240,240,200
  200 CALL PAGE(70)
      WRITE (6,220)
      KKKN=KN/2+1
      DO 210 I=1,KKKN
      KKK=KKKN+I
      VOL1=SQRT(U2TBL(I))
      VOL2=SQRT(U2TBL(KKK))
      WRITE (6,230)I,ZZ(2*I-1),XX(I),VOL1,KKK,ZZ(2*KKK-1),XX(KKK),VOL2
  210 CONTINUE
```

```
220 FORMAT(///,40X, 24HVELOCITY POTENTIAL TABLE ,//,39X, 66H  AXIAL PO
   1SITION IN N        (INCHES)          ,/,39X,33H     VELO ITY POTEN
   2TIAL (NONDIMENSIONAL) ,/,39X, 69HV  AXIAL VELO ITY  NONDIMENSIONAL
   4IZED BY SPEED OF SOUND AT THROAT)
   6 ,//,9X,5HPOINT,11X,1HZ,16X,1HX,15X,1HV,16X,5HPOINT,11X,1HZ,16X,1H
   9X,16X,1HV,//)
230 FORMAT(6X,I3,6X,3(E12.5,4X),6X,I3,6X,2(E12.5,5X),E12.5)
240 CONTINUE
C ****************************************************
C REVERSE ORDER OF TABLE VALUES AND SET UP FOR INTAD*
250 NF = KN+1
    XTABLE(NF) = 0.0
    YTABLE(NF) = 0.0
    DO 260 I = 1,KN
    NK = NF - I
    XTABLE(I) = XX(NK)
    YTABLE(I) = ZYAL(NK)
260 CONTINUE
C
C ************************
C READ ONE CASE AT A TIME*
C ************************
    IWW  = 410
    IWP  = 2
    NP   = DIN(3) + .0001
    IF   (CODE   -  99.1)  290,290,270
270 NPP  =  NP + 3
    NPT  =  3 * NP  + 409
    CALL  PAGE (NPP)
    WRITE (6,280)( DIN(I), I = 410, NPT  )
280 FORMAT(1H0,39X, 6X,4H  WN,12X,6H(SNM),10X,4H DES //
   1         (40X,3E16.6 ))
290 CONTINUE
300 IF  (CODE -  9.0)   340,340,310
C ********************************
C PRINT HEADER AND OUTPUT SYMBOLS*
C ********************************
310 CALL PAGE(70)
    KPAGE=48
    KCOUNT=0
    WRITE (6,320)
320 FORMAT (1H0, 20H PROGRAM  C  OUTPUT   )
    WRITE (6,330)
330 FORMAT(//4X,6H(SNM)C,5X2HWC,6X,7HMACH NO,9X,2HAR,14X,2HAI,14X,2HBR
   1,14X,2HBI,14X,2HCR,14X,2HCI/4X,6H(SNM)N,5X2HWN,9X,1HG,6X,13H-AR/(M
   2ACH NO),3X,13H-AI/(MACH NO),9X,2HT1,14X,2HT2,8X,13H-CR/(MACH NO),3
   3X,13H-CI/(MACH NO)//)
340 CONTINUE
    DO 660 IW =  1,NP
    W  =   DIN(IWW)
    S  =   DIN(IWW+1)
    GO  TO (350,350,360), MDESIR
350 DESIRE    =  DIN(IWW+2)
360 IWW =  IWW + 3
C
    XNOLD=0.0
    XNNEW=0.0
    YOLD=0.0
    XPT = 0.0
    X = 0.0
    XNEW=0.0
    XI = -.001
    H=XI
    W2=W*W
    S2=S*S
    G2=G*G
C ************************************
C     INITIALIZE 8 EQUATIONS AT X=0.*
C ************************************
    DO 370 I = 1,8
370 E(I) = 1.E-05
    I = 0
    CALL ADMSET(8,Y(1),YP(1),YOUT(1),TEMP(1),X,H,E(1))
    A1=.5*(G+1.0)
    C2=1.0
    C3=(G+1.0)*(G+1.0)+4.0*W2
    B6=A1*A1+W2
    B7=.25*(A1*(W2-S2)-W2*(G-1.0))/B6
    B8=-.125*W*(G2-1.0+2.0*(W2-S2))/B6
    B91=B7*(A1*A1*A1+W2)-A1*B8*(1.0-A1*W)+.125*(G2-1.0)*(W2-S2)
    B92=A1*A1*(B7*B7-B8*B8)+2.0*A1*W*B7*B8
    B9=(B91+B92)/B6
    B101=.5*A1*(3.0-G)*W*B7+B8*(A1*A1*A1+W2)+.125*(G-1.0)*W*(A1*A1-S2)
    B102=-A1*W*(B7*B7-B8*B8)+2.0*A1*A1*B7*B8
    B10=(B101+B102)/B6
C
    Y(1)=0.0
    Y(2)=0.0
    Y(3)=0.0
    Y(4)=0.0
    Y(5)=0.0
    Y(6) 0.0
    Y(7)=B7
    Y(8)=B8
C
    U2=1.0
    D11=ATAN((B8+W)/B7)
C
    YP(1)=.5*C2
    YP(2)=0.0
    YP(3)=.5*(G+1.0)*(G+1.0)/(C2*C3)
    YP(4)=-W*(G+1.0)/(C2*C3)
    YP(5)=(G+1.0)*(G+1.0)*S2*C2**(1.0/(G-1.0))/(4.0*C3)
    YP(6)=-.5*W*(G+1.0)*S2*C2**(1.0/(G-1.0))/C3
    YP(7)=-B9
    YP(8)=-B10
380 CALL ADMINT
C *****************************************
C INTERPOLATING ON VELOCITY POTENTIAL TABLE*
C *****************************************
390 CALL INTAD(XTABLE(1),YTABLE(1),X,U2,DU2)
    C2=.5*(G+1.0-U2*(G-1.0))
    C=SQRT(C2)
    U=SQRT(U2)
    DC2=-.5*(G-1.0)*DU2
C *******************************************************
C SINGULARITY AT THROAT-FAKE EQUATIONS 7 AND 8 UNTIL PAST*
C *******************************************************
    IF(X-XI)400,400,410
400 B1=U2*(C2-U2)
    B2=A1*U2*DU2/C2
```

```
      B3=W*U2                                                           NOZM2420
      B4=.25*(S2-U*C2**(G/(G-1.0))*S2)                                  NOZM2430
      B5=.25*((G-1.0)*U2*DU2*W)/C2                                      NOZM2440
C                                                                       NOZM2450
      ABD=Y(7)*Y(7)-Y( 8)*Y( 8)                                         NOZM2460
      YP(7)=(B2*Y(7)-B3*Y( 8)-B4)/B1-ABD                                NOZM2470
      YP( 8)=(B3*Y(7)+B2*Y( 8)+B5)/B1-2.0*Y(7)*Y( 8)                    NOZM2480
C                                                                       NOZM2490
  410 YP(1)=.5*(DU2-W*Y(2)/U2)                                          NOZM2500
      YP(2)=.5*W*Y(1)/U2                                                NOZM2510
      D1=-Y(3)*Y(7)+Y(4)*(Y( 8)-W*(.5/U2+2.0/((G+1.0)*(1.0-U2))))       NOZM2520
      D2=S2*C2**(1.0/(G-1.0))*Y(2)/(2.0*W*U)                            NOZM2530
      D3=(-W*Y(2)/U2+DU2*(1.0+(G-1.0)*Y(1)/C2))/(2.0*C2)                NOZM2540
      YP(3)=D1+D2+D3                                                    NOZM2550
C                                                                       NOZM2560
      D4=-Y(4)*Y(7)-Y(3)*(Y( 8)-W*(.5/U2+2.0/((G+1.0)*(1.0-U2))))       NOZM2570
      D5=-S2*C2**(1.0/(G-1.0))*W*((1.0-U2)/(2.0*U2)+Y(1)/U2)/(2.0*W)    NOZM2580
      D6=(W*Y(1)/U2+DU2*(G-1.0)*Y(2)/C2)/(2.0*C2)                       NOZM2590
      YP(4)=D4+D5+D6                                                    NOZM2600
C                                                                       NOZM2610
      D7=S2*C2**(1.0/(G-1.0))/(4.0*U)-Y(5)*Y(7)                         NOZM2620
      D8=Y(6)*(Y( 8)-W*(.5/U2+2.0/((G+1.0)*(1.0-U2))))                  NOZM2630
      YP(5)=D7+D8                                                       NOZM2640
C                                                                       NOZM2650
      ABC=-Y(6)*Y(7)                                                    NOZM2660
      YP(6)=ABC-Y(5)*(Y( 8)-W*(.5/U2+2.0/((G+1.0)*(1.0-U2))))           NOZM2670
C                                                                       NOZM2680
      CALL ADMCOR                                                       NOZM2690
C                                                                       NOZM2700
  420 XMNEW=U/C                                                         NOZM2710
      XNEW=X                                                            NOZM2720
C                                                                       NOZM2730
      IF(XMNEW-DESIRE)430,500,440                                       NOZM2740
C ********************************************************************* NOZM2750
C IF OUR CALCULATED MACH NUMBER IS CLOSE ENOUGH TO DESIRE WE WILL STOP* NOZM2760
C ********************************************************************* NOZM2770
  430 IF(ABS(XMNEW-DESIRE)-7.E-5)500,500,470                            NOZM2780
  440 IF(XMN-XX(KN))450,460,460                                         NOZM2790
  450 XNEW = XX(KN)                                                     NOZM2800
      GO TO 500                                                         NOZM2810
  460 XMOLD = XMNEW                                                     NOZM2820
      XOLD=XNEW                                                         NOZM2830
      GO TO 380                                                         NOZM2840
C ********************************************************************* NOZM2850
C PASSED DESIRED MACH NUMBER                                          * NOZM2860
C LINEAR INTERPOLATION TO GET X CORRESPONDING TO DESIRED MACH*          NOZM2870
C ********************************************************************* NOZM2880
  470 XPT=XOLD+(XNEW-XOLD)/(XMNEW-XMOLD)*(DESIRE-XMOLD)                 NOZM2890
      XOLD = XNEW                                                       NOZM2900
      XMOLD = XMNEW                                                     NOZM2910
      XNEW = XPT                                                        NOZM2920
      CALL INT4(XTABLE(1),YTABLE(1),XNEW,U2)                            NOZM2930
      C2 = .5*(G+1.0-U2*(G-1.0))                                        NOZM2940
      C = SQRT(C2)                                                      NOZM2950
      U = SQRT(U2)                                                      NOZM2960
      XMNEW = U/C                                                       NOZM2970
      I = I+1                                                           NOZM2980
      IF(I-15)430,480,480                                               NOZM2990
  480 WRITE (6,490)                                                     NOZM3000
  490 FORMAT(72H0 ITERATION SCHEME DOES NOT CONVERGE AFTER 10 ITERATIONSNOZM3010
     1, SEE PROGRAMMER)                                                 NOZM3020
      GO TO 10                                                          NOZM3030
  500 CALL ADMPAR(XNEW)                                                 NOZM3040
C                                                                       NOZM3050
C                                                                       NOZM3060
C ********************************************************************* NOZM3070
C COMPUTE ADMITTANCE COEFFICIENTS AND PRINT FINAL RESULTS*              NOZM3080
C ********************************************************************* NOZM3090
  510 CALL INT4D (XTABLE(1),YTABLE(1),XNEW,U2,DU2)                      NOZM3100
  520 C2=.5*(G+1.0-U2*(G-1.0))                                          NOZM3110
      C=SQRT(C2)                                                        NOZM3120
      U=SQRT(U2)                                                        NOZM3130
C                                                                       NOZM3140
      DC2=-.5*(G-1.0)*DU2                                               NOZM3150
      D=SQRT(2.0/(G+1.0))*U*C2/((C2/(.5*(G+1.0)))**(1.0*G/(G-1.0)))     NOZM3160
      D9=(1.0-U2)*(G+1.0)                                               NOZM3170
      F3R=YOUT(1)/C2                                                    NOZM3180
      F3I=YOUT(2)/C2                                                    NOZM3190
      X12R=2.0*YOUT(3)/D9                                               NOZM3200
      X12I=2.0*YOUT(4)/D9                                               NOZM3210
      X10R=2.0*YOUT(5)/D9                                               NOZM3220
      X10I=2.0*YOUT(6)/D9                                               NOZM3230
      ZR=YOUT(7)                                                        NOZM3240
      ZI=YOUT( 8)                                                       NOZM3250
      ER=C2*X10R-ZR                                                     NOZM3260
      EI=C2*X10I-ZI                                                     NOZM3270
      FR=U2*C2*X10R-ZR*U2                                               NOZM3280
      FI=U2*C2*X10I-ZI*U2-.5*W                                          NOZM3290
      D10=FR*FR+FI*FI                                                   NOZM3300
      AR1= D*(ER*FR+EI*FI)/D10                                          NOZM3310
      AI1= D*(EI*FR-ER*FI)/D10                                          NOZM3320
      IF(S)540,530,540                                                  NOZM3330
  530 G1=W*C2*SQRT(U/(C2**(1.0/(G-1.0))))                               NOZM3340
      GO TO 550                                                         NOZM3350
  540 G1=W*C2*SQRT(U/(C2**(1.0/(G-1.0))))/S                             NOZM3360
  550 BR1= G1*(-FR*X10I+FI*X10R)/D10                                    NOZM3370
      BI1= G1*(FR*X10R+FI*X10I)/D10                                     NOZM3380
      H1=U*C2*SQRT(2.0/(G+1.0))                                         NOZM3390
      XJR=F3R*ZR-F3I*ZI+.5*(1.0-U2)*X10R+.5*W*X12I                      NOZM3400
      XJI=F3I*ZR+F3R*ZI+.5*(1.0-U2)*X10I-.5*W*X12R                      NOZM3410
      CR1 = H1*(XJR*FR+XJI*FI)/D10                                      NOZM3420
      CI1 = H1*(XJI*FR-XJR*FI)/D10                                      NOZM3430
C                                                                       NOZM3440
  560 ALPHAR = -AR1/DESIRE                                              NOZM3450
      ALPHAI = -AI1/DESIRE                                              NOZM3460
      CHIR = -CR1/DESIRE                                                NOZM3470
      CHII = -CI1/DESIRE                                                NOZM3480
      TT = (W/(S*SQRT(.5*(G+1.0))))/SQRT(U*(.5*(G+1.0)-U2*(G-1.0)/2.0)**NOZM3490
     1( 1.0/(G-1.0)))                                                   NOZM3500
      T1 = AR1*TT - BI1                                                 NOZM3510
      T2 = AI1*TT + BR1                                                 NOZM3520
C                                                                       NOZM3530
C ******** ******************                                          NOZM3540
C  CASE IS .OMPLETED                                                    NOZM3550
C ************************                                              NOZM3560
C                                                                       NOZM3570
C  FOR S=0  ADM COEF ARE ALPHA FOR 8005  LONGITUDINAL                   NOZM3580
C                                                                       NOZM3590
C  FOR S=N  ADM COEF ARE  T    FOR  993  TRANSVERSE                    NOZM3600
C                                                                       NOZM3610
      IF(S)980,970,930                                                  NOZM3620
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  570 DOUT(IWO+1)=ALPHAR                                                NOZM3630
      DOUT(IWO+101)=ALPHAI                                              NOZM3640
      DOUT(IWO)=W/GEO                                                   NOZM3650
      DOUT(IWO+100)=W/GEO                                               NOZM3660
      GO TO 590                                                         NOZM3670
  580 CONTINUE                                                          NOZM3680
      DOUT(IW+10)=W/GEO                                                 NOZM3690
      DOUT(IW+49)=T1                                                    NOZM3700
      DOUT(IW+79)=T2                                                    NOZM3710
      DOUT(IW+109) = CR1                                                NOZM3720
      DOUT(IW+139) = CI1                                                NOZM3730
  590 IWO =IWO+2                                                        NOZM3740
      IF  ( CODE  -  9.0)    660,660,600                                NOZM3750
  600 CONTINUE                                                          NOZM3760
      KKKN=(2*IW)+1                                                     NOZM3770
      IF(NOMEG-KKKN)610,620,620                                         NOZM3780
  610 KKKN=KKKN-1                                                       NOZM3790
  620 KCOUNT=KCOUNT+4                                                   NOZM3800
      IF(KCOUNT-KPAGE)640,640,630                                       NOZM3810
  630 CALL PAGE(70)                                                     NOZM3820
      WRITE (6,930)                                                     NOZM3830
      KCOUNT=0                                                          NOZM3840
      KPAGE=48                                                          NOZM3850
C ********************                                                 NOZM3860
C PRINT FINAL RESULTS                                                   NOZM3870
C ********************                                                 NOZM3880
  640 WRITE (6,650)WC(1),WC(KKKN),DESIRE,AR1,AI1,BR1,BI1,CR1,CI1,S,W,G,ANOZM3890
     1LPHAR,ALPHAI,T1,T2,CMIR,CMII                                      NOZM3900
  650 FORMAT(2(3X,F7.4,2X,F7.4,3X,F7.4,4,6E16.5/1)                      NOZM3910
      FCCPS=(WCONST*WC(KKKN))**2.0                                      NOZM3920
      WRITE (6,670)FCCPS                                                NOZM393C
  660 CONTINUE                                                          NOZM3940
  670 FORMAT(4X,8HFC(CPS)=F10.4//)                                      NOZM3950
      DOUT(209)=DESIRE                                                  NOZM3960
      IF(S) 690,680,690                                                 NOZM3970
  680 DOUT(1)=NP                                                        NOZM3980
      DOUT(101)=NP                                                      NOZM3990
      RETURN                                                            NOZM4000
  690 DOUT(18)=NP                                                       NOZM4010
      DOUT(NP+21)=0.0                                                   NOZM4020
      DOUT(NP+51)=0.0                                                   NOZM4030
      DOUT(NP+81)=0.0                                                   NOZM4040
      DOUT(NP+111)=0.0                                                  NOZM4050
      DOUT(NP+141)=0.0                                                  NOZM4060
      RETURN                                                            NOZM4070
      END                                                               NOZM4080
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$IBFTC VELPOT  LIST,M94                                                         VELP
      SUBROUTINE TBLCAL                                                         VELP  10
C TBLCAL SUBROUTINE CALCULATES XX VS U2TBL FROM NOZZLE GEOMETRY                 VELP  20
C SIMPSONS RULE IS USED WITH KN INPUT ODD AND CHANGED TO KN/2+1 IN MAIN         VELP  30
C                                                                               VELP  40
      LOGICAL  LOGIK,  SL1,  SL2,  EORJ                                         VELP  50
      COMMON  /PRCLOG/  LOGIK(50), SL1, SL2, EORJ                               VELP  60
C                                                                               VELP  70
      COMMON  /ABCDF/  EXTRA(100),  ABLOK(600)                                  VELP  80
     1      , XX      , U2TBL   , DESIRE  , RAT     , RAC     , RCC           VELP  90
     2      , RCT     , ALFA    , G       , XN      , Y       , YP            VELP 100
     3      , YOUT    , TEMP    , E       , XTABLE  , YTABLE  , A             VELP 110
     4      , R       , AM      , AP      , AMP     , ZZ      , AMM           VELP 120
     5      , AMP2    , CALFA   , CTALFA  , DELAM   , DELTZ   , FKN           VELP 130
     6      , G1      , G2      , G3      , G4      , JFLAG1  , KNM1          VELP 140
     7      , K       , NN      , PI      , PROD    , RSTA1   , RSTA2         VELP 150
     8      , SALFA   , T1      , T2      , T3      , XINT    , XK            VELP 160
     9      , ZZ1     , ZZ2     , ZZ3     , A1      , ABC     , ABD           VELP 170
      COMMON  /ABCDF/                                                           VELP 180
     1          A11   , ALPHAI  , ALPHAR  , AR1     , B101    , B102          VELP 190
     2      , B10     , B1      , B2      , B3      , B4      , B5            VELP 200
     3      , B6      , B7      , B8      , B91     , B92     , B9            VELP 210
     4      , BR1     , BR2     , C2      , C3      , CHII    , CHIR          VELP 220
     5      , CI1     , CR1     , C       , D10     , D11     , D1            VELP 230
     6      , D2      , D3      , D4      , D5      , D6      , D7            VELP 240
     7      , D8      , D9      , DC2     , D       , DU2     , EI            VELP 250
     8      , ER      , F3I     , F3R     , FI      , FR      , HI            VELP 260
     9      , H       , I       , IWO     , IW      , IWW     , J             VELP 270
      COMMON  /ABCDF/                                                           VELP 280
     1          MDESIR , MK     , M       , S2      , S       , TT            VELP 290
     2      , U2      , U       , W2      , W       , XI0I    , XI0R          VELP 300
     3      , XI2I    , XI2R    , XI      , XJI     , XJR     , XMNEW         VELP 310
     4      , XMOLD   , XNEW    , XOLD    , XPT     , X       , Z1            VELP 320
     5      , ZR                                                               VELP 330
C                                                                               VELP 340
      DIMENSION XX(200),U2TBL(200),XTABLE(200),YTABLE(200),ZZ(200)              VELP 350
      DIMENSION  Y(8),YP(8),YOUT(8),TEMP(72),E(8)                               VELP 360
      DIMENSION A(200),R(200),AM(200),AP(200),AMP(200)                          VELP 370
C                                                                               VELP 380
C                                                                               VELP 390
      FKN = KN                                                                  VELP 400
      KNM1 = KN - 1                                                             VELP 410
      DELAM = 1.0/(FKN+1.0)                                                     VELP 420
      PI = 3.1415927                                                            VELP 430
      ZZ(1)= 0.0                                                                VELP 440
C                                                                               VELP 450
      DO 10 J = 1,200                                                           VELP 460
      ZZ(J) = 0.0                                                               VELP 470
      A(J) = 0.0                                                                VELP 480
      R(J) = 0.0                                                                VELP 490
      AMP(J) = 0.0                                                              VELP 500
      AM(J) = 0.0                                                               VELP 510
      XX(J) = 0.0                                                               VELP 520
      U2TBL(J) = 0.0                                                            VELP 530
   10 AP(J) = 0.0                                                               VELP 540
C                                                                               VELP 550
      R(1)= RAT                                                                 VELP 560
      A(1)=PI*R(1)**2                                                           VELP 570
      U2TBL(1)=1.0                                                              VELP 580
      R(KN) = RAC                                                               VELP 590
      ALFA = ALFA*.01745329                                                     VELP 600
      CALFA=COS(ALFA)                                                           VELP 610
      SALFA=SIN(ALFA)                                                           VELP 620
      CTALFA=CALFA/SALFA                                                        VELP 630
      RSTA1=RAT+RCT*(1.0-CALFA)                                                 VELP 640
      RSTA2=RAC-RCC*(1.0-CALFA)                                                 VELP 650
      ZZ1=RCT*SALFA                                                             VELP 660
      ZZ2=ZZ1+CTALFA*(RSTA2-RSTA1)                                              VELP 670
      ZZ3=ZZ2+RCC*SALFA                                                         VELP 680
      DELTZ = ZZ3/(FKN-1.0)                                                     VELP 690
C                                                                               VELP 700
      JFLAG1=1                                                                  VELP 710
C                                                                               VELP 720
      DO 80 I = 2,KNM1                                                          VELP 730
      ZZ(I) = ZZ(I-1) + DELTZ                                                   VELP 740
      GO TO (20,40,60),JFLAG1                                                   VELP 750
   20 R(I)=RAT+RCT-SQRT(RCT**2-ZZ(I)**2)                                        VELP 760
      IF(R(I)-RSTA1)70,70,30                                                    VELP 770
   30 JFLAG1=2                                                                  VELP 780
   40 R(I)=RSTA1+(RSTA2-RSTA1)*(ZZ(I)-ZZ1)/(ZZ2-ZZ1)                            VELP 790
      IF(R(I) - RSTA2)70,70,50                                                  VELP 800
   50 JFLAG1=3                                                                  VELP 810
   60 R(I)=RAC-RCC+SQRT(RCC**2-(ZZ3-ZZ(I))**2)                                  VELP 820
   70 A(I)=PI*R(I)**2                                                           VELP 830
   80 CONTINUE                                                                  VELP 840
C                                                                               VELP 850
      ZZ(KN) = ZZ(KNM1) + DELTZ                                                 VELP 860
      A(KN) = PI*RAC**2                                                         VELP 870
      AMM = 1.0+ DELAM                                                          VELP 880
      G1=2.0/(G +1.0)                                                           VELP 890
      G2 =(G - 1.0)/2.0                                                         VELP 900
      G3 = (G + 1.0)/(2.0*G - 2.0)                                              VELP 910
      G4=1.0/G1                                                                 VELP 920
C                                                                               VELP 930
      DO 90 J = 1,KN                                                            VELP 940
      AMM = AMM - DELAM                                                         VELP 950
      AM(J) = AMM                                                               VELP 960
      AP(J)=(A(1)/AMM)*(G1*(1.0+G2*AMM**2))**G3                                 VELP 970
   90 CONTINUE                                                                  VELP 980
C                                                                               VELP 990
      DO 100 K = 2,KN                                                           VELP1000
      CALL INTA(AP(1),AM(1),A(K),AMP(K))                                        VELP1010
      AMP2=AMP(K)**2                                                            VELP1020
      U2TBL(K)=(G4*AMP2)/(1.0+G2*AMP2)                                          VELP1030
  100 CONTINUE                                                                  VELP1040
C                                                                               VELP1050
      DESIRE = AMP(KN)                                                          VELP1060
      XINT = 0.0                                                                VELP1070
      NN = KN - 2                                                               VELP1080
      K = 1                                                                     VELP1090
      XK = SQRT(G1*RAT/RCT)                                                     VELP1100
      PROD = 2.0*XK*DELTZ/3.0                                                   VELP1110
      DO 110 J = 1,NN,2                                                         VELP1120
      T1 = SQRT(U2TBL(J))                                                       VELP1130
      T2 = SQRT(U2TBL(J+1))                                                     VELP1140
      T3 = SQRT(U2TBL(J+2))                                                     VELP1150
      XINT = XINT + PROD*(T1+4.0*T2+T3)                                         VELP1160
      K = K + 1                                                                 VELP1170
      XX(K) = XINT/RAT                                                          VELP1180
      U2TBL(K-1) = U2TBL(J)                                                     VELP1190
  110 CONTINUE                                                                  VELP1200
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```
STARTS LONGIT LISTING
      SUBROUTINE LONG
C
      COMMON /ABCDF / DIMP(6950)
      DIMENSION
     1   EXTRA(100),DISTL(29),DISTM(29),AMIT(90),
     2   TAB(150,3), OMG(153), ALFR(150), ALFI(150), W(27)
      EQUIVALENCE
     1   (EXTRA(1),GAMMA),   (DIMP(37), U1BAR ), (EXTRA(2), W ),
     2   (EXTRA(4),RAC), (EXTRA(5), ELCH),(EXTRA(16),SOUND,C0),
     3   (DIMP(7),JLM ), (DIMP(8),ZK ),
     4   (EXTRA(2C),ELNOZ),(EXTRA(9)),DISTL),(EXTRA(7)),DISTM),
     5   (DIMP(1), EXTRA),
     6   (DIMP 151),TAB,OMG),(DIMP(301),ALFR),(DIMP(451),ALFI),
     7    DIMP(601),AMIT)
C
 10 FORMAT (2I3 F7.1, I18 F10.5, 10X F10.5, 10X F10.5)
 20 FORMAT ( / 118 39H RESULTS FOR LONGITUDINAL MODE //21HTHFC(CPS)
   1 15X5HOMEGA[illegible]
 30 FORMAT [illegible] F15.8 [illegible] GAMMA [illegible] F15.8 [illegible]
   [illegible]
      CALL PAGE (60)
      NINC = 20
      EIN = 1.0E-6
      CALL INTA ( DISTL (1), DISTM(1), ELCH, EDIST )
      CALL INTSQ ( 0.0, ELCH, X, NINC )
         CALL INTA ( DISTL(1), DISTM(1), X  , JOFX )
      CALL INTGS ( JOFX, SUMM, EIN, NINC )
      XX = 1.0 - [illegible](EDIST*ELCH)
      L0 = JLM / SOUND
      WRITE (6,30) U1BAR, GAMMA, ZK, XX, JLM
      WRITE (6,20)
      U1BAR2=U1BAR* 1BAR
      T1BAR=1.0-.5*(GAMMA-1.0)*U1BAR2
      C1BAR=SQRT(T1BAR)
      ZETA1B=1.0/(T1BAR-GAMMA*U1BAR2*(K-1.0))
      ASTAR=2.0*C1BAR/(C1BAR**2-U1BAR2)
C
 50 NOMEG = EXTRA(22) + .001
      IJ = NOMEG-1
      KK = 1
      IK = 9*IJ + 1
      DO 60 J = 1, IJ
         OMG(KK) = W(J)
         DELT = 0.2*(W(J+1)-W(J))
         KK = KK+1
         DO 60 I = 1, 4
            OMG(KK) = OMG(KK-1) + DELT
            KK = KK + 1
 60 CONTINUE
      OMG(KK) = W(NOMEG)
      DO 70 KK = 1, IK
         CALL INTA ( AMIT(1), AMIT(31), OMG(KK), ALFR(KK) )
         CALL INTA ( AMIT(1), AMIT(61), OMG(KK), ALFI(KK) )
 70      CONTINUE
      DO 130 I = 1, IK
         IF ( I .EQ. 51 .OR. I .EQ. 101 )     CALL PAGE ( 60
      OMEGA=TAB(I,1)
      ALPRE=TAB(I,2)
      ALPIM=TAB(I,3)
      DENB=(C1BAR-U1BAR*ALPRE)**2+U1BAR2*ALPIM*ALPIM
      BRE=(C1BAR*C1BAR-U1BAR2*(ALPRE*ALPRE+ALPIM*ALPIM))/DENB
      BIM=2.0*C1BAR*U1BAR*ALPIM/DENB
      UL= L0-ZK*XX
      ZETAL=ZETA1B*U1BAR/UL
      A=2.0*ZETA1B*U1BAR*GAMMA*ZK/OMEGA
      B=T1BAR/GAMMA+U1BAR2/GAMMA
      C=2.0*U1BAR*C1BAR/GAMMA
      D=1.0+ZETAL*ZK/OMEGA
      PHI=OMEGA*ASTAR*(1.0-XX)
      THETA=2.0*OMEGA*XX
      SINPHI=SIN(PHI)
      COSPHI=COS(PHI)
      SINTH=SIN(THETA)
      COSTH=COS(THETA)
      CR=1.0+BRE*COSPHI-BIM*SINPHI
      CI=BIM*COSPHI+BRE*SINPHI
      DR=1.0-BRE*COSPHI+BIM*SINPHI
      DI= -BIM*COSPHI-BRE*SINPHI
      ER=1.0-COSTH
      EI= SINTH
      FR=1.0+COSTH
      FI=-SINTH
      CAPI=(FR/GAMMA)*(U1BAR*CR-C1BAR*DR)-(FI/GAMMA)*(U1BAR*CI-C1BAR*DI)
     1+(D*B-U1BAR*A)*(ER*CR-EI*CI)+(C1BAR*A-C*D)*(ER*DR-EI*DI)
      CAPJ=(FI/GAMMA)*(U1BAR*CR-C1BAR*DR)+(FR/GAMMA)*(U1BAR*CI-C1BAR*DI)
     1+(D*B-U1BAR*A)*(ER*CI+EI*CR)+(C1BAR*A-C*D)*(ER*DI+EI*DR)
      CAPK=FR*(B*CR-C*DR)-FI*(B*CI-C*DI)
      CAPL=FI*(B*CR-C*DR) +FR*(B*CI-C*DI)
      DENMN=CAPK*CAPK+CAPL*CAPL
      CAPM=(CAPK*CAPI+CAPL*CAPJ)/DENMN
      CAPN=(CAPK*CAPJ-CAPL*CAPI)/DENMN
      SE= L*GAMMA*(1.0+ZETAL-ZETA1B)
      T=.5*(CAPM*CAPM+CAPN*CAPN)/CAPM
      ZN=T/SE
      COSOD=1.0-CAPM/T
      SINOD = CAPN /T
      OMDEL  = ATAN(SINOD/COSOD)
      IF (SINOD) 80,110,110
 80 IF (COSOD) 100,100,90
 90 OMDEL=6.2831853+OMDEL
      GO TO 120
 100 OMDEL=3.1415927+OMDEL
      GO TO 120
 110 IF (COSOD) 100,120,120
 120 DELTA=OMDEL/OMEGA
C         NON-DIMENSIONALIZED RESULTS
      TAUMS = DELTA*ELCH/SOUND*83.333333
      FREQ = OMEGA*SOUND/ELCH*12.0/6.2831853
      WRITE (6,10)  FREQ, OMEGA, TAUMS, ZN
 130 CONTINUE
      RETURN
          END
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$IBFTC MTAU    LIST,M94                                                        MTAU
      SUBROUTINE  FFF ( FIN, FOUT, CF, NER, W )                               MTAU  10
C*************************************************************************** MTAU  20
      DIMENSION FIN(1),FOUT(1),A(133),B(133),OMGA(1),XN(1),TAU(1),OMX(1)MTAU  30
     1,MTRINT(1),MTIINT(1)                                                    MTAU  40
      DIMENSION XNNEW(41),FCCPS(41),W (1)                                     MTAU  50
      COMMON  /ABCDF /  FXTRA(100),  ABLOK(600), A    , B,  XNNEW, FCCPS MTAU  60
      EQUIVALENCE (A(9),OMX),(A(10),OMGA),(A(5),MTRINT),(A(92),MTIINT),MTAU  70
     1(B(9),XNW),(B(10),OMX),(B(5),TAU),(B(92),XN)                            MTAU  80
C                                                                             MTAU  90
C                                                                             MTAU 100
      CONST=FOUT(101)                                                         MTAU 110
      XNMIN=1000.0                                                            MTAU 120
      CALL PAGE(70)                                                           MTAU 130
      CALL DVCHK (KOOOFX)                                                     MTAU 140
   10 DO 20 I=1,133                                                           MTAU 150
      A(I) =FIN(I)                                                            MTAU 160
   20 B(I)=0.0                                                                MTAU 170
      NER=IFIX(ONW)                                                           MTAU 180
      XNW=ONW                                                                 MTAU 190
      IF(CF-99.0)70,70,30                                                     MTAU 200
   30 CALL PAGE (44)                                                          MTAU 210
      WRITE (6,40)                                                            MTAU 220
   40 FORMAT (1HO,50H PROGRAM  F  INPUT  SOLVE FOR N(W) AND TAU(W)            MTAU 230
     1//19X,8H(OMEGA)D,9X,6HMTRINT,10X,6HMTIINT)                              MTAU 240
      DO 50 I =1,40                                                           MTAU 250
   50 WRITE (6,60)OMGA(I),MTRINT(I), MTIINT(I)                                MTAU 260
   60 FORMAT(1H ,10X,3F16.6)                                                  MTAU 270
   70 CONTINUE                                                                MTAU 280
      DO 120 I =1,40                                                          MTAU 290
      XN(I)=(MTRINT(I)+MTRINT(I) + MTIINT(I)+MTIINT(I))/(2.0*MTRINT(I))       MTAU 300
      DNOM = XN(I) - MTRINT(I)                                                MTAU 310
      CALL QUAD (DNOM,MTIINT(I),TAU(I))                                       MTAU 320
      TAU(I)=(TAU(I)*A(1)*83.333333)/(A(2)*OMGA(I))                           MTAU 330
C A(1)=L,A(2)=CO                                                              MTAU 340
      OMX(I)=OMGA(I)                                                          MTAU 350
      CALL DVCHK  KOOOFX)                                                     MTAU 360
       GO TO (80,90),KOOOFX                                                   MTAU 370
   80 NER=0                                                                   MTAU 380
      GO TO 220                                                               MTAU 390
   90 IF(XN(I))120,120,100                                                    MTAU 400
  100 IF(XN(I)-XNMIN) 110,120,120                                             MTAU 410
  110 XNMIN=XN(I)                                                             MTAU 420
      IMIN=I                                                                  MTAU 430
  120 CONTINUE                                                                MTAU 440
      DO 130 I=1,100                                                          MTAU 450
  130 FOUT(I) = B(I)                                                          MTAU 460
      IF ( CF-9.0 )          180,180,140                                      MTAU 470
  140 CALL PAGE (45)                                                          MTAU 480
      WRITE (6,150)                                                           MTAU 490
  150 FORMAT(1HO,20H PROGRAM  F  OUTPUT  //21X,7HFC(CPS),13X,8H(OMGA)D,MTAU 500
     113X,7HTAU(MS),16X,1HN  )                                                MTAU 510
      DO 160 I=1,40                                                           MTAU 520
      FCCPS(I)=CONST*OMX(I)                                                   MTAU 530
  160 WRITE (6,170)FCCPS(I),OMX(I),TAU(I),XN(I)                               MTAU 540
  170 FORMAT(21X,F7.1 ,11X,F10.5,10X,F10.5,10X,F10.5)                         MTAU 550
  180 MTIINT(41) = 0.0                                                        MTAU 560
      MTRINT(41)=0.0                                                          MTAU 570
      XN(41)=0.0                                                              MTAU 580
      OMX(41)=0.0                                                             MTAU 590
      FCCPS(41)=0.0                                                           MTAU 600
  190 FORMAT(36X,5HXMIN=,F10.5,/36X,8HTAU(MS)=,F10.5,/36X,9H(OMEGA)D=,FMTAU 610
     10.5,/36X,8HFC(CPS)=,F10.1,)                                             MTAU 620
      DO 200 I =1,40                                                          MTAU 630
  200  CALL INT4D(OMX(1),XN(1),OMX(I),SAVNOT,XNNEW(I))                        MTAU 640
      XNNEW(41)=0.0                                                           MTAU 650
       CALL INT4(XNNEW(1),OMX(1),0.0,DOMMIN)                                  MTAU 660
      FCMIN=CONST*DOMMIN                                                      MTAU 670
      CALL INT4(FCCPS(1),MTRINT(1),FCMIN,MTR1)                                MTAU 680
      CALL INT4(FCCPS(1),MTIINT(1),FCMIN,MTI1)                                MTAU 690
      MTRMIN=(MTR1*MTR1+MTI1*MTI1)/(2.0*MTR1)                                 MTAU 700
      DNOM=MTRMIN-MTR1                                                        MTAU 710
      CALL QUAD(DNOM,MTI1,TAUMIN)                                             MTAU 720
      TAUMIN=(TAUMIN*A(1)*83.333333)/(A(2)*DOMMIN)                            MTAU 730
      CALL PAGE (8)                                                           MTAU 740
      WRITE (6,210)                                                           MTAU 750
  210 FORMAT(//21X,58H THE FOLLOWING ARE VALUES INTERPOLATED AT SLOPE OFMTAU 760
     1 N=0.0                    ,/)                                          MTAU 770
      WRITE (6,190)MTRMIN,TAUMIN,DOMMIN,FCMIN                                MTAU 780
  220 RETURN                                                                  MTAU 790
      END                                                                     MTAU 800


$IBFTC QUADR   LIST,M94                                                       QUAD
      SUBROUTINE QUAD (A,B,ANGLE)                                             QUAD  10
      IF(B) 10,50,80                                                          QUAD  20
   10 IF(A) 20,30,40                                                          QUAD  30
   20 ROTATE = 3.1415927                                                      QUAD  40
      GO TO 110                                                               QUAD  50
   30 ANGLE = 4.7123890                                                       QUAD  60
      GO TO 120                                                               QUAD  70
   40 ROTATE = 6.2831853                                                      QUAD  80
      GO TO 110                                                               QUAD  90
   50 IF (A) 60,70,70                                                         QUAD 100
   60 ANGLE = 3.1415927                                                       QUAD 110
      GO TO 120                                                               QUAD 120
   70 ANGLE = 0.0                                                             QUAD 130
      GO TO 120                                                               QUAD 140
   80 IF(A) 20,90,100                                                         QUAD 150
   90 ANGLE = 1.5707963                                                       QUAD 160
      GO TO 120                                                               QUAD 170
  100 ROTATE = 0.0                                                            QUAD 180
  110 ANGLE = ATAN(B/A) + ROTATE                                              QUAD 190
  120 RETURN                                                                  QUAD 200
      END                                                                     QUAD 210


$IBFTC KORE    LIST,M94                                                       KORE
      SUBROUTINE CORE(X,N,CODE)                                               KORE  10
      DIMENSION X(1)                                                          KORE  20
      IF(CODE-500.0)40,10,10                                                  KORE  30
   10 CODE=100.0                                                              KORE  40
      CALL PAGE(70)                                                           KORE  50
      WRITE (6,20)                                                            KORE  60
   20 FORMAT(10X,37HINPUT DATA DUMP FOR PROGRAM FAILIER      //)             KORE  70
      WRITE (6,30)(X(I),I=1,N)                                                KORE  80
   30 FORMAT(5X,10(F10.4,2X))                                                 KORE  90
   40 RETURN                                                                  KORE 100
      END                                                                     KORE 110
```

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$ORIGIN       ALODE,REW

$INCLUDE      JECTOR

$IBFTC INJ     LIST,M94
      SUBROUTINE  INJCTR
C
      COMMON  /PROLOG/  LOGIK(38), HEAD(12), SL1, SL2, EORJ
      COMMON  /JECTOR/  EJDATA( 9600)
C
      EQUIVALENCE  (LOGIK(5),ERUN) , (LOGIK(10),JRUN ) , (LOGIK(9),IRUN)
      LOGICAL  LOGIK, ERUN, JRUN, SL1, SL2, EORJ, IRUN
      DIMENSION  HEAD1(12)
C
      IF ( SL1 )                GO TO 20
      DO 10 I = 1, 9600
   10    EJDATA(I) = 0.0
      SL1 = .TRUE.
      GO TO 30
C
   20 READ (13)  EJDATA
      BACKSPACE  13
   30 CALL  AS198  ( EJDATA, HEAD1, NE )
      IF ( NE .NE. 1 )          CALL  EXIT
      WRITE (13)  EJDATA
      BACKSPACE  13
      IF ( .NOT. JRUN )         GO TO 40
      CALL  JJJ
   40 IF ( ERUN .OR. IRUN )   CALL  INJCIS
C
   50 RETURN
         END


$IBFTC JECT    LIST,M94
      SUBROUTINE JJJ
C
C  ************  DECK MODIFIED 20 AUG 67     ********************
C
      DIMENSION  THET1(1450), R1(1450), TMU(1000)
      DIMENSION              NFLE(1000),X(1000),Y(1000),NTYPEE(1000),R(22)
     1,THETA(182),AS(20),WTE(1000),AAX(1000),AAF(1000),NBAND(1000),XNRE(
     21000),XMUTOT(20),AXTY(200),AFTY(200),XX(1000),YY(1000)
      COMMON  /JECTOR/  DATA ( 9600)
C
      EQUIVALENCE (DATA(3),XM), (DATA(4),XN)
      EQUIVALENCE (DATA(1021),THET1),(DATA(2471),R1),(DATA(3921),TMU)
      EQUIVALENCE (NTYPEE,DATA(2001)),(AXTY,DATA(1001)),(AFTY,DATA(1201)
     1), (DATA(1921),XX),(DATA(2921),YY),(DATA(4921),XMUTOT)
C
      NERROR=0
      SECT=DATA(5)
      WT=DATA(9573)
      RINJ=DATA(9574)
      XMR=DATA(9575)
      FFC=DATA(9576)
      DFFC=DATA(9577)
      NT=DATA(9570)+.0001
      POLAR=DATA(9572)
      NE=DATA(9571)+.0001
      ROX=DATA(9579)
      ROF=DATA(9580)
      EMUMAX=5.0
      PXADJ=1.0
      PFADJ=1.0
      CDX=DATA(9585)
      CDF=DATA(9586)
      XFC=DATA(9591)
      DXFC=DATA(959?)
      PFFC = DATA(9589)/100.0
      PXFC = DATA(9590)/100.0
      IF (XM .EQ. 0.0 ) XM = 20.0
      IF ( XN .EQ. 0.0 ) XN = 180.0
      K=910
        ?NL  ?.?831853/S???
      ?  ?  ?A(322)120,30,30
   ?? ?OTA    3.1415926/SECT
      GO TO ?0
   ?? ROTATE=?.?
   40 IF(POLA? ? ?10 ,?
   ?0 IF(SECT-1.0)80,60,60
   60 DO 70 I=1,NE
      KK=K+1
      NELF(I)=DATA(KK)+.0001
      X(I)=DATA(KK+1)
      Y(I)=DATA(KK+2)
      NTYPEE(I)=DATA(KK+3)+.0001
      SAVE=SQRT(X(I)*X(I)+Y(I)*Y(I))
      Y(I)=(ATAN(Y(I)/X(I)))+ROTATE
      X(I)=SAVE
      K=K+6
   70 CONTINUE
      GO TO 220
   80 DO 170 I=1,NE
      KK=K+1
      NELE(I)=DATA(KK)+.0001
      X(I)=DATA(KK+1)
      Y(I) =DATA(KK+2)
      NTYPEE(I)=DATA(KK+3)+.0001
C     THE FOLLOWING SEGMENT OF CODING REPLACES SUBROUTINE MOVXY...
         IF ( Y(I) )              90,130,140
   90    IF ( X(I) )            100,110,120
  100    ROTATE = 3.1415927
         GO TO 160
  110    X(I) = 1.0E-15
  120    ROTATE = 6.2831853
         GO TO 160
  130    ROTATE = 0.0
         GO TO 160
  140    IF ( X(I) )            100,150,130
  150    X(I) = 1.0E-15
         ROTATE = 0.0
  160 SAVE = SQRT ( X(I)*X(I)+Y(I)*Y(I) )
      SAVE=SQRT(X(I)*X(I)+Y(I)*Y(I))
      Y(I)=(ATAN(Y(I)/X(I)))+ROTATE
      X(I)=SAVE
      K=K+6
  170 CONTINUE
      GO TO 22?
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  185 IF(SECT-1.0)190,190,200                                          JECT 890
  190 ROTATE=0.0                                                       JECT 900
  200 DO 210 I=1,NE                                                    JECT 910
      KK=K+1                                                           JECT 920
      NELE(I)=DATA(KK)+.0001                                           JECT 930
      X(I)=DATA(KK+1)                                                  JECT 940
      Y(I)=(DATA(KK+2)*.0174532)+ROTATE                                JECT 950
      NTYPEE(I)=DATA(KK+3)+.0001                                       JECT 960
      K=K+4                                                            JECT 970
  210 CONTINUE                                                         JECT 980
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCJECT 990
C     CALCULATING AREAS OF ELEMENTS                                  JECT1000
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCJECT1010
  220 NN=4944                                                          JECT1020
      DO 280 I=1,NT                                                    JECT1030
      KK=NN+1                                                          JECT1040
      NST=DATA(KK)+.0001                                               JECT1050
      KK1=KK+1                                                         JECT1060
      JJ=KK1                                                           JECT1070
      NE=DATA(KK1)+.0001                                               JECT1080
      AXTY(NST)=0.0                                                    JECT1090
      IF (NE)230,250,230                                               JECT1100
  230 DO 240 JE=1,NE                                                   JECT1110
      JJ=KK1+JE                                                        JECT1120
      AXTY(NST)=AXTY(NST)+(.7853981*(DATA(JJ)*DATA(JJ)))               JECT1130
  240 CONTINUE                                                         JECT1140
  250 NN1=JJ+1                                                         JECT1150
      NN=NN1                                                           JECT1160
      NF=DATA(NN1)+.0001                                               JECT1170
      AFTY(NST)=0.0                                                    JECT1180
      IF(NF)260,280,260                                                JECT1190
  260 DO 270 JF=1,NF                                                   JECT1200
      NN=NN1+JF                                                        JECT1210
      AFTY(NST)=AFTY(NST)+(.7853981*(DATA(NN)*DATA(NN)))               JECT1220
  270 CONTINUE                                                         JECT1230
  280 CONTINUE                                                         JECT1240
      AXTOT=0.0                                                        JECT1250
      AFTOT=0.0                                                        JECT1260
      DO 290 I=1,NE                                                    JECT1270
      NN=NTYPEE(I)                                                     JECT1280
      AAX(I)=AXTY(NN)                                                  JECT1290
      AAF(I)=AFTY(NN)                                                  JECT1300
      AXTOT=AXTOT+AAX(I)                                               JECT1310
      AFTOT=AFTOT+AAF(I)                                               JECT1320
  290 CONTINUE                                                         JECT1330
      AXTOT=AXTOT*SECT                                                 JECT1340
      AFTOT=AFTOT*SECT                                                 JECT1350
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCJECT1360
C     CALCULATING RADII AND ANGLE BOUNDRIES                          JECT1370
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCJECT1380
  300 NPTS=180.0/SECT                                                  JECT1390
      TPS=NPTS                                                         JECT1400
      DELTH=THFNL/TPS                                                  JECT1410
      AREA = 3.141592 * RINJ**2                                        JECT1420
      ASECT = AREA/(XM*XM)                                             JECT1430
      R(1) = 0.0                                                       JECT1440
      ANP = ASECT * 180.0 / 3.141592                                   JECT1450
      DO 310 I = 2,21                                                  JECT1460
      R(I) = SQRT ( ANP + R(I-1)**2)                                   JECT1470
  310 CONTINUE                                                         JECT1480
      R(22) = 0.0                                                      JECT1490
      XNUM=0.0                                                         JECT1500
      NPTS1=NPTS+1                                                     JECT1510
      DO 320 J=2,NPTS1                                                 JECT1520
      XNUM=XNUM+1.0                                                    JECT1530
      THETA(J)=DELTH*XNUM                                              JECT1540
  320 CONTINUE                                                         JECT1550
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCJECT1560
C     CALCULATING WEIGHT FLOW                                        JECT1570
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCJECT1580
      WFT1=WT/(XMR+1.0)                                                JECT1590
      WXT1=WT-WFT1                                                     JECT1600
      WFT2=WFT1                                                        JECT1610
      WXT2=WXT1                                                        JECT1620
      IF(DFFC)340,340,330                                              JECT1630
  330 WFT2=WFT1*(1.0-PFFC)                                             JECT1640
  340 IF(DXFC)360,360,350                                              JECT1650
  350 WXT2=WXT1*(1.0-PXFC)                                             JECT1660
  360 SIGMEN=WT/(3.141592*RINJ*RINJ)                                   JECT1670
  370 AXTMAX=AXTOT                                                     JECT1680
      AXTMIN=AXTOT                                                     JECT1690
      AFTMAX=AFTOT                                                     JECT1700
      AFTMIN=AFTOT                                                     JECT1710
  380 AFFC=0.0                                                         JECT1720
      AXFC=0.0                                                         JECT1730
      IF(DFFC)400,400,390                                              JECT1740
  390 AFFC=FFC*.785398*DFFC*DFFC                                       JECT1750
      AFTMIN=AFTMIN-AFFC                                               JECT1760
      AFTMAX=AFTMAX-AFFC                                               JECT1770
  400 IF(DXFC)420,420,410                                              JECT1780
  410 AXFC=XFC*.785398*DXFC*DXFC                                       JECT1790
      AXTMIN=AXTMIN-AXFC                                               JECT1800
      AXTMAX=AXTMAX-AXFC                                               JECT1810
  420 AXNOM=(AXTMAX+AXTMIN)/2.0                                        JECT1820
      AFNOM=(AFTMAX+AFTMIN)/2.0                                        JECT1830
      IF(DFFC+DXFC)440,440,430                                         JECT1840
  430 WXT2=(WXT2*AXNOM)/(AXNOM+AXFC)                                   JECT1850
      WFT2=(WFT2*AFNOM)/(AFNOM+AFFC)                                   JECT1860
  440 XMR1=WXT2/WFT2                                                   JECT1870
  450 ETOF=0.0                                                         JECT1880
      ETFF=0.0                                                         JECT1890
      QX=WXT2/AXTOT                                                    JECT1900
      QF=WFT2/AFTOT                                                    JECT1910
      CALL DVCHK (K000FX)                                              JECT1920
  460 DO 480 I=1,NE                                                    JECT1940
      NBAND(I)=0                                                       JECT1950
      WFE1=AAF(I)*QF                                                   JECT1960
      WXE1=AAX(I)*QX                                                   JECT1970
      WTE(I)=WFE1+WXE1                                                 JECT1980
      XMRE(I)=WXE1/WFE1                                                JECT1990
      ETOF=ETOF+WXE1                                                   JECT2000
      ETFF=ETFF+WFE1                                                   JECT2010
      CALL DVCHK (K000FX)                                              JECT2020
       GO TO (470,480),K000FX                                          JECT2030
  470 NBAND(I)=-1                                                      JECT2040
  480 CONTINUE                                                         JECT2050
      ETOF=SECT*ETOF                                                   JECT2060
      ETFF=SECT*ETFF                                                   JECT2070
      WMRELM=ETOF/ETFF                                                 JECT2080
      AXXTT=AXTOT*AXFC                                                 JECT2090
      AFFTT=AFTOT*AFFC                                                 JECT2100
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      WFT2 = ETFF                                                       JECT2110
      WXT2 = ETOF                                                       JECT2120
     WFT1=WFT2/(1.0-PFFC)                                               JECT2130
     WXT1=WXT2/(1.0-PXFC)                                               JECT2140
      WFT1 = WFT1*AFFTT/AFTOT                                           JECT2150
      WXT1 = WXT1*AXXTT/AXTOT                                           JECT2160
     XMRINJ=WXT1/WFT1                                                   JECT2170
     D= ((WXT1/(CDX*AXXTT))**2)*2.2960248                               JECT2180
     WTOT=WXT1+WFT1                                                     JECT2190
     DPX1=D/ROX                                                         JECT2200
     D= ((WFT1/(CDF*AFFTT))**2)*2.2960248                               JECT2210
     DPF1=D/ROF                                                         JECT2220
      TOFCF = WXT1*(1.0 - PXFC)                                         JECT2230
      TOFCF = (TOFCF*(AXXTT - AXFC))/AXXTT                              JECT2240
      TOFCF = WXT1 - TOFCF                                              JECT2250
      TFFC = WFT1*(1.0 - PFFC)                                          JECT2260
      TFFC = (TFFC*(AFFTT - AFFC))/AFFTT                                JECT2270
      TFFC = WFT1 - TFFC                                                JECT2280
     VINJX=SQRT((9279.6*DPX1 /ROX))                                     JECT2290
     VINJF=SQRT((9279.6*DPF1 /ROF))                                     JECT2300
     XXV=TPS*SIGMEN*SECT                                                JECT2310
690  WRITE (6,820)                                                      JECT2320
     GO TO 500                                                          JECT2330
500  WRITE (6,760)AXTOT,AFTOT,AXFC,AFFC,AXXTT,AFFTT,DPX1,DPF1          JECT2340
     WRITE (6,770)WTOT,WMRELM,XMRINJ,FTOF,ETFF,TOFCF,TFFC, WXT1, WFT1 ,JECT2350
    1VINJX,VINJF                                                        JECT2360
     PFFC=PFFC*100.0                                                    JECT2370
     PXFC=PXFC*100.0                                                    JECT2380
510  WRITE (6,830)MT,NT,NE,CDX                                          JECT2390
     WRITE (6,780)CDF,PFFC,PXFC,DFFC,DXFC,FFC,XFC,ROX,ROF               JECT2400
     CALL PAGE(70)                                                      JECT2410
     WRITE (6,810)                                                      JECT2420
     NPGE=49                                                            JECT2430
     DO 540 I=1,NE                                                      JECT2440
     IF(NPGE-I)520,520,530                                              JECT2450
520  CALL PAGE(70)                                                      JECT2460
     NPGE=NPGE+48                                                       JECT2470
     WRITE (6,810)                                                      JECT2480
530  DEGREE=Y(I)/.0174532                                               JECT2490
     B=X(I)*SIN(Y(I))                                                   JECT2500
     A=X(I)*COS(Y(I))                                                   JECT2510
     WRITE (6,800)NELE(I),NTYPEE(I),X(I),DEGREE,A,B                     JECT2520
540  CONTINUE                                                           JECT2530
     CALL PAGE(70)                                                      JECT2540
     NPGE=46                                                            JECT2550
     JCONT=0                                                            JECT2560
     WRITE (6,840)                                                      JECT2570
     NN=4944                                                            JECT2580
     DO 670 I=1,MT                                                      JECT2590
     KK=NN+1                                                            JECT2600
     NST=DATA(KK)+.0001                                                 JECT2610
     KK1=KK+1                                                           JECT2620
     JJ=KK1                                                             JECT2630
     NX=DATA(KK1)+.0001                                                 JECT2640
     JCONT=JCONT+NX+1                                                   JECT2650
     IF(NPGE-JCONT)550,550,560                                          JECT2660
550  CALL PAGE(70)                                                      JECT2670
     WRITE (6,840)                                                      JECT2680
     JCONT=0                                                            JECT2690
560  AXMAX=0.0                                                          JECT2700
     AFMAX=0.0                                                          JECT2710
     WFE1=0.0                                                           JECT2720
     WXE1=0.0                                                           JECT2730
     WRITE (6,850)NST,NX                                                JECT2740
     IF(NX)570,590,570                                                  JECT2750
570  DO 580 JX=1,NX                                                     JECT2760
     JJ=KK1+JX                                                          JECT2770
     A=.7853891*DATA(JJ)*DATA(JJ)                                       JECT2780
     B=A*QX                                                             JECT2790
     WRITE (6,860)DATA(JJ),A,B                                          JECT2800
     AXMAX=AXMAX+A                                                      JECT2810
     WXE1=WXE1+B                                                        JECT2820
580  CONTINUE                                                           JECT2830
590  NN1=JJ+1                                                           JECT2840
     NN=NN1                                                             JECT2850
     NF=DATA(NN1)+.0001                                                 JECT2860
     JCONT=JCONT+NF+2                                                   JECT2870
     IF(NPGE-JCONT)600,600,610                                          JECT2880
600  CALL PAGE (70)                                                     JECT2890
     WRITE (6,840)                                                      JECT2900
     JCONT=0                                                            JECT2910
610  WRITE (6,870)NF                                                    JECT2920
     IF(NF)620,640,620                                                  JECT2930
620  DO 630 JF=1,NF                                                     JECT2940
     NN=NN1+JF                                                          JECT2950
     A=.7853891*DATA(NN)*DATA(NN)                                       JECT2960
     B=A*QF                                                             JECT2970
     WRITE (6,880)DATA(NN),A,B                                          JECT2980
     AFMAX=AFMAX+A                                                      JECT2990
     WFE1=WFE1+B                                                        JECT3000
630  CONTINUE                                                           JECT3010
640  WTOT1=WXE1+WFE1                                                    JECT3020
     IF(WFE)1660,650,660                                                JECT3030
650  WRITE (6,900)AXMAX,AFMAX,WTOT1                                     JECT3040
     GO TO 670                                                          JECT3050
660  XMR1=WXE1/WFE1                                                     JECT3060
     WRITE (6,890)AXMAX,AFMAX,WTOT1,XMR1                                JECT3070
670  CONTINUE                                                           JECT3080
680  READ  (13)  DATA                                                   JECT3090
     BACKSPACE  13                                                      JECT3100
     LINKNT = 0                                                         JECT3110
     AJS = XM*XN/WT                                                     JECT3120
     DO 700 J = 1,NE                                                    JECT3130
     TMU(J) = WTE(J)*AJS                                                JECT3140
     IF (LINKNT .GT. 0) GO TO 690                                       JECT3150
     CALL PAGE(70)                                                      JECT3160
     WRITE (6,910)                                                      JECT3170
     WRITE (6,930)                                                      JECT3180
     LINKNT = 50                                                        JECT3190
690  WRITE(6,920) J, X(J), Y(J), TMU(J)                                 JECT3200
     LINKNT = LINKNT - 1                                                JECT3210
700  CONTINUE                                                           JECT3220
     DO  705  I = 1, NE                                                 JECT3222
        XX(I) = X(I)                                                    JECT3224
705     YY(I) = Y(I)                                                    JECT3225
     WRITE  (13)       DATA                                             JECT3230
     BACKSPACE  13                                                      JECT3240
     XMUMAX=0.0                                                         JECT3250
     AJS = AJS*SECT/XM                                                  JECT3260
     DO 720 J=1,20                                                      JECT3270
     TOTW=0.0                                                           JECT3280
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      XXX = XXV = ASECT                                                    JECT3290
      J=J                                                                  JECT3300
      DO 710 I=1,NE                                                        JECT3310
      IF (X(I) .LE. R(J+1)) .AND. X(I) .GT. R(J)) TOTW = TOTW + WTE(I)     JECT3320
710 CONTINUE                                                               JECT3330
      XMUTOT(J) = TOTW*AJS                                                 JECT3340
      IF(XMUTOT(J)-XMUMAX)730,730,720                                      JECT3350
720 XMUMAX=XMUTOT(J)                                                       JECT3360
730 CONTINUE                                                               JECT3370
      CALL PAGE(70)                                                        JECT3380
      WRITE (6,790)                                                        JECT3390
      DO 740 J=1,20                                                        JECT3400
      XXMAX=XMUTOT(J)/XMUMAX                                               JECT3410
      WRITE (6,7-0)R(J+1),XMUTOT(J),XXMAX                                  JECT3420
740 CONTINUE                                                               JECT3430
      RETURN                                                               JECT3440
750 FORMAT(32X,F6.3,14X,F7.3,13X,F6.4)                                     JECT3450
760 FORMAT(//, 1,28HA....PROPELLENT ORFICE AREAS,//,9X,34HELEMENT TOTAJECT3460
     1L OXIDIZER (PEA       =,F11.8,8H SQ. IN.,15X,30HELEMENT TOTAL FUEL JECT3470
     2AREA       =,F11.8,8H SQ. IN.,//,9X,34HTOTAL OXIDIZER FILM COOLING AJECT3480
     3REA =,F11.8,8H SQ. IN.,15X,30HTOTAL FUEL FILM COOLING AREA =,F11.8JECT3490
     4,8H SQ. IN.,//,9X,34HINJECTOR TOTAL OXIDIZER AREA      =,F11.8,8H SQJECT3500
     5. IN.,15X,30HINJECTOR TOTAL FUEL AREA      =,F11.8,8H SQ. IN.,///,5XJECT3510
     6,54HB....INJECTOR PRESSURE DROPS FOR ABOVE INJECTOR DESIGN,//,9X, JECT3520
     724HOXIDIZER PRESSURE DROP =,F6.1,3HPSI,35X,20HFUEL PRESSURE DROP =JECT3530
     8,F6.1,4H PSI,///,5X,71HC....PROPELLANT FLOWS AND INJECTOR VELOCITIJECT3540
     9ES FOR ABOVE INJECTOR DESIGN,/)                                     JECT3550
770 FORMAT(/,48X,19HTOTAL WEIGHT FLOW =,F6.1,7H LB/SEC,/,42X,39HAVERAG JECT3560
     1E MIXTURE RATIO OF THE ELEMENTS =,F7.3,/,41X,40HOVERALL MIXTURE RAJECT3570
     2TIO FOR THE INJECTOR =,F7.3,///,9X,34HELEMENT TOTAL OXIDIZER FLOW  JECT3580
     3    =,F6.1,7H LB/SEC,2X,26HELEMENT TOTAL FUEL FLOW  =,F6.1,7H LB/JECT3590
     4SEC,/,9X,34HTOTAL OXIDIZER FILM COOLING FLOW =,F6.1,7H LB/SEC,21X,JECT3600
     526HTOYAL FUEL FILM COOLING  =,F6.1,7H LB/SEC,/,9X,34HINJECTOR TOTAJECT3610
     6L OXIDIZER FLOW      =,F6.1,7H LB/SEC,21X,29HINJECTOR TOTAL FUEL FLJECT3620
     70W=,F7.1,7H LB/SEC,/,9X,37HOXIDIZER OVERALL INJECTION VELOCITY =,FJECT3630
     86.1,7H FT/SEC,18X,33HFUEL OVERALL INJECTION VELOCITY =,F6.1,7H FT/JECT3640
     95EC,///)                                                            JECT3650
780 FORMAT(9X,23HFUEL LOSS COEFFICIENT =,F9.3,/,9X,27HPERCENT FUEL FILJECT3660
     1M COOLING =,F5.1,/,9X,31HPERCENT OXIDIZER FILM COOLING =,F5.1,/,9XJECT3670
     2,38HDIAMETER OF FUEL FILM COOLING ORFICE =,F7.5,7SH IN. (NOTE,,THIJECT3680
     3S MIGHT BE AN EQUIVALENT  DIAMETER FOR MULTIPLE-ROW COOLING),/,9X,JECT3690
     442HDIAMETER OF OXIDIZER FILM COOLING ORFICE =,F7.5,21H IN. (SEE ABJECT3700
     5OVE NOTE),/,9X,51HNUMBER OF FUEL FILM COOLING ORIFICES PER INJECTOJECT3710
     6R =,F5.0,/,9X,54HNUMBER OF OXIDIZER FILM COOLING ORFICES PER INJECJECT3720
     7TOR =,F5.0,/,9X,18HOXIDIZER DENSITY =,F7.2,4H PCF,/,9X,14HFUEL DENJECT3730
     8SITY =,F6.1,4H PCF.///)                                             JECT3740
790 FORMAT(///,3X,114HSECTION 4,,RESULTANT FLOW DISTRIBUTION (MU) AS JECT3750
     1A FUNCTION OF ONLY THE RADIUS. I.E,, AVERAGE OF MU IN A RADIAL BANJECT3760
     2D,    ///,32X,6HRADIUS,15X,5HMU(R),11X,13HMU(R)/MU(MAX),/,34X,5HINJECT3770
     3,,//)                                                               JECT3780
800 FORMAT(13X,I3,18X,12,4X,4(10X,F10,5))                                 JECT3790
810 FORMAT(//,2X, 49HSECTION 2,,,, ELEMENT LOCATION AND INJECTION TYPEJECT3800
     1,///,11X, 7HELEMENT,15X, 4HTYPE,17X,1HR,17X, 5HTHETA,17X,1HX,19X,1JECT3810
     2HY,/,13X, 3HNO.,18X, 3HNO.,14X, 8H(INCHES),12X, 8H(DEGREE),12X, 8HJECT3820
     3(INCHES),12X,8H(INCHES),///)                                        JECT3830
820 FORMAT(///,3X, 74HSECTION 1,,,,MISCELLANEOUS INFORMATION FOR INJECJECT3840
     1TOR DESIGNED BY PROJECTS          ,//)                              JECT3850
830 FORMAT(//,5X, 46HD,,,,,,INPUT INFORMATION USED IN COMPUTATIONS  ,/JECT3860
     1/,3X, 23HTOTAL PROPELLENT FLOW =,F6.1,7H LB/SEC,/,9X, 59HTOTAL NUMJECT3870
     2BER OF ELEMENT TYPES (SYMMETRICAL SECTION ONLY) = ,I3,/,9X, 54HTOTJECT3880
     3AL NUMBER OF ELEMENTS (SYMMETRICAL SECTION ONLY) = ,I4,/,9X, 27HOXJECT3890
     4IDIZER LOSS COEFFICIENT =,F5.3,)                                    JECT3900
840 FORMAT(//,2X, 78HSECTION 3,,,,TYPE DESCRIPTION,ORIFICE AREA, PROPEJECT3910
     1LLANT FLOW, AND MIXTURE RATIO,//,3X, 8HTYPE   =-------- OXIDIZER JECT3920
     2ORIFICE DATA -----=-------- -- FUEL ORIFICE DATA -------- =,//,93X,JECT3930
     3 5HTOTAL,5X, 5HTOTAL,5X, 5HTOTAL,4X, 7HMIXTURE,/,,2X, 6HNUMBER,34XJECT3940
     4, 6HNUMBER,33X, 8HOXIDIZER,4X, 4HFUEL,3X,19HPROPELLENT,3X, 5HRATIOJECT3950
     5,/,14X,2HOF,5X, 8HDIAMETER,4X, 4HAREA,6X, 4HFLOW,7X,2HOF,5X, 8HDIAJECT3960
     6METER,4X, 4HAREA,6X, 4HFLOW,6X, 4HAREA,6X, 4HAREA,4X, 9HFLOW RATE,JECT3970
     7/,11X, 7HORIFICE,6X,3HIN.,5X, 7HSQ. IN.,4X, 6HLB/SEC,3X, 8HORIFICEJECT3980
     85,5X, 3HIN.,4X, 7HSQ. IN.,4X, 6HLB/SEC,3X, 7HSQ. IN.,3X, 7HSQ. IN.JECT3990
     9,4X, 6HLB/SEC,//,)                                                  JECT4000
850 FORMAT(3X,I3,7X,I2)                                                    JECT4010
860 FORMAT(22X,F6.4,3X,F8.6,2X,F8.6)                                      JECT4020
870 FORMAT(54X,I2)                                                         JECT4030
880 FORMAT(62X,F6.4,3X,F8.6,2X,F8.6)                                      JECT4040
890 FORMAT(91X,F8.5,2X,F8.5,2X,F8.4,3X,F7.4)                              JECT4050
900 FORMAT(91X,F8.5,2X,F8.5,2X,F8.3,2X,8HINFINITY)                        JECT4060
910 FORMAT (///,10X15HELEMENT RESULTS )                                   JECT4070
920 FORMAT (32X15,11XF10.3,10XF10.4,11XF10.4 )                            JECT4080
930 FORMAT (///1X7HELEMENT14X6HRADIUS15X5HANGLE11X12HDISTRIBUTION/90X     JECT4090
     111HCOEFFICIENT/34X3HNO.35X7HRADIANS15X2HMU// )                      JECT4100
                    END                                                    JECT4110
```

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BIBFTC INJDS   LIST,M94
      SUBROUTINE  INJDIS
C
C  ************  DECK MODIFIED 20 AUG 67     ********************
C
      REAL IPP,IPR,IPT,INTEG,IPX
      INTEGER DSCRB, TIME
      LOGICAL  LOGIK,  SL1,  SL2,  EORJ, IRUN
      COMMON  /PROLOG/  LOGIK(50), SL1, SL2, EORJ
      COMMON  /JECTOR/  DATA ( 9600)
      COMMON    GAMMA, NW,  WC,  AVN,  BVN,  CVNR,  CVNI,  CE,  CI
      DIMENSION
     1    U      (1000),  AVN    (  30),  BVN    (  30),  CVNR  (  30),
     2    CVNI  (  30),  RR     (1000),  THATA (1000),  FIRST (  30),
     3    SECOND(  30),  Z      (   2),                  WC    (  30),
     4     IPP(50), OPP(50), IPR(50), OPR(50), IPT(50), OPT(50),
     5    X      (1000),  Y      (1000)
      EQUIVALENCE  ( IRUN, LOGIK(9) ),
     1    (E1     ,DATA(1)),                     (XM     ,DATA(3)),
     2    (XN     ,DATA(4)),(V      ,DATA(6)),(SVN    ,DATA(8)),
     3    (POC   ,DATA(13)),                     (Z1 ,DATA(15)),
     4    (RR, A, DATA(1921) ),(THATA, Y, DATA(2971)),
     5    (U   ,DATA(3921)),
     6                                     (IPP   ,DATA(20)),
     7    (OPP   ,DATA(70)),(IPR ,DATA(120)), (OPR ,DATA(170)),
     8    (IPT ,DATA(220)),(OPT ,DATA(270)),(TFLP,DATA(9596)),
     9    (TFLR,DATA(9597)),(TFLT,DATA(9598))
C
   10 FORMAT (//12X30HRESULTS OF DESCRIBING FUNCTION // 23X10HELEMENT
     1 6HRADIUS4X5HANGLE3X10HFRACTIONAL /13X5HOMEGA7X3HNO.7X3H    7X3HRAD
     2 4X9HFLOW-RATE10X2HFP12X2HFR12X2HFT // )
   20 FORMAT (10XF9.4,I9,F11.5,F10.4,F11.5,2X3F14.6 )
   30 FORMAT (//  12X41HRESULTS OF INJECTION DISTRIBUTION EFFECTS //
     143X5HOMEGA6X3HAVN8X3HBVN7X3HCVN7X3HCVN / 48X3(6X4HREAL1,6X4HIMAG/
     2/ )
   40 FORMAT (39X5F10.4 )
   50 FORMAT ( 44X3HALL  4F10.4 )
   60 FORMAT ( // 5X39HINPUT TO INJECTION DISTRIBUTION PROGRAM//10X9HCON
     1STANTS//14X18HNUMBER OF OMEGAS = I3//14X20HNUMBER OF ELEMENTS =I5,
     1 13H FOR EACH OF I4, 20H SYMMETRIC SECTIONS.
     2//14X22HRADIAL DIVISIONS(XM) = F5.0//14X24HANGULAR DIVISIONS (XN)
     3=F5.0//14X27HACOUSTIC MODE NUMBER(SVN) =F7.4//14X30HORDER OF BESSE
     4L FUNCTIONS(V) = F3.0//14X17HINJECTOR RADIUS =F8.3,5H, IN.//14X32H
     5RATIO OF SPECIFIC HEATS(GAMMA) =F7.4//14X39HMAXIMUM PRESSURE AMPLI
     6TUDE RATIO(POO) =F7.3///14X39HTRANSFER FUNCTIONS FOR LINEAR OPERAT
     7ION//20X16HPRESSURE(TFLP) =F7.3//20X23HRADIAL VELOCITY(TFLR) =F7.3
     8//20X27HTANGENTIAL VELOCITY(TFLT) =F7.3 )
   70 FORMAT (// 10X17HINPUT FREQUENCIES )
   80 FORMAT (/ 7X 5F20.4 )
   90 FORMAT (///10X19HELEMENT INFORMATION )
  100 FORMAT (//31X7HELEMENT14X6HRADIUS15X5HANGLE11X12HDISTRIBUTION/90X
     111HCOEFFICIENT/34X3HNO.17X3HIN.15X7HRADIANS15X2HMU// )
  110 FORMAT (32XI5,11XF10.3,10XF10.4,11XF10.4 )
  120 FORMAT (1H1//26H TABULAR NONLINEAR EFFECTS//11X8HPRESSURE11X10HCOM
     1BUSTION12X6HRADIAL12X10HCOMBUSTION10X10HTANGENTIAL10X10HCOMBUSTION
     2/51X8HVELOCITY32X8HVELOCITY/ 9X 3(12HPERTURBATION13X4HGAIN12X) )
  130 FORMAT ( 6(F18.3,2X) )
  140 FORMAT (//33X65H************  THESE VALUES PERTAIN TO A STANDING MO
     1DE  ********** )
  150 FORMAT (//33X65H************  THESE VALUES PERTAIN TO A SPINNING MO
     1DE  ********** )
  160 FORMAT (23X42HTHE VALUE OF IZZIT IS ZERO AND NOT ALLOWED)
  170 FORMAT(23X45HVALUE OF BESSEL ARGUMENT TOO HIGH OR LOW Z = F10.4)
C
  180 DSCRB = 1
      IF ( .NOT. IRUN )     GO TO 190
      CE = 100.0
      DSCRB = 2
      GO TO 200
  190 NW = 1
      WC(1) = 1.0
  200 TIME = 1
      RINJ = DATA(9574)
      NE = DATA(9571)  +0.0001
      NS = DATA(5) + 0.0001
      NUMBR = DATA(9599)  + 0.0001
      IZZIT = DATA(2)
      K = V +0.0001
      KK = K + 1
      L = 2*K - 1
      M = L + 2
      N = M + 2
      IF ( E1 .LE. 0.0 )    E1 = 0.0001
      IF ( NUMBR .LE. 0 )     NUMBR = 10
      IF ( CE .LE. 99.0 )     GO TO 260
      CALL  PAGE  ( 70 )
      WRITE (6,60) NW,NE,NS,XM,XN,SVN,V,RINJ,GAMMA,POO,TFLP,TFLR,TFLT
      GO TO (220,210), DSCRB
  210 WRITE (6,70)
      WRITE (6,80) (WC(IW), IW = 1,NW)
  220 LINKNT = 0
      DO 240 J = 1,NE
      IF (LINKNT .GT. 0) GO TO 230
      CALL  PAGE  ( 70 )
      WRITE (6,90)
      WRITE (6,100)
      LINKNT = 50
  230 WRITE (6,110) J, RR(J), THATA(J), U(J)
      LINKNT = LINKNT - 1
  240 CONTINUE
      GO TO (260,250), DSCRB
  250 WRITE (6,120)
      WRITE (6,130) (IPP(I),OPP(I),IPR(I),OPR(I),IPT(I),OPT(I),I=1,50)
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
C          RUNNING DESCRIBING FUNCTION IMPLIES THAT THE EXPANSION
C   COEFFICIENTS AVN, BVN, AND CVN ARE FUNCTIONS OF THE FREQUENCY,OMEGA.
C   THEREFORE, AN OMEGA LOOP MUST BE ESTABLISHED, OTHERWISE, THIS LOOP
C  IS GONE THROUGH ONLY ONCE.
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
  260 DO 470 IW = 1, NW
      WCR = WC(IW)
      VOO = POO/(GAMMA*WCR)
      SUMP = 0.0
      SUMR = 0.0
      SUMT = 0.0
      LINKNT = 0
      DO 450 J = 1, NE
      R = RR(J)/RINJ
      ETA = U(J)/(XM*XN)
C ***********************************************************************
C      THE CALL TO BESSEL REQUIRES THE DEFINITION OF THE REAL PORTION
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C  OF THE ARGUMENT, Z(1), AND THE IMAGINARY PORTION, Z(2).     FOR A    INJD1200
C  GIVEN ORDER V, THE OUTPUT OF BESSEL GIVES JOR(Z1), JOI(Z2), J1R(Z1), INJD1210
C  J1I(Z2),  ...., JVR(Z1), JVI(Z2).     THEREFORE, THE ANSWERS WILL BE   INJD1220
C  STORED  IN THE FOLLOWING FASHION.  J(V-1) = FIRST(L),  J(V) =          INJD1230
C  FIRST(N),  AND J(V+1) = FIRST(N).                                      INJD1240
C**********************************************************************INJD1250
      KERR = 0                                                           INJD1260
      Z(1) = SVN*R                                                       INJD1270
      Z(2) = 0.0                                                         INJD1280
      CALL  BESSEL  ( FIRST(1), SECOND(1), KK, Z(1), KERR )              INJD1290
      IF ( KERR )     270,270,950                                        INJD1300
  270 SIVN = FIRST(N)                                                    INJD1310
      DSIVN = ( V*FIRST(N) - Z(1)*FIRST(N) )/R                           INJD1320
      Z(1) = SVN                                                         INJD1330
      Z(2) = 0.0                                                         INJD1340
      CALL  BESSEL  ( FIRST(1), SECOND(1), KK, Z(1), KERR )              INJD1350
      IF  ( KERR )     280,280,950                                       INJD1360
  280 GO TO (290,320),  TIME                                             INJD1370
  290 IF ( K )    300,300,310                                            INJD1380
  300 D = ( FIRST(N)*FIRST(N) + FIRST(L)*FIRST(L) ) / 2.0                INJD1390
      GO TO 320                                                          INJD1400
  310 D = ( FIRST(N)*FIRST(N) - FIRST(L)*FIRST(N))*3.14159/(2.0**DATA(5))INJD1410
  320 IF ( IZZIT )    330,340,340                                        INJD1420
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXINJD1430
C  IZZIT IS NEGATIVE FOR STANDING MODES AND POSITIVE FOR SPINNING MODES INJD1440
CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXINJD1450
  330 VT = V*THATA(J)                                                    INJD1460
      CVT = COS(VT)                                                      INJD1470
      SVT = SIN(VT)                                                      INJD1480
      GO TO 350                                                          INJD1490
  340 CVT = 1.0                                                          INJD1500
      SVT = 1.0                                                          INJD1510
  350 FP = 1.0                                                           INJD1520
      FR = 1.0                                                           INJD1530
      FT = 1.0                                                           INJD1540
      GO TO (420,360), DSCRB                                             INJD1550
  360 PO = ABS(POO*SIVN*CVT)                                             INJD1560
      VO = ABS(VOO*DSIVN*CVT)                                            INJD1570
      WO = ABS(VOO*SIVN*V*SVT/R)                                         INJD1580
       A = -3.14159                                                      INJD1590
       B = -A                                                            INJD1600
      IF ( TFLP )     370,380,370                                        INJD1610
  370 SAVEP = 1.0/(3.14159*PO*TFLP)                                      INJD1620
      CALL INTGR(A,B,PSI,NUMBR)                                          INJD1630
      CPSI = COS(PSI)                                                    INJD1640
      IPX = PO*CPSI                                                      INJD1650
      CALL INTA(IPP(1), OPP(1), IPX, OPX)                                INJD1660
      F = OPX*CPSI                                                       INJD1670
       CALL INTGS(F,INTEG,E1,NN)                                         INJD1680
      FP = SAVEP*INTEG                                                   INJD1690
  380 IF ( TFLR )     390,400,390                                        INJD1700
  390 SAVER = 1.0/(3.14159*VO*TFLR)                                      INJD1710
      CALL INTGR(A,B,PSI,NUMBR)                                          INJD1720
      CPSI = COS(PSI)                                                    INJD1730
      IPX = VO*CPSI                                                      INJD1740
      CALL INTA (IPR(1), OPR(1), IPX, OPX)                               INJD1750
      F = OPX*CPSI                                                       INJD1760
      CALL INTGS (F, INTEG, E1, NN)                                      INJD1770
      FR = SAVER*INTEG                                                   INJD1780
  400 IF ( TFLT )     410,420,410                                        INJD1790
  410 SAVET = 1.0/(3.14159*VT*TFLT)                                      INJD1800
       CALL INTGR(A,B,PSI,NUMBR)                                         INJD1810
      CPSI = COS(PSI)                                                    INJD1820
      IPX = WO*CPSI                                                      INJD1830
      CALL INTA (IPT(1), OPT(1), IPX, OPX)                               INJD1840
      F = OPX*CPSI                                                       INJD1850
      CALL INTGS(F,INTEG,E1, NN)                                         INJD1860
      FT = SAVET*INTEG                                                   INJD1870
  420 TERMP = ETA*FP*SIVN**2*CVT**2                                      INJD1880
      SUMP = SUMP + TERMP                                                INJD1890
      TERMR = ETA*FR*SIVN*DSIVN*CVT**2                                   INJD1900
      SUMR = SUMR + TERMR                                                INJD1910
      TERMT = -ETA*FT*SIVN**2*CVT*V*SVT/R                                INJD1920
      SUMT = SUMT + TERMT                                                INJD1930
      TIME = 2                                                           INJD1940
      GO TO (430,430),  DSCRB                                            INJD1950
  430 IF ( LINKNT .GT. 0 )      GO TO 440                                INJD1960
      CALL  PAGE  ( 70 )                                                 INJD1970
      WRITE (6,10)                                                       INJD1980
      LINKNT = 50                                                        INJD1990
  440 WRITE (6,20)  WCR, J, R, THATA(J), ETA, FP, FR, FT                 INJD2000
      LINKNT = LINKNT - 1                                                INJD2010
  450 CONTINUE                                                           INJD2020
      DD = D                                                             INJD2030
      IF (IZZIT .GT. 0) DD = D/2.0                                       INJD2040
      AVN(IW) = SUMP/DD                                                  INJD2050
      BVN(IW) = SUMR/DD                                                  INJD2060
      IF (IZZIT .GT. 0)  GO TO 460                                       INJD2070
      CVNR(IW) = SUMT/DD                                                 INJD2080
      CVNI(IW) = 0.0                                                     INJD2090
      GO TO 470                                                          INJD2100
  460 CVNR(IW) = 0.0                                                     INJD2110
      CVNI(IW) = SUMT/DD                                                 INJD2120
  470 CONTINUE                                                           INJD2130
      IF (CE .LT. 10.0 ) GO TO 530                                       INJD2140
      CALL  PAGE  ( 70 )                                                 INJD2150
      WRITE (6,30)                                                       INJD2160
      GO TO (480,490),  DSCRB                                            INJD2170
  480 WRITE (6,50)  AVN(1 ), BVN(1 ), CVNR(1 ), CVNI(1 )                 INJD2180
      GO TO 500                                                          INJD2190
  490 WRITE (6,40)  ( WC(I), AVN(I), BVN(I), CVNR(I), CVNI(I),  I=1,NW )INJD2200
  500 IF ( IZZIT ) 510,560,520                                           INJD2210
  510 WRITE(6,140)                                                       INJD2220
      GO TO 530                                                          INJD2230
  520 WRITE (6,150)                                                      INJD2240
  530 CONTINUE                                                           INJD2250
  540 RETURN                                                             INJD2260
  550 WRITE (6,170) Z(1)                                                 INJD2270
      GO TO 540                                                          INJD2280
  560 WRITE (6,160)                                                      INJD2290
      GO TO 540                                                          INJD2300
      END                                                                INJD2310
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SIBMAP BESS    LIST,REF,DECK                                                  BESS0010
*      MAP                                                                    BESS0020
       PMC     ON                                                             BESS0030
       ENTRY   BESSEL                                                         BESS0040
       LBL     BESSEL,X                                                       BESS0050
*      CALL BESSEL (FIRST,SECOND,N,ARG,KODE )                                 BESS0060
*                                                                            BESS0070
*      FIRST   = FIRST LOCATION OF ASCENDING STORING SEQUENCE FOR JN(Z),      BESS0080
*                OR IN(Z).                                                   BESS0090
*      SECOND  = FIRST LOCATION OF ASCENDING STORING SEQUENCE FOR YN(Z),      BESS0100
*                OR KN(Z).                                                   BESS0110
*      N       = HIGHEST INTEGRAL ORDER DESIRED FOR BOTH JN(Z) AND YN(Z),     BESS0120
*                OR IN(Z) AND KN(Z).                                         BESS0130
*      ARG     = LOCATION OF Z = X+I*Y WITH X=ARG(1) AND Y=ARG(2).            BESS0140
*      KODE    = +0,COMPUTE JN(Z) AND YN(Z).                                  BESS0150
*                LESS ZERO,COMPUTE IN(Z) AND KN(Z).                          BESS0160
*      DIMENSIONS REQUIREMENTS FIRST(300),SECOND(2*N+2),ARG(2)                BESS0170
*                                                                            BESS0180
COMMON BSS     20                                                             BESS0190
BESSEL SXA     BS4,4                                                          BESS0200
       SXA     BS4+1,1                                                        BESS0210
       SXA     BS4+2,2                                                        BESS0220
       TRI     BESS1,4,-2                                                     BESS0230
BESS1  CAL     1,4                                                            BESS0240
       STA     BESSP+1                                                        BESS0250
       CAL     2,4                                                            BESS0260
       ALS     18                                                             BESS0270
       STD     BESSP+1                                                        BESS0280
       LDQ*    3,4                                                            BESS0290
       STQ     BESSP+2                                                        BESS0300
       CAL*    5,4                                                            BESS0310
       STP     BESSF+1                                                        BESS0320
       CLA     4,4                                                            BESS0330
       STA     BESS2                                                          BESS0340
       ADD     =1                                                             BESS0350
       STA     BESS3                                                          BESS0360
BESS2  CLA     **                                                             BESS0370
       LDQ     =,5E-5                                                         BESS0380
       TLQ     BESS3                                                          BESS0390
       TRA     ERRR1                                                          BESS0400
BESS3  LDQ     **                                                             BESS0410
BESSF  TSX     BFBF,4                                                         BESS0420
       PZE     **,,**          L(J),L(Y)                                      BESS0430
       PZE     **              N                                              BESS0440
       TRA     ERRR2           ERROR,,BFBF                                    BESS0450
       PXD     0,0                                                            BESS0460
BS4    AXT     **,4                                                           BESS0470
       AXT     **,1                                                           BESS0480
       AXT     **,2                                                           BESS0490
       STO*    7,4                                                            BESS0500
       TRA     1,4                                                            BESS0510
ERRR1  CLA     =1                                                             BESS0520
       TRA     BS4                                                            BESS0530
ERRR2  CLA     =2                                                             BESS0540
       TRA     BS4                                                            BESS0550
*      REM ALL ORDERS OF THE BESSEL FUNCTIONS Y SUB K TIMES (Z)               BESS0560
*          AND J SUB K TIMES (Z) FOR COMPLEX Z                                BESS0570
BFBF   STI     BFB1                                                           BESS0580
       LDI     1,4                                                            BESS0590
       LPT     400000                                                         BESS0600
       XCA                                                                    BESS0610
       SXD     G20,1                                                          BESS0620
       SXD     G21,2                                                          BESS0630
       SXD     G22,4                                                          BESS0640
       STO     COMMON+15                                                      BESS0650
       STO     COMMON+16                                                      BESS0660
       CLA     0                                                              BESS0670
       STO     CL                                                             BESS0680
       CLA     8                                                              BESS0690
       STO     CL+1                                                           BESS0700
       CLA     TRA1                                                           BESS0710
       STO     8                                                              BESS0720
       EFTM                                                                   BESS0730
R29    CAL     1,4                                                            BESS0740
       STA     BFR1                                                           BESS0750
       COM                                                                    BESS0760
       ACL     L11                                                            BESS0770
       STO     COMMON+17                                                      BESS0780
       CLA     2,4                                                            BESS0790
       ALS     18                                                             BESS0800
       STD     BFR1                                                           BESS0810
       CLA     COMMON+15                                                      BESS0820
       LDQ     COMMON+16                                                      BESS0830
       TSX     BF7F,4                                                         BESS0840
BFR1   PZE     **,0,**0                                                       BESS0850
G20    TXL     BFBX,0,*                                                       BESS0860
       LDQ     COMMON+15                                                      BESS0870
B61    FMP     COMMON+15                                                      BESS0880
       STO     COMMON+5                                                       BESS0890
       LDQ     COMMON+16                                                      BESS0900
       FMP     COMMON+16                                                      BESS0910
       FAD     COMMON+5                                                       BESS0920
       FDH     LOC4                                                           BESS0930
       STQ     COMMON+5                                                       BESS0940
       CLA     COMMON+5                                                       BESS0950
       CALL ALOG(COMMON+5)                                                    BESS0960
       TRA     G21+1                                                          BESS0970
G21    TXL     BFBX,0,*                                                       BESS0980
       FDH     LOC2                                                           BESS0990
       XCA                                                                    BESS1000
       FAD     OILFR                                                          BESS1010
       STO     COMMON+8        RL+GAM                                         BESS1020
       LDQ     COMMON+15                                                      BESS1030
       CLA     SHCON                                                          BESS1040
       LRS     0                                                              BESS1050
       TLQ     R2                                                             BESS1060
       TRA     R3                                                             BESS1070
R2     LDQ     COMMON+16                                                      BESS1080
       CLA     PIV2                                                           BESS1090
       LLS     0                                                              BESS1100
G22    TXL     R4,0,*                                                         BESS1110
R3     CLA     COMMON+16                                                      BESS1120
       FDP     COMMON+15                                                      BESS1130
       STQ     COMMON                                                         BESS1140
       CALL ATAN(COMMON)                                                      BESS1150
       LDQ     COMMON+15                                                      BESS1160
       TQP     R4                                                             BESS1170
       STO     COMMON                                                         BESS1180
       CLA     LP1                                                            BESS1190
       LDQ     COMMON+16                                                      BESS1200
       LLS     0                                                              BESS1210
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                FAD     COMMON                                          BESS1220
R4              STO     COMMON+9                                        BESS1230
                LXA     COMMON+17,1                                     BESS1240
                CLA     0,1                                             BESS1250
                LDQ     1,1                                             BESS1260
                TSX     MULT,4                                          BESS1270
                STO     COMMON+4                                        BESS1280
                STO     COMMON+5                                        BESS1290
                STZ     COMMON+8                                        BESS1300
                STZ     COMMON+9                                        BESS1310
                LXD     A38,2                                           BESS1320
                SXD     R68,2                                           BESS1330
B63             CLA     LOC1                                            BESS1340
R10             STO     COMMON+6                                        BESS1350
                FAD     LOC1                                            BESS1360
                STO     COMMON+7                                        BESS1370
                CLA     8,1                                             BESS1380
B64             FDP     COMMON+7                                        BESS1390
                STO     COMMON+10                                       BESS1400
                CLA     4,1                                             BESS1410
                FDP     COMMON+6                                        BESS1420
                STO     COMMON+11                                       BESS1430
                CLA     COMMON+11                                       BESS1440
R65             FSB     COMMON+10                                       BESS1450
                FAD     COMMON+8                                        BESS1460
                STO     COMMON+8                                        BESS1470
                CLA     9,1                                             BESS1480
B66             FDP     COMMON+7                                        BESS1490
                :       COMMON+11                                       BESS1500
                LLS     9,1                                             BESS1510
                FDP     COMMON+6                                        BESS1520
                STO     COMMON+10                                       BESS1530
                CLA     COMMON+10                                       BESS1540
R67             FSB     COMMON+11                                       BESS1550
                FAD     COMMON+9                                        BESS1560
                STO     COMMON+9                                        BESS1570
                CLA     COMMON+6                                        BESS1580
                FAD     LOC2                                            BESS1590
                TXI     R68,1,-8                                        BESS1600
B6E             TXH     R10,1,0                                         BESS1610
Z60             LDQ     COMMON+8                                        BESS1620
                FMP     LOC2                                            BESS1630
                FAD     COMMON+4                                        BESS1640
                XCA                                                     BESS1650
                FMP     TVPI                                            BESS1660
                LXD     COMMON+17,2                                     BESS1670
                LXA     COMMON+17,1                                     BESS1680
                STO     0,2             RYZ                             BESS1690
                LDQ     COMMON+9                                        BESS1700
                FMP     LOC2                                            BESS1710
                FAD     COMMON+5                                        BESS1720
                XCA                                                     BESS1730
                FMP     TVPI                                            BESS1740
                STO     1,2             IYZ                             BESS1750
                LXD     G22,4                                           BESS1760
                CLA     2,4                                             BESS1770
                TZE     EXIT                                            BESS1780
                TSX     YM2,4                                           BESS1790
                LXD     G22,4                                           BESS1800
                CLA     2,4                                             BESS1810
                LRS     1                                               BESS1820
                TZE     EXIT                                            BESS1830
                LLS     1                                               BESS1840
                COM                                                     BESS1850
                ACL     L1                                              BESS1860
                ALS     19                                              BESS1870
                ACL     COMMON+17       -L(YSUBN)                       BESS1880
                TXI     AB80,1,-2                                       BESS1890
AR80            TXI     R71,2,-2                                        BESS1900
R71             STD     R15                                             BESS1910
                STD     R75                                             BESS1920
                CLA     COMMON+16                                       BESS1930
                LDQ     LSIX                                            BESS1940
                LLS     0                                               BESS1950
                TLQ     METH2                                           BESS1960
                CLA     L7                                              BESS1970
R14             FAD     LOC1                                            BESS1980
                STO     COMMON+5                                        BESS1990
                ACL     C2                                              BESS2000
                STO     COMMON+8                                        BESS2010
                STZ     COMMON+9                                        BESS2020
                CLA     COMMON+15                                       BESS2030
                LDQ     COMMON+16                                       BESS2040
                TSX     DIV,4                                           BESS2050
                STO     COMMON+8                                        BESS2060
                STO     COMMON+9                                        BESS2070
                CLA     0,2                                             BESS2080
                LDQ     1,2                                             BESS2090
                TSX     MULT,4                                          BESS2100
                STO     COMMON+8                                        BESS2110
F21             FSB     0,2,2                                           BESS2120
                STO     2,2                                             BESS2130
                CLA     COMMON+8                                        BESS2140
                FSB     0,1,2                                           BESS2150
                STO     9,2                                             BESS2160
                CLA     COMMON+5                                        BESS2170
                TXI     R15,2,-2                                        BESS2180
R15             TXH     R14,2,0                                         BESS2190
YMX             TXL     EXIT,0,0                                        BESS2200
METH2           TSX     YM22,4                                          BESS2210
                TXI     B74,1,-2                                        BESS2220
R74             TXI     B75,2,-2                                        BESS2230
R75             TXH     METH2,2,0                                       BESS2240
EXIT            LXD     G22,4                                           BESS2250
                TRA     RFR                                             BESS2260
BA0             LXD     G21,2                                           BESS2270
                LXD     G20,1                                           BESS2280
                CLA     CL                                              BESS2290
                STO     0                                               BESS2300
                CLA     CL+1                                            BESS2310
                STO     8                                               BESS2320
                TRA     4,4                                             BESS2330
RFBX            CLA     COMMON+15                                       BESS2340
                LDQ     COMMON+16                                       BESS2350
                LXD     G22,4                                           BESS2360
                TXI     R80,4,1                                         BESS2370
YM2             SXD     YMX,4                                           BESS2380
                CLA     TVPI                                            BESS2390
                STO     COMMON+8                                        BESS2400
                STZ     COMMON+9                                        BESS2410
                CLA     COMMON+15                                       BESS2420
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                LDQ     COMMON+16                                       BESS2430
                TSX     DIV,4                                           BESS2440
                STO     COMMON+6                                        BESS2450
                STQ     COMMON+7                                        BESS2460
                TRA     YM5                                             BESS2470
YM2             SXD     YMX,4                                           BESS2480
YM5             CLA     COMMON+6                                        BESS2490
                LDQ     COMMON+7                                        BESS2500
                STO     COMMON+8                                        BESS2510
                STQ     COMMON+9                                        BESS2520
                CLA     0,1                                             BESS2530
                LDQ     1,1                                             BESS2540
                TSX     DIV,4                                           BESS2550
                STO     COMMON                                          BESS2560
                STQ     COMMON+1                                        BESS2570
                CLA     2,1                                             BESS2580
                STO     COMMON+8                                        BESS2590
                CLA     3,1                                             BESS2600
                STO     COMMON+9                                        BESS2610
                CLA     0,1                                             BESS2620
                LDQ     1,1                                             BESS2630
                TSX     DIV,4                                           BESS2640
                STO     COMMON+8                                        BESS2650
                STQ     COMMON+9                                        BESS2660
                CLA     0,2                                             BESS2670
                LDQ     1,2                                             BESS2680
                TSX     MULT,4                                          BESS2690
                STQ     COMMON+3                                        BESS2700
                FSB     COMMON                                          BESS2710
                STO     2,2                                             BESS2720
                CLA     COMMON+3                                        BESS2730
                FSB     COMMON+1                                        BESS2740
                STO     3,2                                             BESS2750
                LXD     YMX,4                                           BESS2760
                TRA     1,4                                             BESS2770
LOC4    DEC 4.                                                          BESS2780
L11     OCT 1000001                                                     BESS2790
OILER   DEC .5772156649                                                 BESS2800
LSIX    DEC 6.                                                          BESS2810
PIV2    DEC 1.570796325                                                 BESS2820
LPI     DEC 3.14159265                                                  BESS2830
TVPI    DEC .63661977236                                                BESS2840
CI      BSS     2                                                       BESS2850
AFA     LDI     AF81                                                    BESS2860
                CLA     1,4                                             BESS2870
                TPL     AB0             EXIT                            BESS2880
                STA     AF82            L(J)                            BESS2890
                ACL     AFB4                                            BESS2900
                STA     BF82+1          L(J)+1                          BESS2910
                ARS     18                                              BESS2920
                STA     BF83            L(Y)                            BESS2930
                ACL     AFB4                                            BESS2940
                STA     BF83+1          L(Y)+1                          BESS2950
                CAL     2,4                                             BESS2960
                ADD     BFB4                                            BESS2970
                PAX     ,1                                              BESS2980
                AXT     0,2                                             BESS2990
AFA6    CLS*    AFA2+1          -IJ                                     BESS3000
                FSB*    AF83            -RY                             BESS3010
                XCA                                                     BESS3020
                FMP     BF85                                            BESS3030
                STO*    AF83            RK0                             BESS3040
                CLA*    BF82            RJ                              BESS3050
                FSB*    BF83+1          -IY                             BESS3060
                XCA                                                     BESS3070
                FMP     BF85                                            BESS3080
                STO*    BF83+1          IK0                             BESS3090
                TNX     AB0,1,1                                         BESS3100
                TXI     AFSS9,2,-2                                      BESS3110
AFSS9   CLS*    AFA2            -RJ                                     BESS3120
                FAD*    AFA3+1          IY                              BESS3130
                XCA                                                     BESS3140
                FMP     BF85                                            BESS3150
                XCA                                                     BESS3160
                CLS*    BF83            -RY                             BESS3170
                STQ*    BF83            RK1                             BESS3180
                FSB*    BF82+1          -IJ                             BESS3190
                XCA                                                     BESS3200
                FMP     BF85                                            BESS3210
                STO*    BF83+1          IK1                             BESS3220
                CLS*    AFA2                                            BESS3230
                LDQ*    AF82+1                                          BESS3240
                STO*    AFA2+1                                          BESS3250
                STQ*    BF82                                            BESS3260
                TNX     AB0,1,1                                         BESS3270
                TXI     BESS6,2,-2                                      BESS3280
BESS6   CLA*    BF82+1          IJ                                      BESS3290
                FAD*    BF83            RY                              BESS3300
                XCA                                                     BESS3310
                FMP     BF85                                            BESS3320
                STO*    BF83            RK2                             BESS3330
                CLS*    BF82            -RJ                             BESS3340
                STO*    BF82                                            BESS3350
                FAD*    BF83+1          IY                              BESS3360
                XCA                                                     BESS3370
                FMP     BF85                                            BESS3380
                STO*    BF83+1                                          BESS3390
                CLS*    BF82+1                                          BESS3400
                STO*    BF82+1                                          BESS3410
                TNX     AB0,1,1                                         BESS3420
                TXI     BESS7,2,-2                                      BESS3430
BESS7   CLA*    BF82            RJ                                      BESS3440
                FSB*    BF83+1          -IY                             BESS3450
                XCA                                                     BESS3460
                FMP     BF85                                            BESS3470
                XCA                                                     BESS3480
                CLA*    BF83            RY                              BESS3490
                STQ*    BF83            RK3                             BESS3500
                FAD*    AFA2+1          IJ                              BESS3510
                XCA                                                     BESS3520
                FMP     BF85                                            BESS3530
                STO*    BF83+1          IK3                             BESS3540
                CLS*    BF82+1                                          BESS3550
                LDQ*    BF82                                            BESS3560
                STO*    BF82                                            BESS3570
                STQ*    BF82+1                                          BESS3580
                TNX     AB0,1,1                                         BESS3590
                TXI     AFA6,2,-2                                       BESS3600
AF81    PZE     ,,0             INDICATORS                              BESS3610
AF82    PZE     ,,0,2           L(J)                                    BESS3620
                PZE     ,,0,2                                           BESS3630
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[illegible] [illegible] [illegible]              [illegible]
            [illegible] [illegible]
[illegible] [illegible] [illegible]
[illegible] [illegible] [illegible]              [illegible]
[illegible] [illegible] [illegible]
            [illegible] [illegible]
            [illegible] [illegible]
            [illegible] [illegible]
            [illegible] [illegible]
            [illegible] [illegible]
            [illegible] [illegible]
            CLA     0
            [illegible] [illegible]
            CLA     [illegible]
            [illegible] 0
            [illegible]
            CLA     1,4
            TRL     A21
            CLA     COMMON+[illegible]
            [illegible] COMMON+[illegible]
            STO     COMMON+[illegible]
            STO     COMMON+[illegible]
A21         CLA     COMMON+5
            LDQ     [illegible]
            LLS     9
            TLQ     A59
            LDQ     TEN
[illegible] TRL     A110+[illegible]
A59         CLA     COMMON+[illegible]
F29         FDP     COMMON+5
A110        CLA     [illegible]
            LRS     0
            STO     COMMON+7                 [illegible]
            TLQ     F1
A2[illegible] CLA   COMMON+4
            TSX     [illegible]
[illegible] TRL     [illegible]
            STO     COMMON+3
            STO     COMMON+4
            CLA     COMMON+5
            CALL COS(COMMON+5)
            XCA
F[illegible] FMP    COMMON+3
            STO     COMMON+3                 [illegible](COS(Z))
            CLA     COMMON+4
            CALL SIN(COMMON+5)
            XCA
F29         FMP     COMMON+4
            CHS
            STO     COMMON+4                 [illegible](COS(Z))
F1          CLA     COMMON+5
            LDQ     COMMON+6
            SSP
            LRS     0
            TLQ     A2[illegible]
            XCA
[illegible] STO     COMMON+0
            XCA
            FMP     L3W7
            STO     COMMON+0                 3/2P
            LDQ     [illegible]
            CAL     1,4
            COM
            ACL     L1
            STA     COMMON                   (-J)
            ALS     18
            STO     A10
            CLA     1,4
            ARS     18
            SSP
            ADD     C1
            FAD     C1                       FLOATING N
            LDQ     COMMON+8
            TLQ     A24
            CLA     COMMON+8
A24         FAD     TEN
            UFA     C1                       N PRIME=MAX(3/2P,N)+10
            STO     COMMON+10
            FAD     C1
            STO     COMMON+1
            CAL     COMMON+10
            ALS     1
            COM
            ADM     L1
            ADM     COMMON
            STA     COMMON+2
            ALS     18
            STD     A41                      -(J+2NPR+2)
            STD     A32
            STD     A45
            STD     A38
            CLA     COMMON+9
            TZE     RF7X
            CLA     COMMON+6
            SSP
            LDQ     LOC29
            TLQ     A68
            CLA     AZ
            TRA     A69
A68         CLA     AZ1
A69         LXA     COMMON+2,1
            STO     2,1
            STO     3,1
            STZ     4,1
            STZ     5,1
            CLA     COMMON+1
            FAD     LOC1
RF7X        STO     COMMON+1
            ACL     C2
            STO     COMMON+8
            STZ     COMMON+9
            CLA     2,1
            LDQ     3,1
            TSX     MULT,4
            STO     COMMON+8
            STQ     COMMON+9
            CLA     COMMON+5
            LDQ     COMMON+6
            TSX     DIV,4
            STO     COMMON+10
[illegible] FAD     4,1
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                   1,1                      RES54850
         [illegible] COMMON-1               RES54860
         [illegible] [illegible]            RES54870
         [illegible] [illegible]            RES54880
         [illegible] COMMON,2               RES54890
         [illegible] [illegible]            RES54900
         [illegible] [illegible]            RES54910
[illegible] [illegible] [illegible]  -J     RES54920
         [illegible] [illegible]            RES54930
A44      [illegible] COMMON+7               RES54940
         [illegible] COMMON,1               RES54950
         [illegible] COMMON+15              RES54960
         [illegible] COMMON+11              RES54970
         [illegible] A63                    RES54980
         [illegible] LF[illegible]          RES54990
         TRA     A6[illegible]              RES55000
A63      CLA     [illegible]                RES55010
A6[illegible] STZ A67                       RES55020
         AC[illegible] LT                   RES55030
         STZ     A6[illegible]              RES55040
[illegible] CLA  9,1                        RES55050
[illegible] [illegible]                     RES55060
         FAD     COMMON+7                   RES55070
         STO     COMMON+5                   RES55080
         CLA     1,1                        RES55090
A?       [illegible]                        RES55100
                 COMMON+11                  RES55110
         [illegible] COMMON+11              RES55120
         TXI     A32,1,-8                   RES55130
A??      TXH     A65,1,0                    RES55140
         LXA     COMMON,1                   RES55150
         XCA                                RES55160
         FMP     [illegible]                RES55170
         FAD     [illegible]                RES55180
         STO     COMMON+17                  RES55190
         LDQ     COMMON+10                  RES55200
         [illegible] LOC2                   RES55210
         FAD     9,1                        RES55220
         STO     COMMON+12                  RES55230
         CLA     COMMON+7                   RES55240
         LDQ     L?05                       RES55250
         TLQ     A33                        RES55260
         CLA     LOC1                       RES55270
         STO     COMMON+9                   RES55280
         STQ     COMMON+4                   RES55290
A3?      CLA     COMMON+5                   RES55300
         LDQ     COMMON+4                   RES55310
         STO     COMMON+8                   RES55320
         STQ     COMMON+9                   RES55330
         CLA     COMMON+15                  RES55340
         LDQ     COMMON+11                  RES55350
         TSX     DIV,4                      RES55360
         STO     COMMON+8                   RES55370
         STQ     COMMON+9                   RES55380
         CLA     9,1                        RES55390
         LDQ     1,1                        RES55400
         TSX     MULT,4                     RES55410
         STO     9,1                        RES55420
         STQ     1,                         RES55430
         TXI     A45,1,-2                   RES55440
A45      TXH     A34,1,0                    RES55450
         LXA     COMMON+2,1                 RES55460
         LXD     LZ,2                       RES55470
A37      STZ     9,1                        RES55480
         TXI     A35,2,-1                   RES55490
A35      TXI     A34,1,-1                   RES55500
A36      TXH     A37,2,-8                   RES55510
         TRA     [illegible]                RES55520
         CLA     1,4                        RES55530
         TRL     97                         RES55540
         LXA     COMMON,2                   RES55550
A39      CLS     2,2                        RES55560
         LDQ     3,2                        RES55570
         STO     2,2                        RES55580
         STQ     3,2                        RES55590
         CLS     4,2                        RES55600
         STO     4,2                        RES55610
         CLS     5,2                        RES55620
         STO     5,2                        RES55630
         CLS     7,2                        RES55640
         LDQ     6,2                        RES55650
         STQ     7,2                        RES55660
         STO     6,2                        RES55670
         TXI     A38,2,-8                   RES55680
A38      TXH     A39,2,0                    RES55690
97       LXD     XR4,4                      RES55700
A40      LXD     COMMON+14,2                RES55710
         LXD     XR1,1                      RES55720
         CLA     LFST                       RES55730
         STO     0                          RES55740
         CLA     LFST+1                     RES55750
         STO     4                          RES55760
         TRA     1,4                        RES55770
FRR?     CLA     COMMON+5                   RES55780
         LDQ     COMMON+6                   RES55790
         LXD     XR4,4                      RES55800
         TXI     A40,4,1                    RES55810
RETX     LXA     COMMON,1                   RES55820
         CLA     LOC1                       RES55830
         STO     2,1                        RES55840
A42      STZ     1,                         RES55850
         TXI     A41,1,-1                   RES55860
A41      TXH     A42,1,0                    RES55870
MULT     TRL     97,0,0                     RES55880
DIV      STO     COMMON+10                  RES55890
         STO     COMMON+11                  RES55900
         SSP                                RES55910
         LRS     0                          RES55920
         TLQ     88                         RES55930
         XCA                                RES55940
         TZE     FRR2                       RES55950
         CLA     COMMON+10                  RES55960
D10      FDP     COMMON+11                  RES55970
D11      STO     COMMON+12        C/D       RES55980
D13      FMP     COMMON+12                  RES55990
D14      FAD     LOC1                       RES56000
         XCA                                RES56010
         FMP     COMMON+11                  RES56020
         STO     COMMON+13        DEN       RES56030
         LDQ     COMMON+12                  RES56040
         FMP     COMMON+8                   RES56050
```

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D35      FAD    COMMON+9                                       BESS56060
F31      FDP    COMMON+13                                      BESS56070
         STO    COMMON+11                                      BESS56080
         LDQ    COMMON+12                                      BESS56090
D36      FMP    COMMON+9                                       BESS56100
         FSB    COMMON+8                                       BESS56110
DFZ      TPL    D93,0,0                                        BESS56120
D61      CLA    COMMON+11                                      BESS56130
D37      FDP    COMMON+10                                      BESS56140
D39      STO    COMMON+12                                      BESS56150
D88      FMP    COMMON+12                                      BESS56160
D40      FAD    LOC1                                           BESS56170
         XCA                                                   BESS56180
         FMP    COMMON+10                                      BESS56190
         STO    COMMON+13          DEN                         BESS56200
         LDQ    COMMON+12                                      BESS56210
         FMP    COMMON+9                                       BESS56220
D41      FAD    COMMON+8                                       BESS56230
F30      FDP    COMMON+13                                      BESS56240
         STO    COMMON+11                                      BESS56250
         LDQ    COMMON+12                                      BESS56260
D42      FMP    COMMON+8                                       BESS56270
D44      CHS                                                   BESS56280
         FAD    COMMON+9                                       BESS56290
D85      FDP    COMMON+13                                      BESS56300
         CLA    COMMON+11                                      BESS56310
         TRA    1,4                                            BESS56320
MULT     STO    COMMON+10                                      BESS56330
         STQ    COMMON+11                                      BESS56340
         FMP    COMMON+9                                       BESS56350
MT1      STO    COMMON+12          BD                          BESS56360
         LDQ    COMMON+11                                      BESS56370
         FMP    COMMON+8                                       BESS56380
MT2      STO    COMMON+11          AD                          BESS56390
         LDQ    COMMON+10                                      BESS56400
         FMP    COMMON+8                                       BESS56410
         FSB    COMMON+12                                      BESS56420
MT3      STO    COMMON+12                                      BESS56430
         LDQ    COMMON+10                                      BESS56440
         FMP    COMMON+9                                       BESS56450
         FAD    COMMON+11                                      BESS56460
MT4      XCA                                                   BESS56470
         CLA    COMMON+12                                      BESS56480
         TRA    1,4                                            BESS56490
SPILL    STO    SVE                                            BESS56500
         STQ    SVE+1                                          BESS56510
         CLA    0                                              BESS56520
         LRS    21                                             BESS56530
         LBT                                                   BESS56540
         TRA    SP1                FAD,FSB,FMP O.F. OR U.F.    BESS56550
         RND                       FDP U.F. OR O.F.            BESS56560
         LBT                                                   BESS56570
         TRA    ERR2               OVERFLOW                    BESS56580
         LLS    3                                              BESS56590
         LBT                                                   BESS56600
         TRA    OOK                                            BESS56610
         LDQ    LZ                                             BESS56620
         TRA*   0                                              BESS56630
OOK      LDQ    SVE+1                                          BESS56640
         TRA*   0                                              BESS56650
SP1      LLS    1                                              BESS56660
         LBT                                                   BESS56670
         TRA    SP2                                            BESS56680
         TRA    ERR2               O.F.                        BESS56690
SP2      LLS    1                                              BESS56700
         TZE    OK                                             BESS56710
         CLA    LZ                                             BESS56720
         TRA*   0                                              BESS56730
OK       CLA    SVE                                            BESS56740
         TRA*   0                                              BESS56750
SVE      BSS    2                                              BESS56760
TEST     BSS    2                                              BESS56770
TRA1     TRA    SPILL                                          BESS56780
CON2     OCT 200777777777                                      BESS56790
AZ       OCT 1400000000                                        BESS56800
AZ1      OCT 100400000000                                      BESS56810
TEN      DEC 10.                                               BESS56820
LOC25    DEC 25.                                               BESS56830
C1       OCT 233000000000                                      BESS56840
C2       OCT 1000000000                                        BESS56850
LOC1     DEC 1.                                                BESS56860
LZ       PZE    0                                              BESS56870
L1       DEC                                                   BESS56880
L2       DEC                                                   BESS56890
LTN5     DEC .03492                                            BESS56900
LOC2     DEC 2.                                                BESS56910
L3V2     DEC 1.5                                               BESS56920
LFSB4    FSB    4,1                                            BESS56930
LFAD4    FAD    4,1                                            BESS56940
SMCON    OCT 1040000000                                        BESS56950
HY3F     LAS    HY3F1              10 EXP-4                    BESS56960
         TRA    HY3F1+3            UNDERFLOW IMPOSSIBLE        BESS56970
HY3F1    TXI    HY3F1+1,0,26531         OCT 1636430..... = 1E-4  BESS56980
         LDQ    HY3F2              SMALL ARGUMENT APPROXIMATION  BESS56990
         TRA    2,4                                            BESS57000
         STO    COMMON                                         BESS57010
         SSP                                                   BESS57020
         LDQ    HY3F3              88.028                      BESS57030
         TLQ    1,4                ERROR                       BESS57040
         LDQ    HY3F4              LN 2/2                      BESS57050
         TLQ    HY3F4                                          BESS57060
         LDQ    COMMON                                         BESS57070
         FMP    COMMON                                         BESS57080
         STO    COMMON+1           X SQUARED                   BESS57090
         FAD    HY3F5              30                          BESS57100
         XCA                                                   BESS57110
         FMP    COMMON+1           X SQ                        BESS57120
         FAD    HY3F6              360                         BESS57130
         FDP    HY3F7              720                         BESS57140
         FMP    COMMON+1           X SQ                        BESS57150
         FAD    HY3F2              1                           BESS57160
         STO    COMMON+2           COSH X                      BESS57170
         CLA    COMMON+1           X SQ                        BESS57180
         FAD    HY3F8              42                          BESS57190
         XCA                                                   BESS57200
         FMP    COMMON+1           X SQ                        BESS57210
         FAD    HY3F9              840                         BESS57220
         FDP    HY3F10             5040                        BESS57230
         FMP    COMMON+1           X SQ                        BESS57240
         XCA                                                   BESS57250
         FMP    COMMON                                         BESS57260
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        FAD     COMMON                                                 BESS7270
        TRA     MY3FC                                                  BESS7280
[illegible] [illegible] 35      COMPUTE EXPONENTIAL                    BESS7290
        ADD     MY3F11                                                 BESS7300
        STA     BESS8                                                  BESS7310
        MPY     MY3F12                                                 BESS7320
BESS8   LRS     *                                                      BESS7330
        ALS     35                                                     BESS7340
        STQ     COMMON+4                                               BESS7350
        LDQ     *                                                      BESS7360
        STQ     COMMON+1         4,31                                  BESS7370
        MPY     COMMON+1         4,31                                  BESS7380
        STO     COMMON+2         4+4=8,27                              BESS7390
        ADD     MY3F13           8,27                                  BESS7400
        STO     COMMON+3         8,27                                  BESS7410
        CLA     MY3F14           12,23                                 BESS7420
        DVP     COMMON+3         8,27                                  BESS7430
        STQ     COMMON+3         4,31                                  BESS7440
        LDQ     COMMON+2         8,27                                  BESS7450
        MPY     MY3F15           0,35                                  BESS7460
        LLS     4                4,31                                  BESS7470
        SUB     COMMON+3         4,31                                  BESS7480
        ADD     MY3F16           4,31                                  BESS7490
        STO     COMMON+1         4,31                                  BESS7500
        STO     COMMON+3         4,31                                  BESS7510
        CLA     COMMON+1         5,31 (2F)                             BESS7520
        LDQ     MY3F2                                                  BESS7530
        VDP     COMMON+1,0,27                                          BESS7540
        XCA                                                            BESS7550
        ORA     MY3F17                                                 BESS7560
        FAD     MY3F2                                                  BESS7570
        ADD     COMMON+4                                               BESS7580
        SUB     MY3F18           EXP X IN AC. DIVIDE BY 2              BESS7590
        STO     COMMON+4                                               BESS7600
        CLA     MY3F19           1/4                                   BESS7610
        FDP     COMMON+4         EXP X/2                               BESS7620
        STQ     COMMON+5         EXP -X /2                             BESS7630
        XCA                                                            BESS7640
        FAD     COMMON+4                                               BESS7650
        STO     COMMON+7                                               BESS7660
        CLA     COMMON+4                                               BESS7670
        FSB     COMMON+5         SINH X IN AC                          BESS7680
        LDQ     COMMON                                                 BESS7690
        LLS     0                SIGN X IN AC                          BESS7700
MY3FC   LDQ     COMMON+2                                               BESS7710
        TRA     2,4              EXIT                                  BESS7720
MY3F2   DEC 1.                                                         BESS7730
MY3F3   DEC 88.028                                                     BESS7740
MY3F4   OCT 177542710350                LN 2/2. ERROR = 0.000000000095 BESS7750
MY3F5   DEC 30.                                                        BESS7760
MY3F6   DEC 360.                                                       BESS7770
MY3F7   DEC 720.                                                       BESS7780
MY3F8   DEC 42.                                                        BESS7790
MY3F9   DEC 840.                                                       BESS7800
MY3F10  DEC 5040.                                                      BESS7810
MY3F11  OCT 242                                                        BESS7820
MY3F12  DEC 1.44269504089                                              BESS7830
MY3F13  DEC 87.417497202                      A                        BESS7840
MY3F14  DEC 617.9722695812                    B                        BESS7850
MY3F15  DEC 0.034657359[illegible]            C                        BESS7860
MY3F16  DEC 9.9545957821                      D                        BESS7870
MY3F17  OCT 201000000000                                               BESS7880
MY3F18  OCT 1000000000                                                 BESS7890
MY3F19  DEC 0.25                                                       BESS7900
        END                                                            BESS7910

$ENTRY V8050

$DATA
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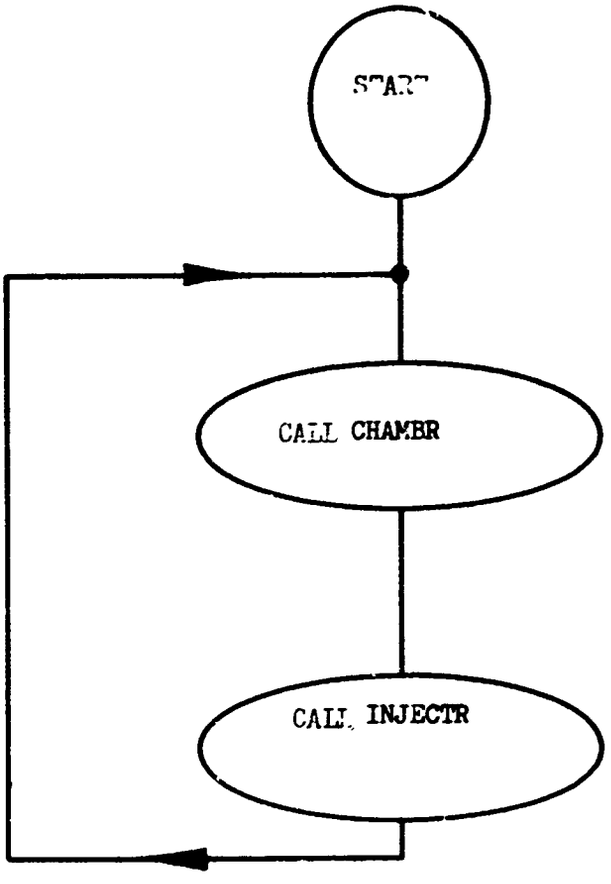
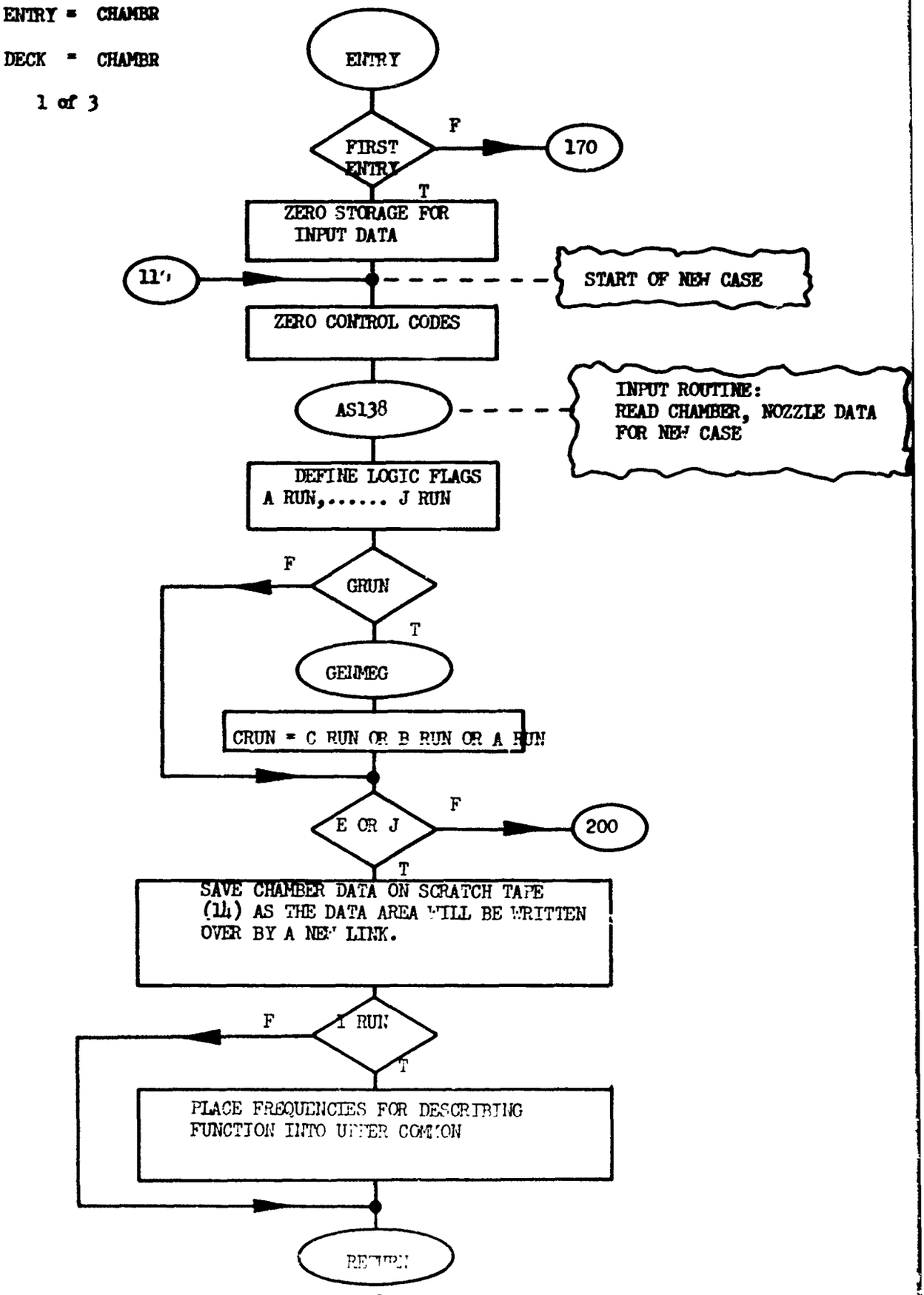


NOTE: SUBROUTINE CHAMBER PERFORMS MOST OF THE LOGICAL AND CONTROL FUNCTIONS OF AN AUTONOMOUS MAIN PROGRAM. CONTROL IS RETURNED TO THIS PROGRAM IF AND ONLY IF AN ILLEGAL OR ROUTINE IS REQUIRED.

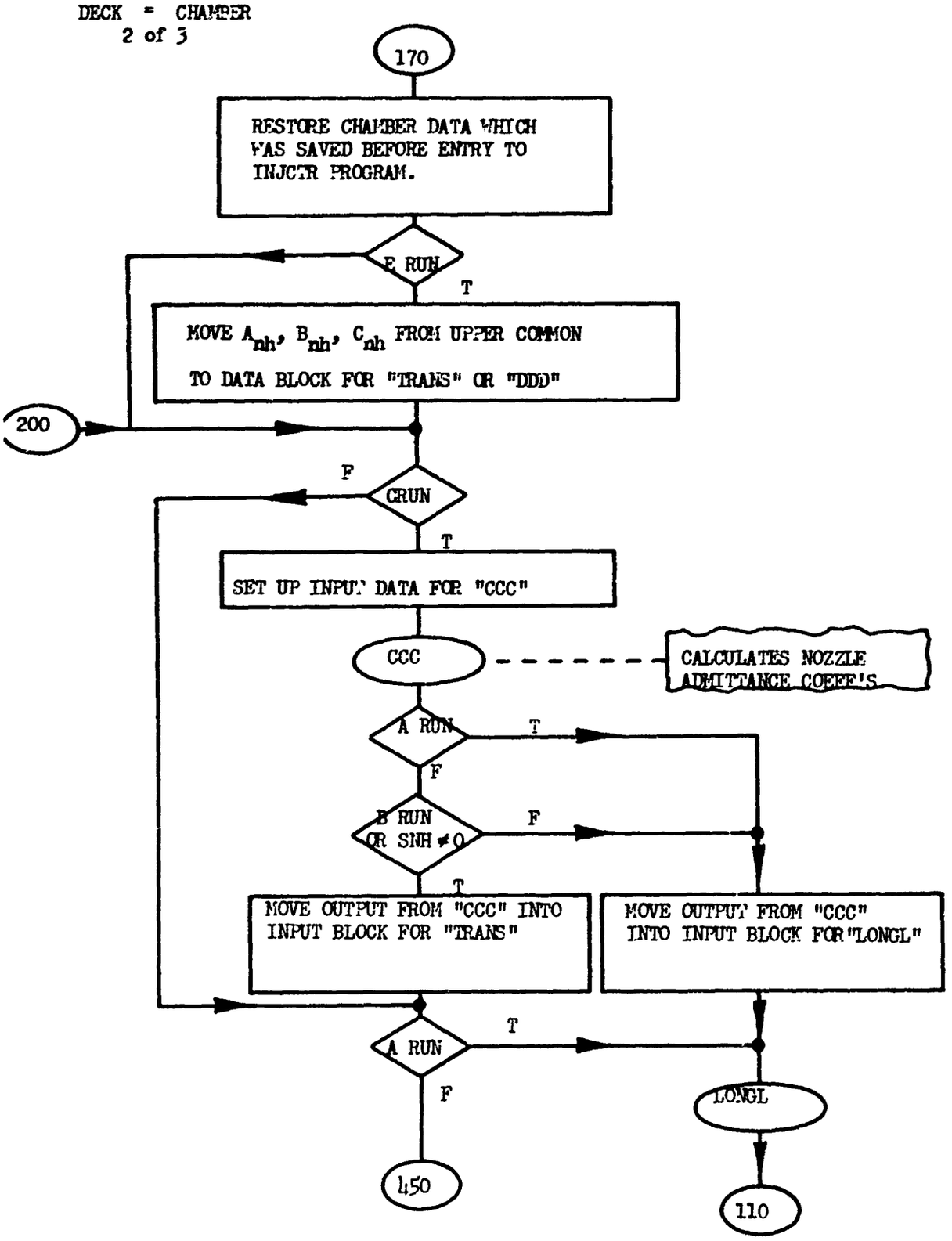
ENTRY = CHAMBR

DECK = CHAMBR

1 of 3

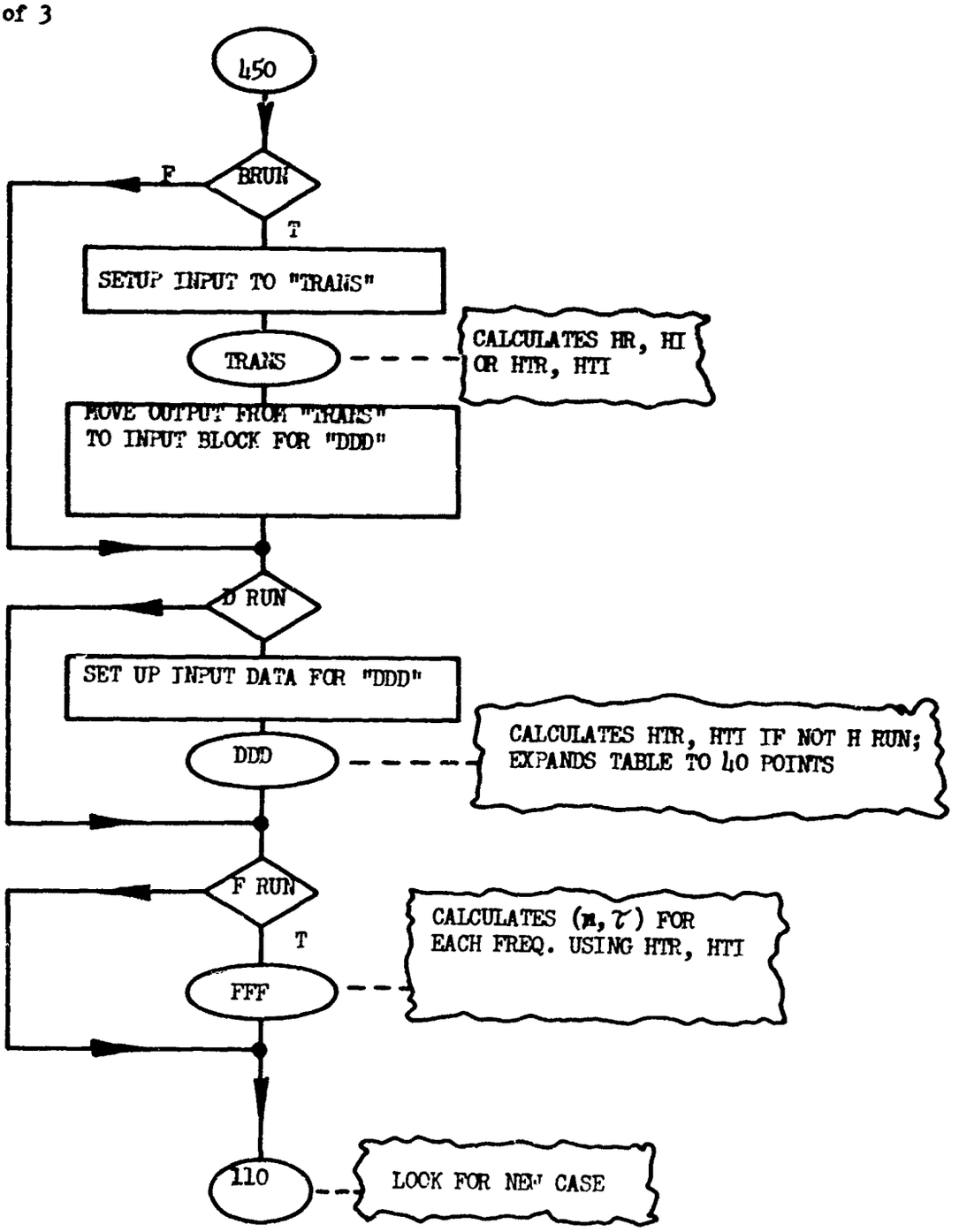


DECK = CHAMBER
2 of 3



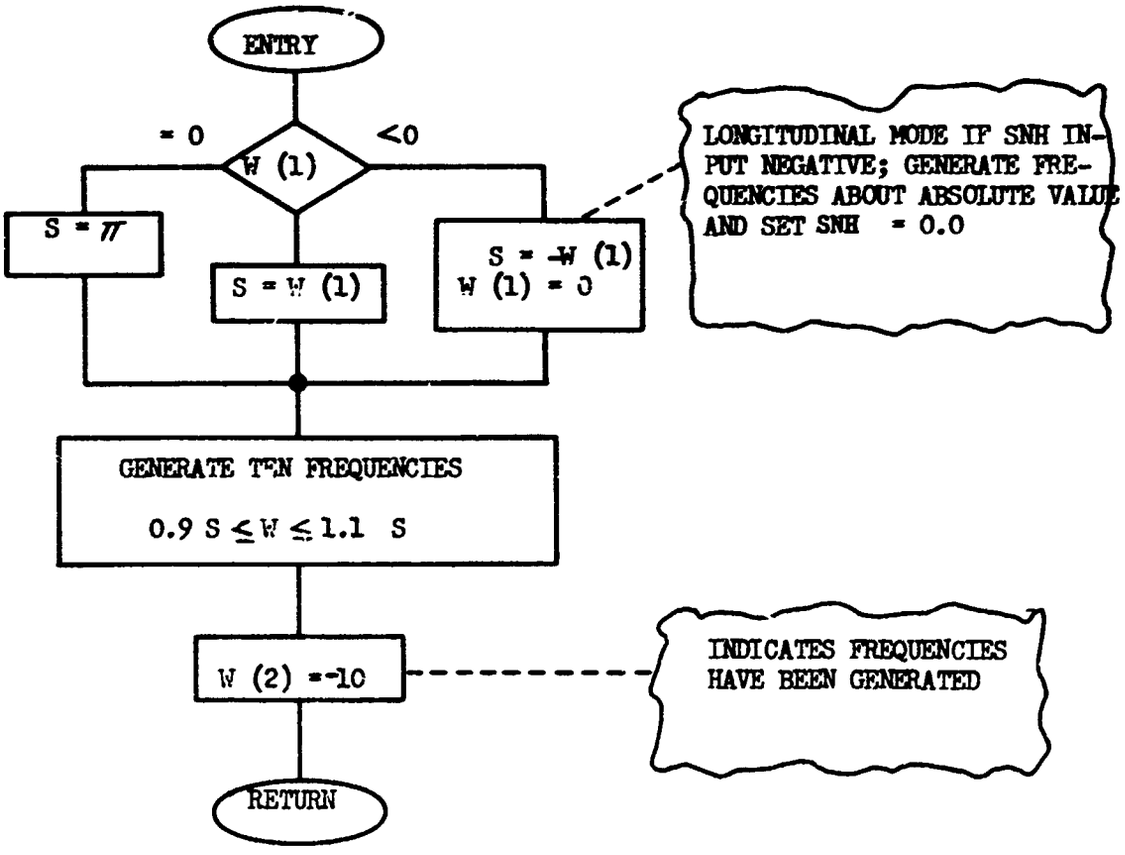
DECK = CHAMBER

3 of 3



ENTRY = GEMMEG

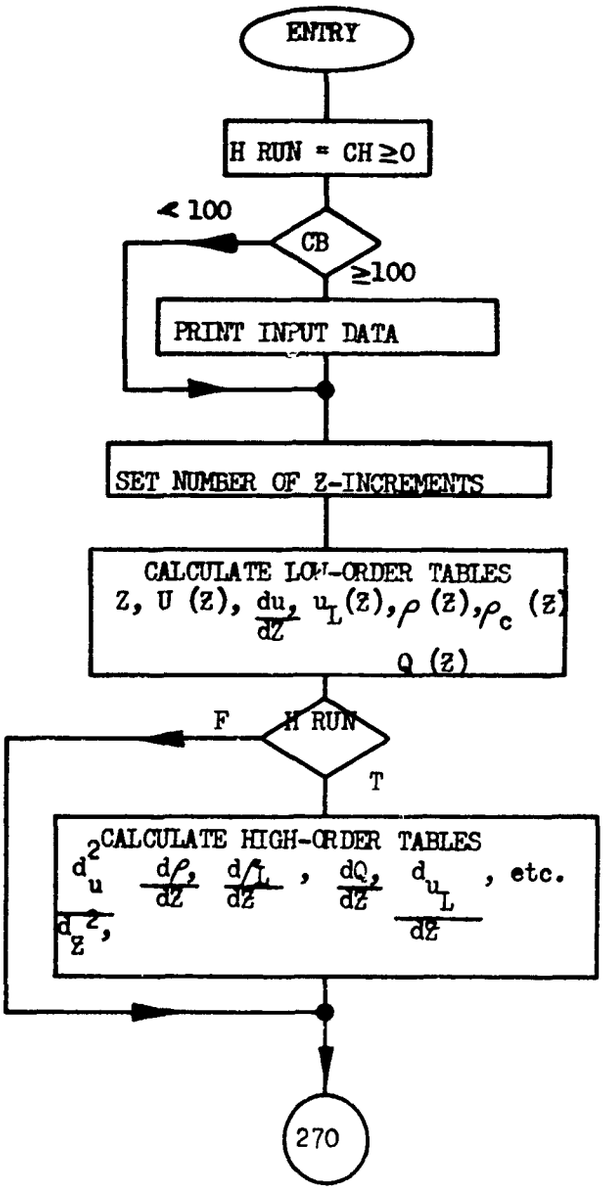
LOCK = WGEN



ENTRY = TRANS

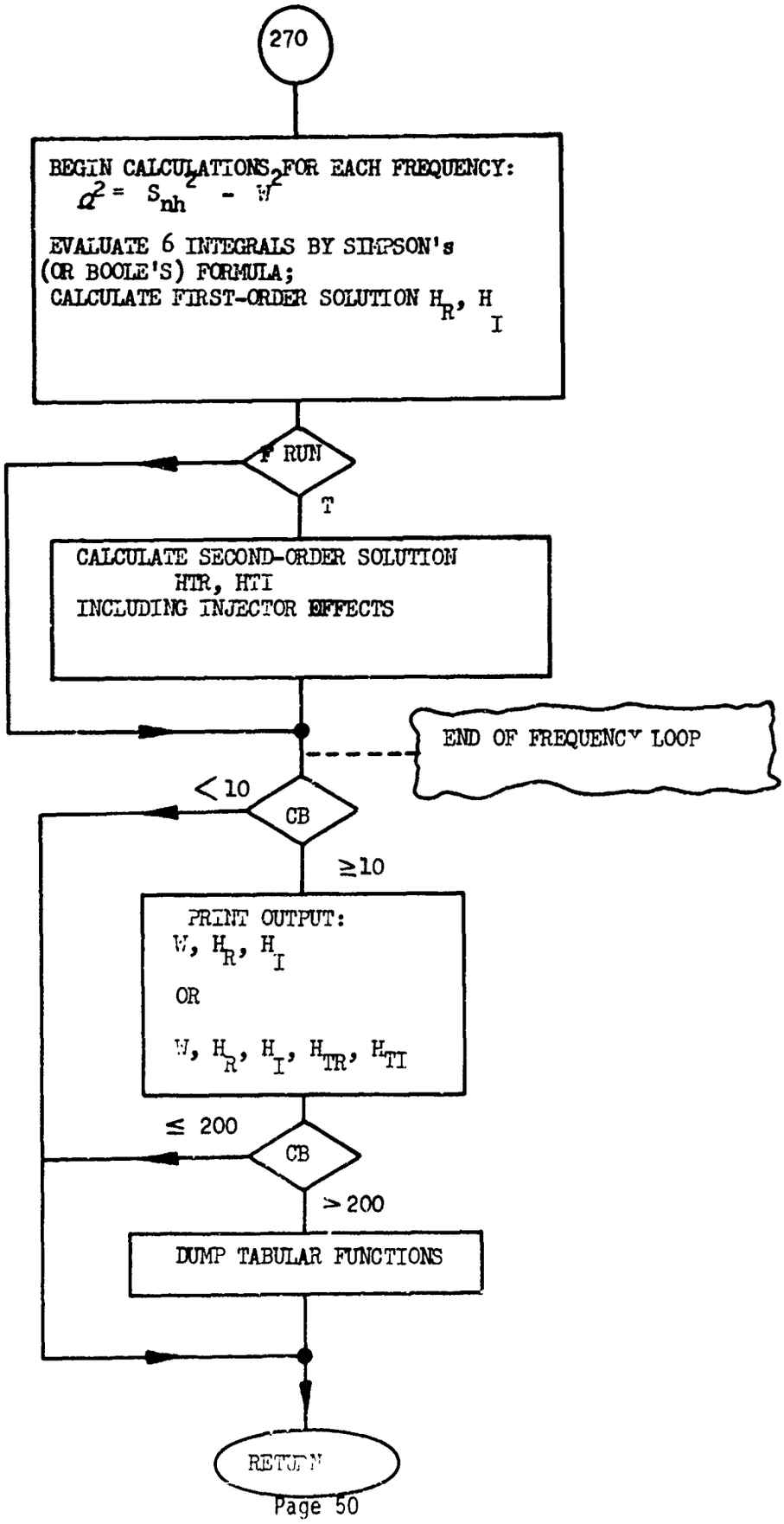
DECK = HYMN

1 of 2

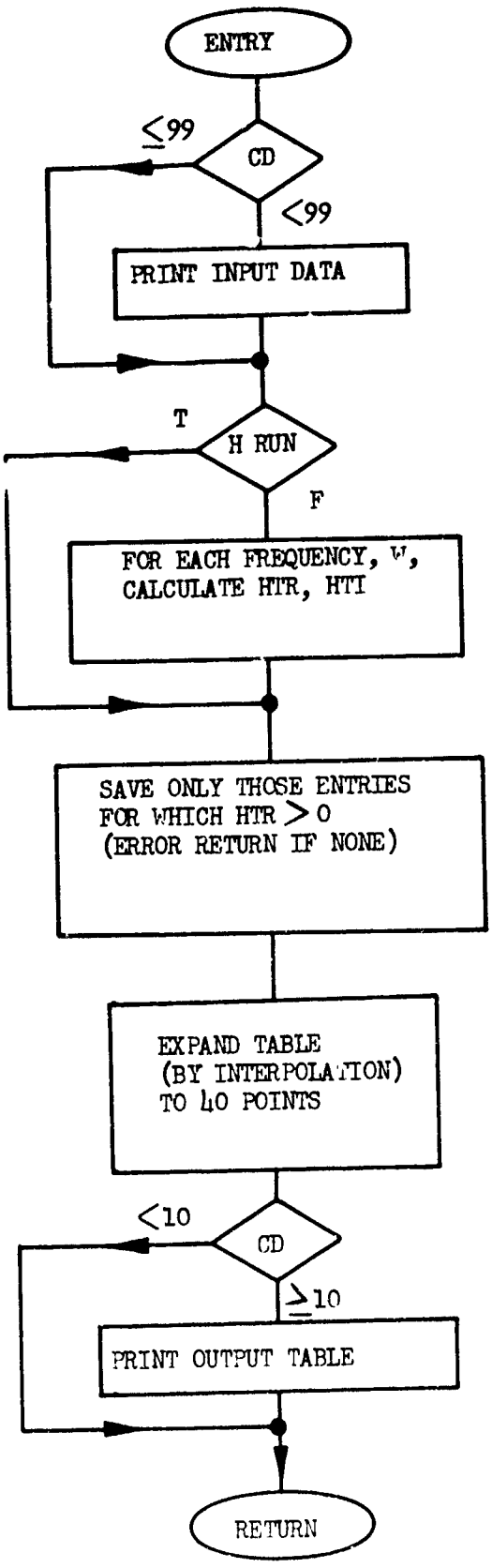


DECK = HYEN

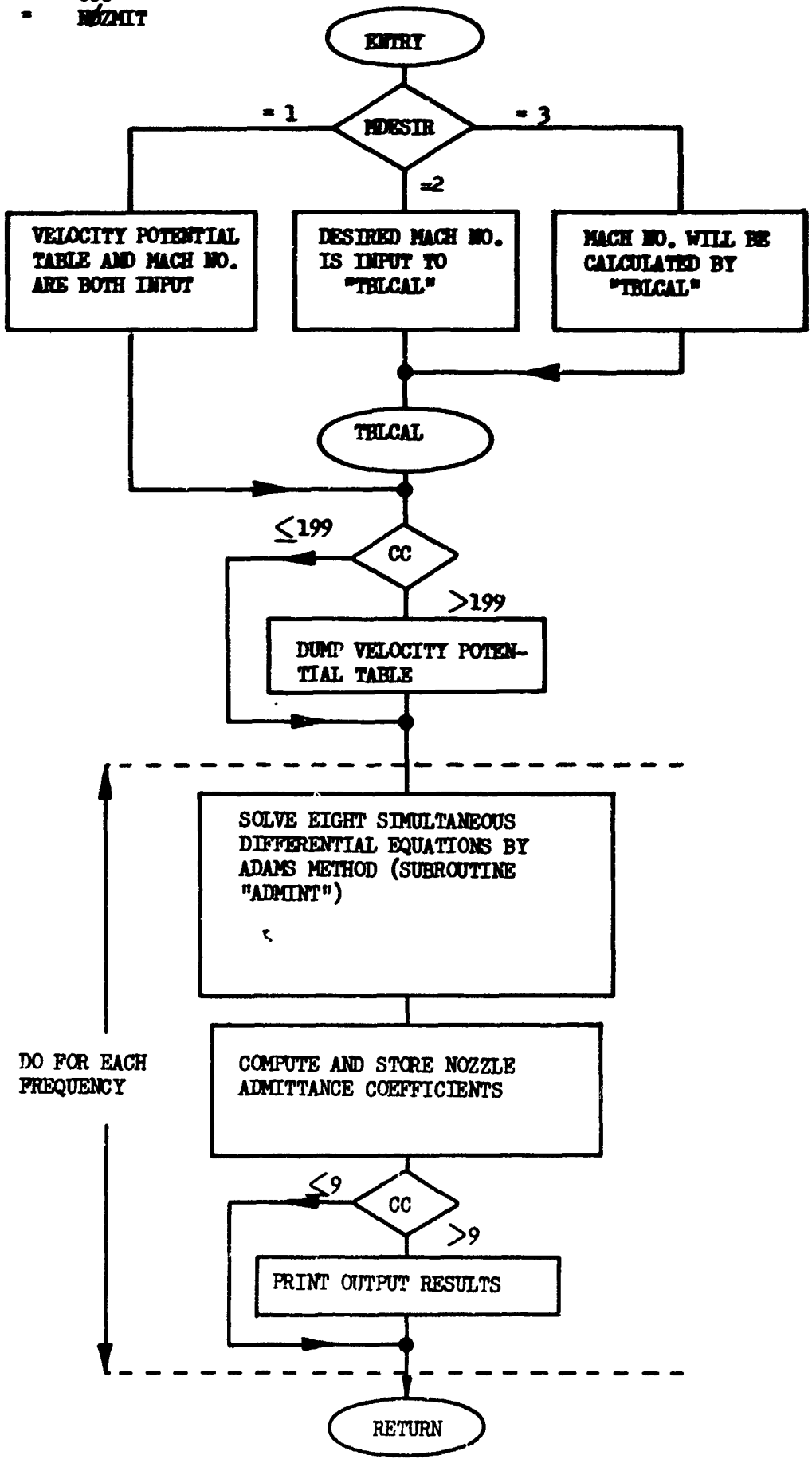
2 of 2



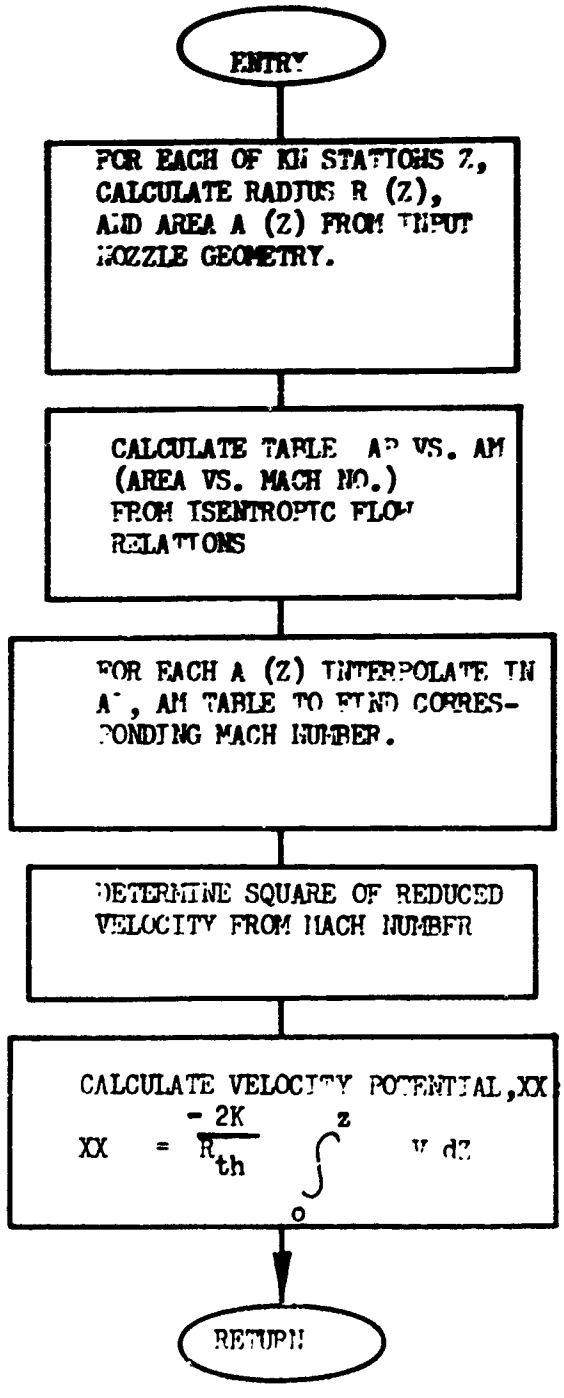
ENTRY = DDD
DECK = HTINT



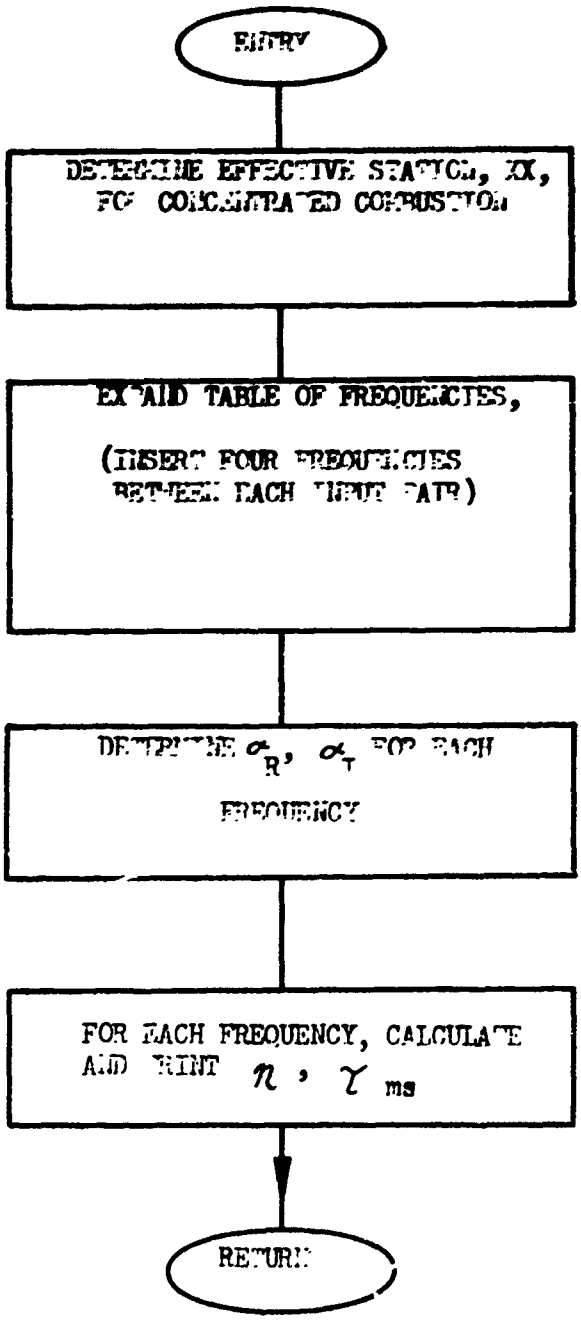
ENTRY = CCC
DECK = NOZMIT



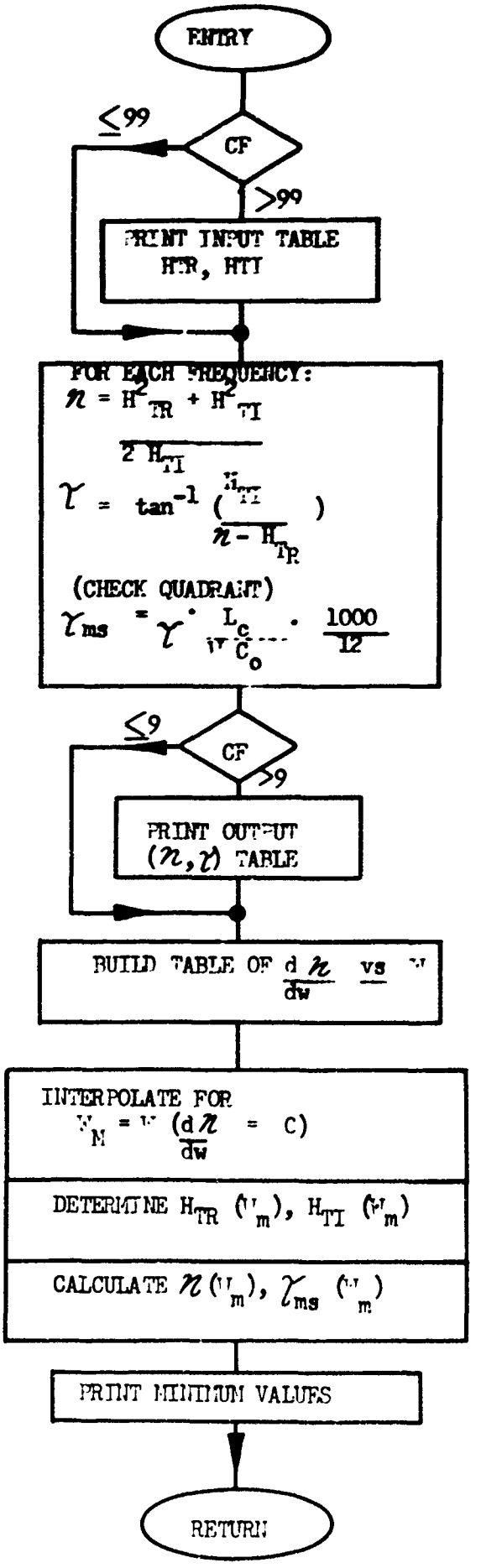
ENTRY = TBLCAL
DECK = VELPOT



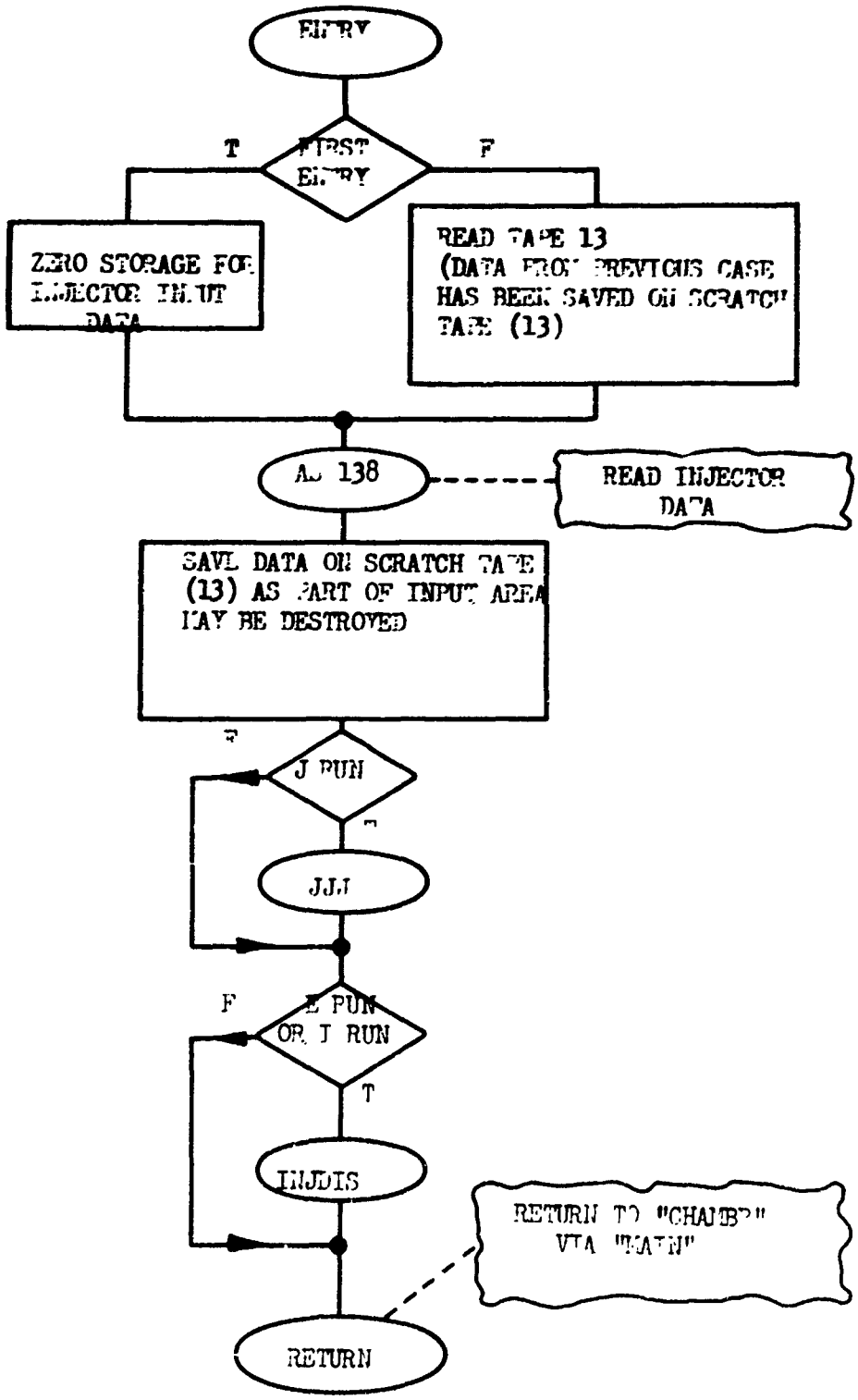
ENTRY = LØNGL
DECK = LØNGL



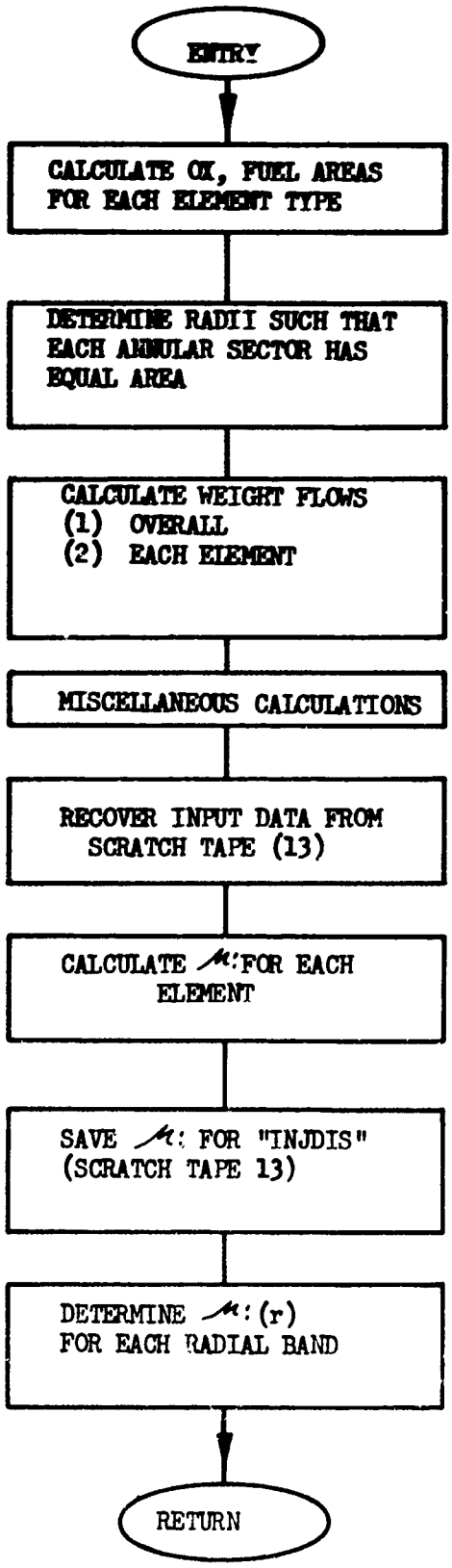
ENTRY = FFF
DECK = RTAU



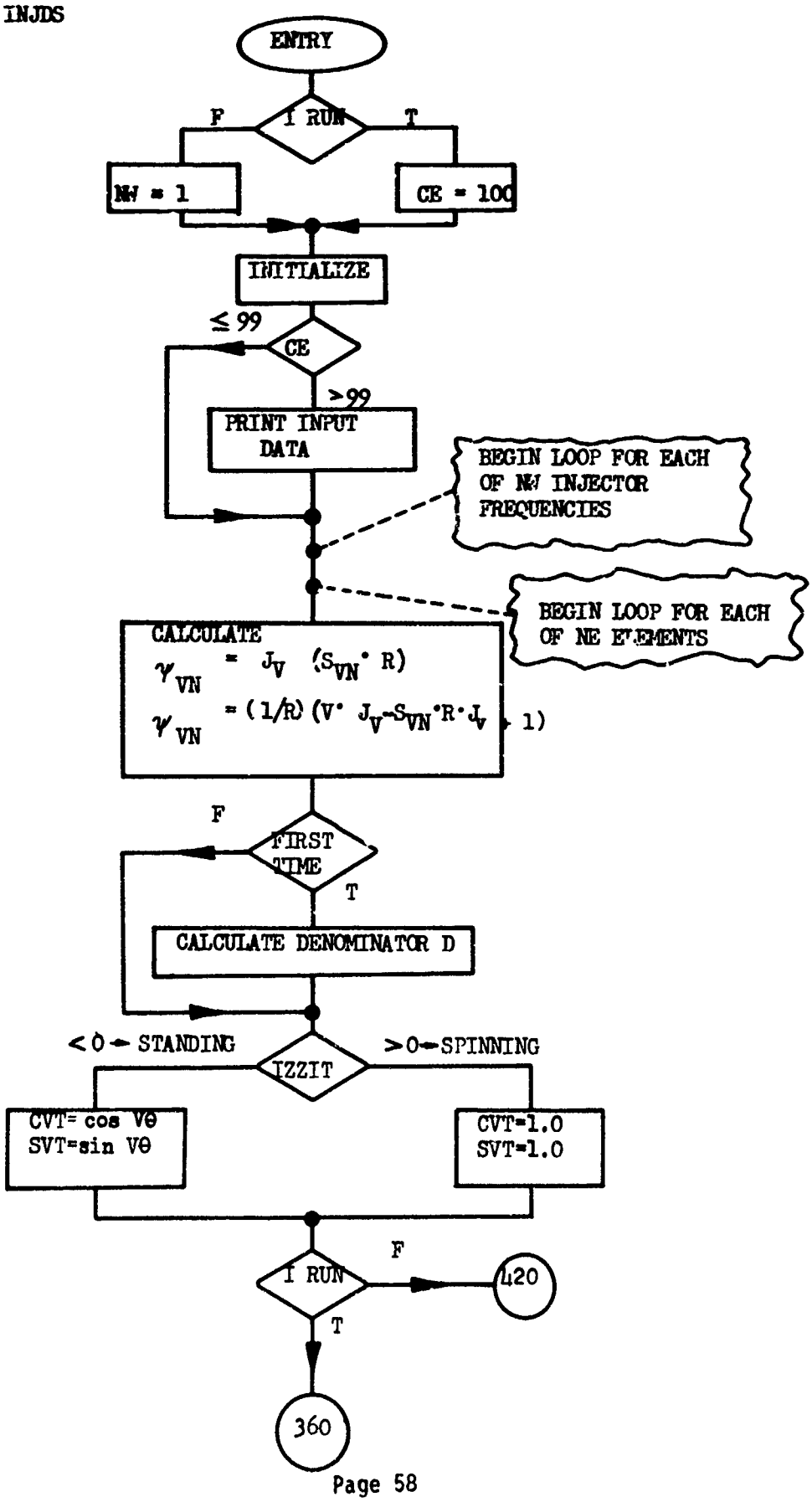
ENTRY = INJCTR
DECK = INJ



ENTRY = JJJ
DECK = JBCT

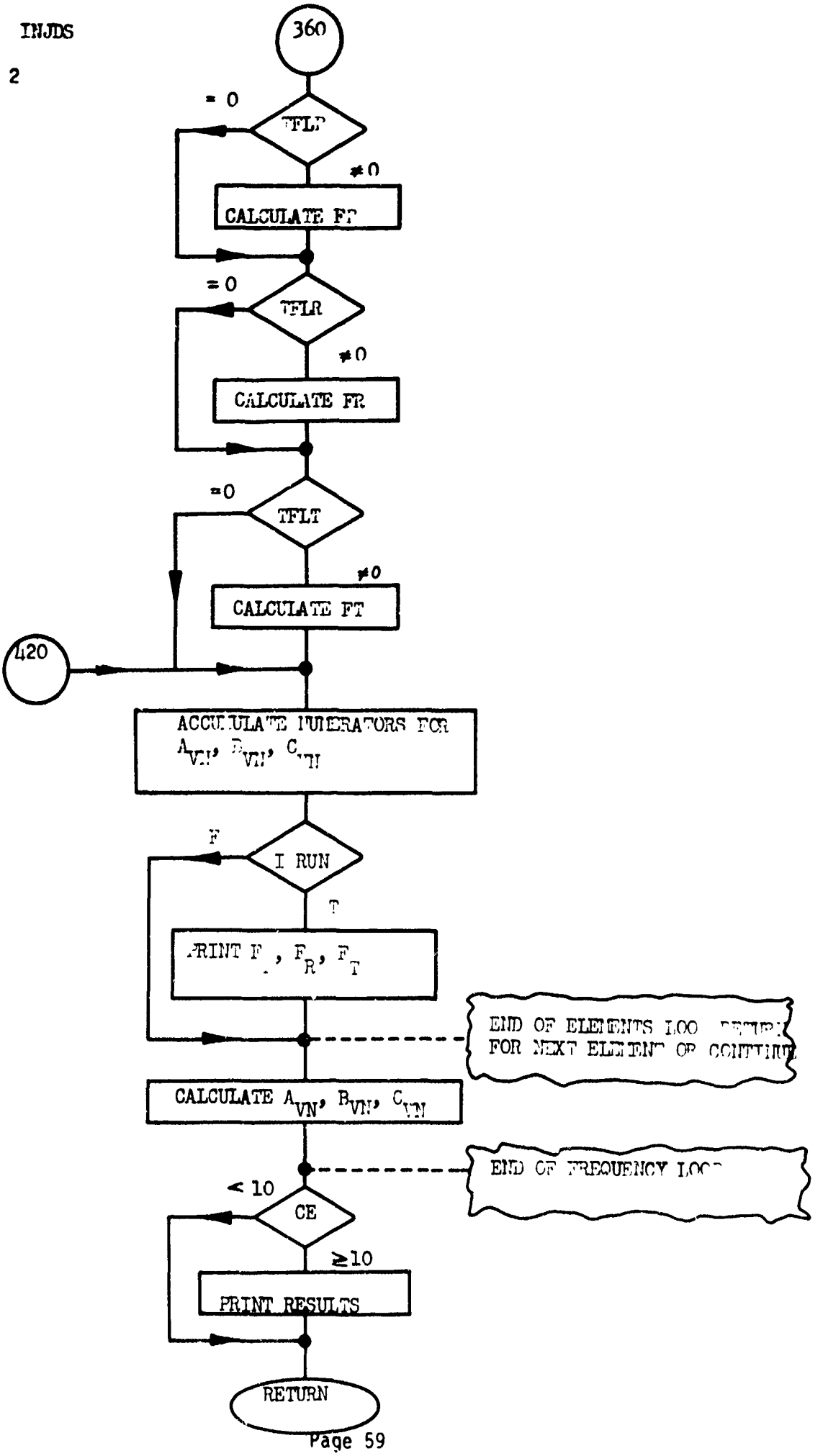


ENTRY = INJDIS
DECK = INJDS



DECK = INJDS

2 of 2



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Smith, A. J., Jr; Reardon, F. H.; et al

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13 ABSTRACT

The main objective of this report is to include, under one cover, all of the work concerned with the development of the Sensitive Time Lag Theory of liquid rocket engine combustion instability. This work includes all the aspects of the theory from the mathematical formulation of the analytical model to the application of the model to actual engine problems. The initial section of the report reviews the logical considerations of the instability phenomenon and relates how the time lag concept conforms analytically as well as experimentally to the problem. Thereafter, the mathematics of the model are developed with the major emphasis placed on the linearized model; however, various aspects of the nonlinear model are also discussed. The mathematical analysis gives rise to a computer program, which is presented in Volume I in the form of an Engineer's instruction manual and in Volume II in the form of a detailed description for the Programmer. The report then focuses its attention on the designer and instructs him in not only how to use the model in practical situations but also how to interpret and correlate test data. The main body of the text concludes with a critique of the time lag concept and outlines the kind of research that is needed in order to improve the time lag model.