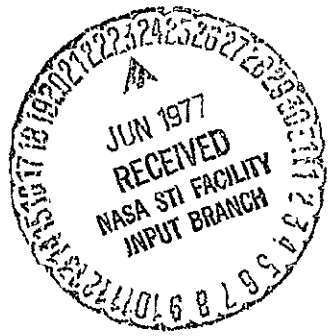
CR135172

A Method to Estimate Weight and Dimensions of Aircraft Gas Turbine Engines

Final Report

Volume III: Programmer's Manual

May 1977



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16 Abstract

A computerized method has been developed to estimate weight and envelope dimensions of aircraft gas turbine engines within ±5% to 10% The method is based on correlations of component weight and design features of 29 data base engines Rotating components are estimated by a preliminary design procedure where blade geometry, operating conditions, material properties, shaft speed, hub-tip ratio, etc , are the primary independent variables used The development and justification of the method selected, the various methods of analysis, the use of the program, and a description of the input-output data are discussed in this report

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A METHOD TO ESTIMATE WEIGHT AND DIMENSIONS OF
AIRCRAFT GAS TURBINE ENGINES
Vol III – Programmers Manual
By R. J. Pera, E Onat, N L. Prewitt, G. W Klees, E Tjonneland

1.0 SUMMARY

The purpose of this volume is to aid the programmer responsible for maintaining the computer code for weight estimating (WATE-1). A User's Manual (CR135171) and Method of Analysis (CR135170) are also available which describe the operation and use of WATE-1.

Included in this volume are program checkout cases in Appendix A starting on Pg. A1 and Fortran Listings in Appendix B, starting with Pg B1 An Index of material contained in each appendix is given on Pg A1 and B1

The code is in FORTRAN IV and has been checked out on IBM 370/168. The code is single precision except for the values in the Navy-NASA Engine program (NNEP). The code was designed to minimize conversion requirements to other machines.

1 no subroutines are required beyond those in the IBM FORTRAN IV manual, and
2 there is no character manipulation, only full word tests are used when testing BCD input

The NNEP/WATE-1 code requires $75B48_{16}$ core (482120_{10} bytes) to run without buffers The execution of a design point followed by a weight estimation and printer plot is 4 seconds CPU time, using an existing load module (all data reference 370/168)

2.0 CONVERSION FACTORS

The array CONVER in common CONVER are conversion factors to convert English units to SI units.

ARRAY #	VALUE	UNITS ENGLISH	to	UNITS SI
1	2.54	inch		cm
2	.3048	feet		meter
3	.4536	lb_m		K_g
4	0929	ft^2		$meter^2$
5	02768	lb_m/in^3		K_g/cm^3
6	.689475	lb_f/in^2		$Newton/cm^2$
7	4 882	lb_m/ft^2		K_g/m^2
8	.555	^oR		^oK
9	1 05435	BTU/sec		K WATTS
10	07457	HP		K WATTS
11	47 88	lb_f/ft^2		$Newton/m^2$

3.0 DISCUSSION

3.1 Program Structure

The execution flow was designed to minimize the interaction of the basic NNEP program and the weight estimation routines. The only data flowing between the two is via the common blocks SNGL and DBL and the variables IWT and IPLT The subroutine THERM is used to obtain thermodynamic properties of the fluid. An assumption is made that the thermodynamic properties are established at each station prior to calling WTEST subroutine.

Routine WTEST acts as a control routine which calls the component routines. These component routines are independent of each other although some use the same lower level routine as some other component routine After all weights and dimensions have been estimated routine ENGPLT is called to make the printer plot For a description of subroutine connectivity, see Figure 1

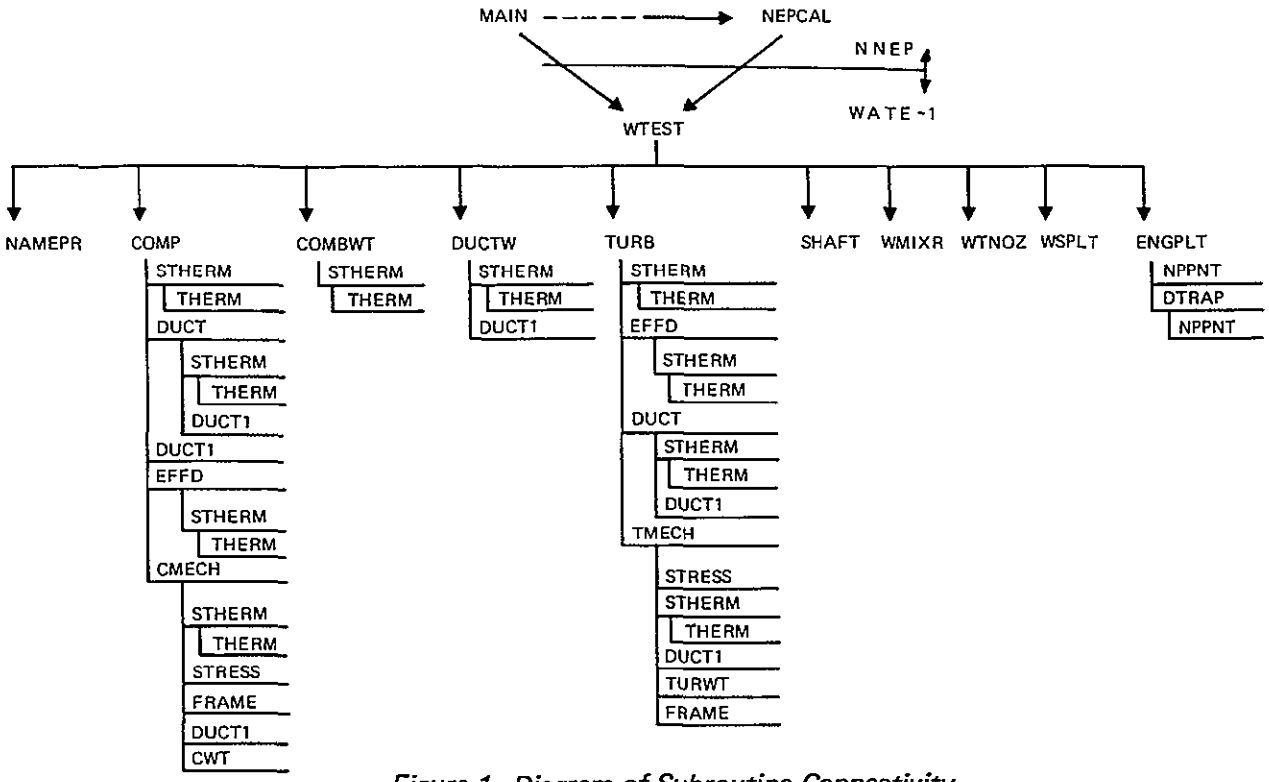

Figure 1 Diagram of Subroutine Connectivity

3.2 Data Flow

The following variables in NNEP common blocks may be referenced by a component weight estimating routine depending on the component type. DATOUT, WTF, TOPRES, TOTEMP, FAR, CORFLO, JCONF, JTYPE, NCOMP, NOSTAT, NFINIS. In no case is any value changed by the weight estimation code. Each call to WTEST routine will cause a NAMELIST read of "W" data (see User's manual) This is the one and only read in weight estimation code Based on the information in NCOMP and JTYPE the proper component routine is called with the component number (I) as an argument. Each component is expected to fill WATE (I), ALENG (I), TLENG (I), RØ (1,I), RØ (2,I), RI (1,I), RI (2,I) Rotating components also fill RPMT (I). The shaft component fills DSHAFT (N) where N is the shaft count from the inside out. The meaning of these variables is covered in the User's Manual.

3.3 Program Checkout

The concept for program testing is to use one definition through NNEP and then vary the weight data so as to execute all the subtypes of components In the case of rotating/fixed splitters, these were tested using a namelist read program instead of NNEP to fill the common blocks The checkout results are shown in Appendix A

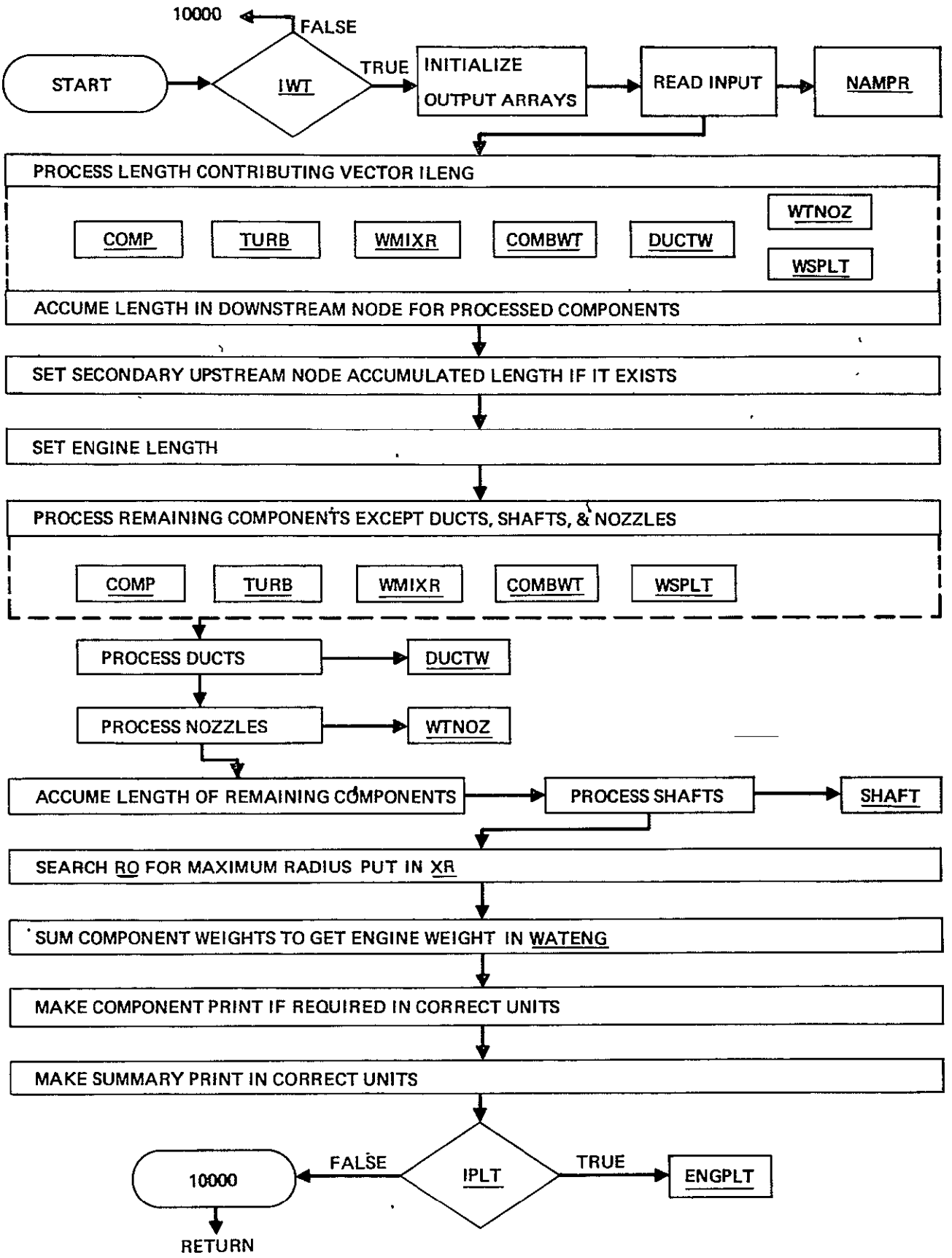

Figure 2 Functional Flow Chart of WTEST

APPENDIX A – Results of Program Checkout

TABLE DATA INPUT SUMMARY 16 TABLES

TABLE NUMBER	REFERENCE NUMBER	ARRAY LOCATION
1	3761	1
2	3762	1075
3	3763	2149
4	3704	3223
5	3705	4297
6	3706	5371
7	3707	6445
8	3708	7681
9	3709	8917
10	3801	10153
11	3802	10606
12	3803	11203
13	3804	11656
14	3901	12397
15	3902	12799
16	3903	13213

DATA STORAGE ALLOCATION 20000
DATA STORAGE NOT USED 6385

```
&D MODE=1,
IWT=T,
KONFIG(1,1)='INLT',1,0,2,0,SPEC(1,1)=238.5,4*0,0.9,
KONFIG(1,2)='COMP',2,0,4,0,SPEC(1,2)=1.8,0,1,3761,1,3762,1,3763,1,0,0,.87,2.86,
1,
KONFIG(1,4)='DUCT',11,0,15,0,SPEC(1,4)=6*0,
KONFIG(1,3)='SPLT',4,0,5,11,SPEC(1,3)=.77,
KONFIG(1,5)='COMP',5,0,6,7,SPEC(1,5)=1.3,.026,1,3707,1,3708,1,3709,1,0,0,.87,
9.406,.985,
KONFIG(1,6)='DUCT',6,0,8,0,SPEC(1,6)=.10,0,0,2650,.94,18300,
KONFIG(1,7)='TURB',8,7,9,0,SPEC(1,7)=4,1,1,3801,1,3802,1,1,1,1,.86,5680,1,
KONFIG(1,8)='TURB',9,0,10,0,SPEC(1,8)=2.5,0,1,3803,1,3804,1,1,1,1,.86,5244,1,
KONFIG(1,9)='MIXR',10,15,12,0,SPEC(1,9)=0,0,.24,
KONFIG(1,10)='DUCT',12,0,13,0,SPEC(1,10)=.06,3*0,.90,18300,
KONFIG(1,11)='NOZZ',13,0,14,0,SPEC(1,11)=0,1,0,0,.98,1,0,0,1,
KONFIG(1,12)='SHFT',2,8,0,0,SPEC(1,12)=4000,8*1,
KONFIG(1,13)='SHFT',5,7,0,0,SPEC(1,13)=6000,8*1,
KONFIG(1,14)='CNTL',SPCNTL(1,14)=1,8,'STAP',8,13,0,1,
KONFIG(1,15)='CNTL',SPCNTL(1,15)=1,7,'STAP',8,9,0,1,
KONFIG(1,16)='CNTL',SPCNTL(1,16)=1,5,'STAP',8,8,0,1,
KONFIG(1,17)='CNTL',SPCNTL(1,17)=1,3,'DOUT',8,9,0,1,
KONFIG(1,18)='CNTL',SPCNTL(1,18)=1,2,'STAP',8,5,0,1,
KONFIG(1,19)='CNTL',SPCNTL(1,19)=1,1,'STAP',8,2,0,1,
KONFIG(1,20)='CNTL',SPCNTL(1,20)=1,12,'DOUT',8,12,0,1,
KONFIG(1,21)='CNTL',SPCNTL(1,21)=1,13,'DOUT',8,13,0,1,
&END

 THE FOLLOWING REPRESENTS THE CONFIGURATION FOR MODE=   1
 SIMPLE MODEL
         CONFIGURATION DATA   15 STATIONS   21 COMPONENTS

  COMPONENT   NKIND COMPONENT      UPSTREAM        DOWNSTREAM
    NUMBER             TYPE       STATIONS         STATIONS
```

1	1	INLET	1	0	2	0
2	4	COMPRESR	2	0	4	0
3	7	SPLITTER	4	0	5	11
4	2	DUCT B	11	0	15	0
5	4	COMPRESR	5	0	6	7
6	2	DUCT B	6	0	8	0
7	5	TURBINE	8	7	9	0
8	5	TURBINE	9	0	10	0
9	8	MIXER	10	15	12	0
10	2	DUCT B	12	0	13	0
11	9	NOZZLE	13	0	14	0
12	11	SHAFT	2	8	0	0
13	11	SHAFT	5	7	0	0
14	12	CONTROL	13	0	8	0
15	12	CONTROL	9	0	7	0
16	12	CONTROL	8	0	5	0
17	12	CONTROL	9	0	3	0
18	12	CONTROL	5	0	2	0
19	12	CONTROL	2	0	1	0
20	12	CONTROL	12	0	12	0
21	12	CONTROL	13	0	13	0

CONTROL INFORMATION

```
14      VARY DATINP  1 OF COMPONENT  8 SO THAT STATP  8 OF FLOW STATION 13 EQUALS  0.0
15      VARY DATINP  1 OF COMPONENT  7 SO THAT STATP  8 OF FLOW STATION  9 EQUALS  0.0
16      VARY DATINP  1 OF COMPONENT  5 SO THAT STATP  8 OF FLOW STATION  8 EQUALS  0.0
17      VARY DATINP  1 OF COMPONENT  3 SO THAT DATOUT 8 OF COMPONENT  9 EQUALS  0.0
18      VARY DATINP  1 OF COMPONENT  2 SO THAT STATP  8 OF FLOW STATION  5 EQUALS  0.0
19      VARY DATINP  1 OF COMPONENT  1 SO THAT STATP  8 OF FLOW STATION  2 EQUALS  0.0
20      VARY DATINP  1 OF COMPONENT 12 SO THAT DATOUT 8 OF COMPONENT 12 EQUALS  0.0
21      VARY DATINP  1 OF COMPONENT 13 SO THAT DATOUT 8 OF COMPONENT 13 EQUALS  0.0

CASE IDENTIFICATION    SIMPLE MODEL
```

INPUT DATA

COMPONENT NO.	TYPE	DATINP1	DATINP2	DATINP3	DATINP4	DATINP5	DATINP6	DATINP7	DATINP8	DATINP9
1	INLET	0.23850D 03	0.0	0.0	0.0	0.0	0.90000D 00	0.0	0.0	0.0
2	COMPRESR	0.18000D 01	0.0	0.10000D 01	0.37610D 04	0.10000D 01	0.37620D 04	0.10000D 01	0.37630D 04	0.10000D 01
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	0.13000D 01	0.26000D-01	0.10000D 01	0.37070D 04	0.10000D 01	0.37080D 04	0.10000D 01	0.37090D 04	0.10000D 01
6	DUCT B	0.10000D 00	0.0	0.0	0.26500D 04	0.94000D 00	0.18300D 05	0.0	0.0	0.0
7	TURBINE	0.40000D 01	0.10000D 01	0.10000D 01	0.38010D 04	0.10000D 01	0.38020D 04	0.10000D 01	0.10000D 01	0.10000D 01
8	TURBINE	0.25000D 01	0.0	0.10000D 01	0.38030D 04	0.10000D 01	0.38040D 04	0.10000D 01	0.10000D 01	0.10000D 01
9	MIXER	0.0	0.0	0.24000D 00	0.0	0.0	0.0	0.0	0.0	0.0
10	DUCT B	0.60000D-01	0.0	0.0	0.0	0.90000D 00	0.18300D 05	0.0	0.0	0.0
11	NOZZLE	0.0	0.10000D 01	0.0	0.0	0.98000D 00	0.10000D 01	0.0	0.0	0.10000D 01
12	SHAFT	0.40000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
13	SHAFT	0.60000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
14	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
15	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
16	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
17	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
18	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
19	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
20	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
21	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01

```
MODE    1 NOW BEING USED
&W
IPLT=T,
ISII=F,
ISIO=T,
ICUTCD=2,
ILENG(1)=2,3,5,6,7,8,9,10,11,
IWMEC(1,2)='FAN ',1,1,4,3*0,
IWMEC(1,3)='SPLT',6*0,
IWMEC(1,4)='DUCT',3,5*0,
IWMEC(1,5)='HPC ',1,2,4*0,
IWMEC(1,6)='PBUR',1,5*0,
IWMEC(1,7)='HPT ',0,5,-5,3*0,
IWMEC(1,8)='LPT ',1,2,7,3*0,
IWMEC(1,9)='MIX ',6*0,
IWMEC(1,10)='AUG ',6*0,
IWMEC(1,11)='NOZ ',2,-10,4*0,
IWMEC(1,12)='SHAF',1,8,3*0,2,
IWMEC(1,13)='SHAF',2,7,3*0,5,
DESVAL(1,2)=.524,1.7,.45,1.5,3.5,2.5,.45,0.,0.,1.,0.,2.,1.,
DESVAL(1,3)=15*0.,
DESVAL(1,4)=.45,2*0.,11.,11*0.,
DESVAL(1,5)=.45,1.35,.70,1.2,2.,1.5,.3,0.,0.,1.,0.,2.,1.,
DESVAL(1,6)=100.,.015,0.,5.,11*0.,
DESVAL(1,7)=.5,.28,1.5,1.5,1.5,.55,150000.,3.,1.,6*0.,
DESVAL(1,8)=.55,.243,1.5,2.,3.,.6,150000.,3.,1.,6*0.,
DESVAL(1,9)=15*0.,
DESVAL(1,10)=250.,.016,13*0.,
DESVAL(1,11)=1.,14*0.,
DESVAL(1,12)=50000.,.3,.85,12*0.,
DESVAL(1,13)=50000.,.3,13*0.,
&END

************
*          *
*  FAN   2 *
*          *
************2
DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.524   174.   288.   91192.   75626.     0.6458  1.4005

  U TIP   STRESS      DEN   W/AREA    TR      H/T
  383.7 18448.8    0.005   11.421    1.800    0.450

 COMPRESSOR  2 MECHANICAL DESIGN

 LOADING    N STG    DIAM  U TIP C     RPM    C RPM
   0.874     3.00  101.54    383.7  7216.9   7216.9

FRAME WT  =    43.40
```

```
STAGE    1
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
29.3 26.8 26.8  0.0 12.018.669.00465.00465  3.50
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP    STR    WEIGHT TIN
1.4789  17.6 0.524  0.646 22.85  50.77  59  383.7 18449.    95.  288.

STAGE    2
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
41.1 15.5 15.5 22.9  9.515.697.00465.00465  3.00
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP    STR    WEIGHT TIN
1.4155  17.6 0.499  0.481 28.00  48.12  67  363.7 13921.   105.  327.

STAGE    3
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
43.9 10.4 10.4 21.0  8.414.400.00465.00465  2.50
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP    STR    WEIGHT TIN
1.3671  17.6 0.475  0.373 30.92  46.30  70  349.9 10872.    94.  365.

FRAME WT  =  129.34


 N STG  WEIGHT  LENGTH
    3   466.61   73.15

DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.450  177.  404. 260810. 227078.    0.2992  1.3951

  PR    AD EF     PO     TO     HP
 2.8600  0.8700260809.8   403.8   1261.
  HI      HO     WI     CWI
 130.69  183.53  108.18  120.20

********** TOTAL COMP WEIGHT IS   466.609

**********
*          *
*  HPC   5 *
*          *
**********2
DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.450  177.  404. 260810. 227078.    0.1690  1.3951

  U TIP  STRESS     DEN  W/AREA   TR     H/T
  391.7 16086.6   0.005   3.356   1.200   0.700

 COMPRESSOR  5 MECHANICAL DESIGN

 LOADING   N STG   DIAM  U TIP C    RPM   C RPM
   0.651   10.00   64.96   330.9 11515.5  9727.5

FRAME WT  =   53.63
```

```
STAGE    1
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
10.8   6.5   6.5 16.5   4.711.401.00465.00465  2.00
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP     STR    WEIGHT TIN
1.3603   18.8 0.450  0.169 22.74  32.48   50  391.7 16087.    45.  404.

STAGE    2
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 9.0   4.0   4.0 13.4   3.7 9.241.00465.00465  1.94
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP     STR    WEIGHT TIN
1.3241   18.8 0.435  0.134 23.93  31.61   60  381.2 12767.    34.  445.

STAGE    3
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 7.3   2.6   2.6 11.1   3.0 7.699.00465.00465  1.89
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP     STR    WEIGHT TIN
1.2948   18.8 0.420  0.109 24.76  30.97   70  373.5 10375.    27.  485.

STAGE    4
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 6.1   2.0   2.0   9.5   2.5 6.560.00465.00465  1.83
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP     STR    WEIGHT TIN
1.2704   18.8 0.405  0.090 25.35  30.49   81  367.7  8603.    22.  525.

STAGE    5
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 5.2   1.6   1.6   8.2   2.2 5.699.00465.00465  1.78
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP     STR    WEIGHT TIN
1.2499   18.8 0.390  0.076 25.79  30.12   93  363.2  7258.    19.  565.

STAGE    6
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 4.6   1.2   1.2   7.3   1.9 5.033.00465.00465  1.72
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP     STR    WEIGHT TIN
1.2324   18.8 0.375  0.065 26.12  29.83  104  359.7  6218.    16.  605.

STAGE    7
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 4.2   1.0   1.0   6.5   1.7 4.512.00465.00465  1.67
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP     STR    WEIGHT TIN
1.2173   18.8 0.360  0.057 26.38  29.60  115  356.9  5398.    14.  644.

STAGE    8
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 7.3   1.4   1.4   5.9   1.5 4.099.00792.00792  1.61
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP     STR    WEIGHT TIN
1.2042   18.8 0.345  0.050 26.59  29.41  126  354.7  8075.    18.  683.

STAGE    9
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 7.0   1.2   1.2   5.5   1.4 3.771.00792.00792  1.56
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP     STR    WEIGHT TIN
1.1926   18.8 0.330  0.044 26.75  29.26  136  352.9  7176.    16.  721.

STAGE   10
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 6.8   1.0   1.0   5.1   1.3 3.509.00792.00792  1.50
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP     STR    WEIGHT TIN
1.1824   18.8 0.315  0.040 26.89  29.14  146  351.4  6442.    15.  760.
```

```
 N STG  WEIGHT  LENGTH

   10   279.63   64.60

DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.300  166.  798.2453176.2309282.    0.0360  1.3539

  PR     AD EF      PO      TO      HP
 9.4060  0.8700********   797.6   2533.
  HI       HO      WI      CWI
 183.53  371.37   61.12   28.11

******************** TOTAL COMP WEIGHT IS   279.634

*************
*           *
*  PBUR  6  *
*           *
*************2
BURNER NUMBER     6
  RIN     ROUT      LENGTH      MACH      WSPEC
  22.246   32.789   18.000     0.055    22.440
  CAS WT   LIN WT   NOZ WT    INC WT     FRAME     WTOT
    11.0     18.3      8.1       7.5      68.6     113.5



*************
*           *
*  HPT   7  *
*           *
*************2
DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.500  361. 1456.2207860.1882986.    0.0369  1.2968

  U TIP  STRESS     DEN  W/AREA   TR      H/T
  337.1  6770.3   0.008   1.203   1.000   0.922

 TURBINE  7  MECHANICAL DESIGN
    H/T   N STG LOADING    AREA
  0.922   2.000   0.280   0.037
    UT     RTIP    RHUB   DEL H     RPM     TORQ
  337.1    28.0   184.0 11515.5 25703.8

STAGE    1
 DISK   BLADE  VANE   HWD    CASE   AR
  2.91   1.04   3.83   9.85   1.81  1.50
  PR   DEL H  MACH  AREA  R HUB  R TIP  NB  U TIP   STR    WEIGHT  LENGTH
1.8453  92.0 0.500  0.037 25.77  27.96 180  337.1  6770.   19.43    5.12

STAGE    2
 DISK   BLADE  VANE   HWD    CASE   AR
  4.88   2.91  10.75  16.09   3.10  1.50
  PR   DEL H  MACH  AREA  R HUB  R TIP  NB  U TIP   STR    WEIGHT  LENGTH
2.0063  92.0 0.525  0.062 25.77  29.34 116  353.8 11346.   37.73    8.37

 N STG  LENGTH  WEIGHT
    2    13.49   57.17
```

```
DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.550   350. 1127.  595416.  490421.     0.1122   1.3127

  PR       TR      AD EF     PO       TO      TO.1
 3.7081   1.2928   0.8600595415.9   1126.5   1126.5
 H IN     H OUT     AREA    FLOW      HP
 737.29   553.26     0.48    62.40    2533.

******************** TOTAL TURB WEIGHT IS     57.166


*************
*           *
*  LPT   8  *
*           *
*************2
DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.550   350. 1127.  595538.  490523.     0.1122   1.3127

  U TIP   STRESS      DEN   W/AREA    TR      H/T
  221.6   8072.8    0.008    3.793   1.000    0.765

 TURBINE   8  MECHANICAL DESIGN
    H/T    N STG LOADING     AREA
  0.765    2.000    0.243    0.112
     UT     RTIP     RHUB    DEL H      RPM      TORQ
  221.6     29.3     91.6   7216.9  20419.6

STAGE     1
 DISK    BLADE   VANE    HWD     CASE    AR
  2.29   10.14   29.95   17.63    4.49   2.00
  PP   DEL H  MACH   AREA  R HUB  R TIP  NB  U TIP   STR    WEIGHT  LENGTH
1.4669  45.8 0.550  0.112 22.42  29.32  80  221.6  8073.    64.49   12.11

STAGE     2
 DISK    BLADE   VANE    HWD     CASE    AR
  3.13   12.50   36.93   15.43    4.22   3.00
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB  U TIP   STR    WEIGHT  LENGTH
1.5156  45.8 0.575  0.153 22.42  31.48  98  237.9 11045.    72.22   10.60

FRAME WT  =    76.11


 N STG  LENGTH  WEIGHT
    2    34.06  212.82

DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.600   352.  956.  267825.  212419.     0.2166   1.3249

  PR       TR      AD EF     PO       TO      TO.1
 2.2236   1.1779   0.8600267824.9    956.4    956.4
 H IN     H OUT     AREA    FLOW      HP
 553.29   461.67     1.56    62.40    1261.
```

```
****************** TOTAL TURB WEIGHT IS   212.822


************
*          *
*  AUG  10 *
*          *
************2
BURNER NUMBER    10
  RIN     ROUT      LENGTH      MACH      WSPEC
   0.0     61.264    48.000     0.143    58.089
  CAS WT    LIN WT    NOZ WT    INC WT     FRAME     WTOT
    10.8      54.4     134.3       0.0     199.5

************
*          *
*  NOZ  11 *
*          *
************2
NOZZLE   11
WEIGHT=    258.07 LENGTH=   122.528 TR WT=     0.0


************
*          *
*  DUCT  4 *
*          *
************2
DUCT ,   4
RH= 40.0708 RT= 44.9444 LENG=157.8737
AREA=  0.1302 RHO=.0046504
OUTER CASE= 7.0493 INNER CASE= 6.2849 TOTAL=13.3342

************
*          *
*  SHAF 12 *
*          *
************2
SHAFT  12
   DO      DI    LENG      DN      WT
  9.00    7.65 123.81    0.65   18.16



************
*          *
*  SHAF 13 *
*          *
************2
SHAFT  13
   DO      DI    LENG      DN      WT
 11.05   10.02   45.72    1.27    6.50



************
*          *
*  ACCS WT *
*          *
************2

  ACCS WT= 136.721
```

WEIGHT INPUT DATA IN ENGL UNITS
WEIGHT OUTPUT DATA IN SIU UNITS

COMP NO	WT EST	COMP LEN	ACCU LEN	UPSTREAM RADIUS RI	UPSTREAM RADIUS RO	RI	RO	DOWNSTREAM RADIUS RI	DOWNSTREAM RADIUS RO	RI	RO	NSTAGE
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0
2	467.	73.	73.	23.	51.	0.	0.	33.	45.	0.	0.	3
3	0.	0.	73.	0.	0.	0.	0.	33.	40.	40.	45.	0
4	13.	158.	231.	40.	45.	0.	0.	40.	45.	0.	0.	0
5	280.	65.	138.	23.	32.	0.	0.	27.	29.	0.	0.	10
6	113.	46.	183.	22.	33.	0.	0.	22.	33.	0.	0.	0
7	57.	13.	197.	26.	28.	0.	0.	26.	32.	0.	0.	2
8	213.	34.	231.	22.	29.	0.	0.	22.	35.	0.	0.	2
9	0.	0.	231.	11.	40.	40.	54.	11.	54.	0.	0.	0
10	199.	122.	353.	0.	61.	0.	0.	0.	61.	0.	0.	0
11	258.	123.	475.	0.	61.	0.	0.	0.	56.	0.	0.	0
12	18.	0.	0.	23.	51.	26.	28.	0.	0.	0.	0.	0
13	7.	0.	0.	23.	32.	0.	0.	0.	0.	0.	0.	0

TOTAL BARE ENGINE WEIGHT= 1625. ACCESSORIES= 136.72

ESTIMATED TOTAL LENGTH= 475. ESTIMATED MAXIMUM RADIUS= 61.

UPDATED INPUT DATA TO REFLECT CALCULATED INPUT

COMPONENT NO.	TYPE	DATINP1	DATINP2	DATINP3	DATINP4	DATINP5	DATINP6	DATINP7	DATINP8	DATINP9
1	INLET	0.23850D 03	0.0	0.14696D 02	0.0	0.0	0.90000D 00	0.0	0.0	0.0
2	COMPRESR	0.18000D 01	0.0	0.40000D 04	0.37610D 04	0.26590D 03	0.37620D 04	0.10113D 01	0.37630D 04	0.99222D 00
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	0.13000D 01	0.26000D-01	0.51455D 04	0.37070D 04	0.61418D 02	0.37080D 04	0.90909D 00	0.37090D 04	0.13246D 01
6	DUCT B	0.10000D 00	0.0	0.0	0.26500D 04	0.94000D 00	0.18300D 05	0.0	0.0	0.0
7	TURBINE	0.40000D 01	0.10000D 01	0.46733D 00	0.38010D 04	0.70645D 00	0.38020D 04	0.96727D 00	0.90244D 00	0.10000D 01
8	TURBINE	0.25000D 01	0.0	0.38577D 00	0.38030D 04	0.72633D 00	0.38040D 04	0.94012D 00	0.81558D 00	0.10000D 01
9	MIXER	0.70773D 03	0.63925D 03	0.24000D 00	0.0	0.0	0.0	0.0	0.0	0.0
10	DUCT B	0.60000D-01	0.0	0.0	0.0	0.90000D 00	0.18300D 05	0.0	0.0	0.0
11	NOZZLE	0.47288D 03	0.10000D 01	0.0	0.0	0.98000D 00	0.10000D 01	0.0	0.0	0.10000D 01
12	SHAFT	0.40000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
13	SHAFT	0.60000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01

CASE IDENTIFICATION SIMPLE MODEL

STATION PROPERTY OUTPUT DATA

FLOW STATION	WEIGHT FLOW STATP1	TOTAL PRESSURE STATP2	TOTAL TEMPERATURE STATP3	FUEL/AIR RATIO STATP4	REFERRED FLOW STATP5	MACH NUMBER STATP6	STATIC PRESSURE STATP7	INTERFACE CORRECTED FLOW ERROR STATP8
1	0.23850D 03	0.14696D 02	0.51867D 03	0.0	0.23850D 03	0.0	0.0	0.0
2	0.23850D 03	0.13226D 02	0.51867D 03	0.0	0.26499D 03	0.0	0.0	0.0
4	0.23850D 03	0.37828D 02	0.72687D 03	0.0	0.10969D 03	0.0	0.0	0.0
5	0.13475D 03	0.37828D 02	0.72687D 03	0.0	0.61970D 02	0.0	0.0	0.0
6	0.13124D 03	0.35581D 03	0.14356D 04	0.0	0.90183D 01	0.0	0.0	0.0
7	0.35034D 01	0.35581D 03	0.14356D 04	0.0	0.0	0.0	0.0	0.0
8	0.13405D 03	0.32022D 03	0.26500D 04	0.21425D-01	0.13906D 02	0.0	0.0	0.0
9	0.13756D 03	0.86376D 02	0.20278D 04	0.20868D-01	0.46276D 02	0.0	0.0	0.0
10	0.13756D 03	0.38849D 02	0.17216D 04	0.20868D-01	0.94801D 02	0.240000 00	0.37401D 02	0.0
11	0.10375D 03	0.37828D 02	0.72687D 03	0.0	0.47717D 02	0.0	0.0	0.0
12	0.24131D 03	0.37401D 02	0.13157D 04	0.11790D-01	0.15101D 03	0.0	0.0	0.0
13	0.24131D 03	0.35157D 02	0.13157D 04	0.11790D-01	0.16065D 03	0.10000D 01	0.18780D 02	0.0
14	0.24131D 03	0.35157D 02	0.13157D 04	0.11790D-01	0.16065D 03	0.11729D 01	0.14696D 02	0.0
15	0.10375D 03	0.37828D 02	0.72687D 03	0.0	0.47717D 02	0.12734D 00	0.37401D 02	0.0

COMPONENT OUTPUT DATA

COMPONENT NO.	TYPE	DATOUT1	DATOUT2	DATOUT3	DATOUT4	DATOUT5	DATOUT6	DATOUT7	DATOUT8	DATOUT9
1	INLET	0.0	0.0	0.0	0.10000D 01	0.10000D 01	0.0	0.90000D 00	0.10000D 01	0.0
2	COMPRESR	-0.16912D 05	0.40000D 04	0.0	0.18000D 01	0.40000D 04	0.10000D 01	0.26590D 03	0.87000D 00	0.28600D 01
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	-0.33969D 05	0.60000D 04	0.0	0.13000D 01	0.51455D 04	0.98500D 00	0.61418D 02	0.87000D 00	0.94060D 01
6	DUCT B	0.0	0.10000D 00	0.0	0.21425D-01	0.0	0.10123D 05	0.0	0.94000D 00	0.26500D 04
7	TURBINE	0.33969D 05	0.60000D 04	0.10000D 01	0.40000D 01	0.46733D 00	0.56800D 04	0.70645D 00	0.86000D 00	0.37073D 01
8	TURBINE	0.16912D 05	0.40000D 04	0.10000D 01	0.25000D 01	0.38577D 00	0.52440D 04	0.72633D 00	0.86000D 00	0.22234D 01
9	MIXER	0.70773D 03	0.63925D 03	0.10387D 01	0.10114D 01	0.47274D 03	0.16773D 03	0.0	0.94990D-16	0.10000D 01
10	DUCT B	0.0	0.60000D-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	NOZZLE	0.13785D 05	0.18379D 04	0.23923D 01	0.48393D 03	0.47288D 03	0.10000D 01	0.98000D 00	0.18721D 01	0.23923D 01
12	SHAFT	0.0	0.40000D 04	0.40000D 04	0.40000D 04	0.0	0.0	0.0	0.0	0.0
13	SHAFT	0.0	0.60000D 04	0.60000D 04	0.60000D 04	0.0	0.0	0.0	0.0	0.0

MACH= 0.0 ALTITUDE= 0. RECOVERY= 0.9000 0 ITERATIONS 2 PASSES

AIRFLOW (LB/SEC)	238.50	GROSS THRUST	13785.01	FUEL FLOW (LB/HR)	10122.81
NET THRUST	13785.01	TSFC	0.7343	NET THRUST/AIRFLOW	57.7988
TOTAL INLET DRAG	0.0	TOTAL BRAKE SHAFT HP	0.0	BOATTAIL DRAG	0.0
INSTALLED THRUST	13785.01	INSTALLED TSFC	0.7343	SPILLAGE + LIP DRAG	0.0

SIMPLE MODEL
&D LONG=F,DRAW=F,BOAT=T,SPILL=T,AMINDS=1.6 &END

TABLE DATA INPUT SUMMARY 16 TABLES

TABLE NUMBER	REFERENCE NUMBER	ARRAY LOCATION
1	3761	1
2	3762	1075
3	3763	2149
4	3704	3223
5	3705	4297
6	3706	5371
7	3707	6445
8	3708	7681
9	3709	8917
10	3801	10153
11	3802	10606
12	3803	11203
13	3804	11656
14	3901	12397
15	3902	12799
16	3903	13213

DATA STORAGE ALLOCATION 20000
DATA STORAGE NOT USED 6385

```
&D MODE=1,
IWT=T,
KONFIG(1,1)='INLT',1,0,2,0,SPEC(1,1)=238.5,4*0,0.9,
KONFIG(1,2)='COMP',2,0,4,0,SPEC(1,2)=1.8,0,1,3761,1,3762,1,3763,1,0,0,.87,2.86,
1,
KONFIG(1,4)='DUCT',11,0,15,0,SPEC(1,4)=6*0,
KONFIG(1,3)='SPLT',4,0,5,11,SPEC(1,3)=.77,
KONFIG(1,5)='COMP',5,0,6,7,SPEC(1,5)=1.3,.026,1,3707,1,3708,1,3709,1,0,0,.87,
9.406,.985,
KONFIG(1,6)='DUCT',6,0,8,0,SPEC(1,6)=.10,0,0,2650,.94,18300,
KONFIG(1,7)='TURB',8,7,9,0,SPEC(1,7)=4,1,1,3801,1,3802,1,1,1,1,.86,5680,1,
KONFIG(1,8)='TURB',9,0,10,0,SPEC(1,8)=2.5,0,1,3803,1,3804,1,1,1,1,.86,5244,1,
KONFIG(1,9)='MIXR',10,15,12,0,SPEC(1,9)=0,0,.24,
KONFIG(1,10)='DUCT',12,0,13,0,SPEC(1,10)=.06,3*0,.90,18300,
KONFIG(1,11)='NOZZ',13,0,14,0,SPEC(1,11)=0,1,0,0,.98,1,0,0,1,
KONFIG(1,12)='SHFT',2,8,0,0,SPEC(1,12)=4000,8*1,
KONFIG(1,13)='SHFT',5,7,0,0,SPEC(1,13)=6000,8*1,
KONFIG(1,14)='CNTL',SPCNTL(1,14)=1,8,'STAP',8,13,0,1,
KONFIG(1,15)='CNTL',SPCNTL(1,15)=1,7,'STAP',8,9,0,1,
KONFIG(1,16)='CNTL',SPCNTL(1,16)=1,5,'STAP',8,8,0,1,
KONFIG(1,17)='CNTL',SPCNTL(1,17)=1,3,'DOUT',8,9,0,1,
KONFIG(1,18)='CNTL',SPCNTL(1,18)=1,2,'STAP',8,5,0,1,
KONFIG(1,19)='CNTL',SPCNTL(1,19)=1,1,'STAP',8,2,0,1,
KONFIG(1,20)='CNTL',SPCNTL(1,20)=1,12,'DOUT',8,12,0,1,
KONFIG(1,21)='CNTL',SPCNTL(1,21)=1,13,'DOUT',8,13,0,1,
&END

 THE FOLLOWING REPRESENTS THE CONFIGURATION FOR MODE=   1
 SIMPLE MODEL
         CONFIGURATION DATA   15 STATIONS   21 COMPONENTS

  COMPONENT  NKIND COMPONENT     UPSTREAM       DOWNSTREAM
    NUMBER           TYPE        STATIONS        STATIONS
```

1	1	INLET	1	0	2	0
2	4	COMPRESR	2	0	4	0
3	7	SPLITTER	4	0	5	11
4	2	DUCT B	11	0	15	0
5	4	COMPRESR	5	0	6	7
6	2	DUCT B	6	0	8	0
7	5	TURBINE	8	7	9	0
8	5	TURBINE	9	0	10	0
9	8	MIXER	10	15	12	0
10	2	DUCT B	12	0	13	0
11	9	NOZZLE	13	0	14	0
12	11	SHAFT	2	8	0	0
13	11	SHAFT	5	7	0	0
14	12	CONTROL	13	0	8	0
15	12	CONTROL	9	0	7	0
16	12	CONTROL	8	0	5	0
17	12	CONTROL	9	0	3	0
18	12	CONTROL	5	0	2	0
19	12	CONTROL	2	0	1	0
20	12	CONTROL	12	0	12	0
21	12	CONTROL	13	0	13	0

CONTROL INFORMATION

```
14      VARY DATINP  1 OF COMPONENT  8 SO THAT STATP   8 OF FLOW STATION 13 EQUALS  0.0
15      VARY DATINP  1 OF COMPONENT  7 SO THAT STATP   8 OF FLOW STATION  9 EQUALS  0.0
16      VARY DATINP  1 OF COMPONENT  5 SO THAT STATP   8 OF FLOW STATION  8 EQUALS  0.0
17      VARY DATINP  1 OF COMPONENT  3 SO THAT DATOUT  8 OF COMPONENT  9 EQUALS  0.0
18      VARY DATINP  1 OF COMPONENT  2 SO THAT STATP   8 OF FLOW STATION  5 EQUALS  0.0
19      VARY DATINP  1 OF COMPONENT  1 SO THAT STATP   8 OF FLOW STATION  2 EQUALS  0.0
20      VARY DATINP  1 OF COMPONENT 12 SO THAT DATOUT  8 OF COMPONENT 12 EQUALS  0.0
21      VARY DATINP  1 OF COMPONENT 13 SO THAT DATOUT  8 OF COMPONENT 13 EQUALS  0.0
```

CASE IDENTIFICATION SIMPLE MODEL

INPUT DATA

COMPONENT NO.	TYPE	DATINP1	DATINP2	DATINP3	DATINP4	DATINP5	DATINP6	DATINP7	DATINP8	DATINP9
1	INLET	0.23850D 03	0.0	0.0	0.0	0.0	0.90000D 00	0.0	0.0	0.0
2	COMPRESR	0.18000D 01	0.0	0.10000D 01	0.37610D 04	0.10000D 01	0.37620D 04	0.10000D 01	0.37630D 04	0.10000D 01
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	0.13000D 01	0.26000D-01	0.10000D 01	0.37070D 04	0.10000D 01	0.37080D 04	0.10000D 01	0.37090D 04	0.10000D 01
6	DUCT B	0.10000D 00	0.0	0.0	0.26500D 04	0.94000D 00	0.18300D 05	0.0	0.0	0.0
7	TURBINE	0.40000D 01	0.10000D 01	0.10000D 01	0.38010D 04	0.10000D 01	0.38020D 04	0.10000D 01	0.10000D 01	0.10000D 01
8	TURBINE	0.25000D 01	0.0	0.10000D 01	0.38030D 04	0.10000D 01	0.38040D 04	0.10000D 01	0.10000D 01	0.10000D 01
9	MIXER	0.0	0.0	0.24000D 00	0.0	0.0	0.0	0.0	0.0	0.0
10	DUCT B	0.60000D-01	0.0	0.0	0.0	0.90000D 00	0.18300D 05	0.0	0.0	0.0
11	NOZZLE	0.0	0.10000D 01	0.0	0.0	0.98000D 00	0.10000D 01	0.0	0.0	0.10000D 01
12	SHAFT	0.40000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
13	SHAFT	0.60000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
14	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
15	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
16	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
17	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
18	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
19	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
20	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
21	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01

```
MODE    1 NOW BEING USED
&W
IPLT=T,
ISII=F,
ISIO=F,
IOUTCD=2,
ILENG(1)=2,3,5,6,7,8,9,10,11,
IWMEC(1,2)='FAN ',1,1,4,3*0,
IWMEC(1,3)='SPLT',6*0,
IWMEC(1,4)='DUCT',3,5*0,
IWMEC(1,5)='HPC ',1,2,4*0,
IWMEC(1,6)='PBUR',1,5*0,
IWMEC(1,7)='HPT ',0,5,-5,3*0,
IWMEC(1,8)='LPT ',1,2,7,3*0,
IWMEC(1,9)='MIX ',6*0,
IWMEC(1,10)='AUG ',6*0,
IWMEC(1,11)='NOZ ',2,-10,4*0,
IWMEC(1,12)='SHAF',1,8,3*0,2,
IWMEC(1,13)='SHAF',2,7,3*0,5,
&END

************
*          *
*  FAN   2 *
*          *
************2
DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.550  596.  519.   1905.   1551.    6.7289  1.4005

  U TIP  STRESS     DEN  W/AREA   TR     H/T
 1258.9 26757.6   0.168   2.302   1.800   0.450

 COMPRESSOR  2 MECHANICAL DESIGN

 LOADING   N STG   DIAM  U TIP C    RPM   C RPM
   0.874    3.00   39.33  1258.9  7335.4  7335.4

FRAME WT  =   92.60



STAGE    1
  WD    WB    WS    WN    WC    CL    RHOB  RHOD   AR
 62.   50.   50.    0.   22.    6.3 0.168 0.168  4.00
  PR   DEL H  MACH  AREA  R HUB  R TIP  NB U TIP    STR   WEIGHT TIN
1.4789  16.7 0.550  6.729  8.85  19.67  68 1258.9 26758.  184.  519.

STAGE    2
  WD    WB    WS    WN    WC    CL    RHOB  RHOD   AR
 86.   29.   29.   42.   18.    5.3 0.168 0.168  3.50
  PR   DEL H  MACH  AREA  R HUB  R TIP  NB U TIP    STR   WEIGHT TIN
1.4155  16.7 0.517  5.057 10.80  18.67  78 1194.9 20358.  203.  588.

STAGE    3
  WD    WB    WS    WN    WC    CL    RHOB  RHOD   AR
 92.   19.   19.   38.   15.    4.7 0.168 0.168  3.00
  PR   DEL H  MACH  AREA  R HUB  R TIP  NB U TIP    STR   WEIGHT TIN
1.3671  16.7 0.483  3.964 11.90  17.98  83 1151.1 16067.  184.  658.

FRAME WT  =  278.15
```

```
 N STG  WEIGHT  LENGTH
    3   940.48   24.49

DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.450  582.  727.   5447.   4743.    3.2206  1.3951

  PR    AD EF     PQ     TQ     HP
 2.8600  0.8700  5447.2   726.9  16910.
  HI      HO     WI     CWI
 123.95  174.07  238.50  265.00

****************** TOTAL COMP WEIGHT IS   940.481

*************
*           *
*  HPC   5  *
*           *
************2
DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.400  520.  727.   5447.   4880.    1.9973  1.3951

  U TIP  STRESS     DEN  W/AREA   TR     H/T
 1355.1 25943.6   0.168   0.720   1.200   0.700

 COMPRESSOR  5 MECHANICAL DESIGN

 LOADING   N STG   DIAM  U TIP C    RPM   C RPM
   0.650    9.00   26.80  1144.7 11590.1  9790.5

FRAME WT  =  129.77



STAGE    1
  WD    WB    WS    WN    WC    CL    RHOB  RHOD   AR
 32.   14.   14.   28.    8.    3.1 0.168 0.168  3.00
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP    STR   WEIGHT TIN
1.4051  19.8 0.400  1.997  9.38  13.40  94 1355.1 25944.   95.  727.

STAGE    2
  WD    WB    WS    WN    WC    CL    RHOB  RHOD   AR
 27.    8.    8.   23.    6.    2.6 0.168 0.168  2.81
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP    STR   WEIGHT TIN
1.3600  19.8 0.389  1.536  9.93  13.00 112 1314.6 19975.   72.  808.

STAGE    3
  WD    WB    WS    WN    WC    CL    RHOB  RHOD   AR
 21.    6.    6.   19.    5.    2.2 0.168 0.168  2.63
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP    STR   WEIGHT TIN
1.3243  19.8 0.378  1.215 10.29  12.71 129 1285.7 15816.   56.  889.

STAGE    4
  WD    WB    WS    WN    WC    CL    RHOB  RHOD   AR
 17.    4.    4.   17.    4.    1.9 0.168 0.168  2.44
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP    STR   WEIGHT TIN
1.2951  19.8 0.367  0.984 10.54  12.50 146 1264.4 12815.   46.  970.
```

```
STAGE    5
  WD    WB    WS    WN    WC    CL    RHOB  RHOD   AR
 14.    3.    3.   15.    4.    1.7 0.168 0.168  2.25
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP     STR    WEIGHT TIN
1.2709  19.8 0.356  0.812 10.73  12.34 162 1248.4 10588.   39. 1049.

STAGE    6
  WD    WB    WS    WN    WC    CL    RHOB  RHOD   AR
 12.    3.    3.   14.    3.    1.5 0.168 0.168  2.06
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP     STR    WEIGHT TIN
1.2506  19.8 0.344  0.682 10.87  12.22 175 1236.1  8895.   34. 1128.

STAGE    7
  WD    WB    WS    WN    WC    CL    RHOB  RHOD   AR
 20.    4.    4.   13.    3.    1.4 0.286 0.286  1.88
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP     STR    WEIGHT TIN
1.2333  19.8 0.333  0.581 10.97  12.13 185 1226.5 12905.   43. 1206.

STAGE    8
  WD    WB    WS    WN    WC    CL    RHOB  RHOD   AR
 18.    3.    3.   12.    3.    1.4 0.286 0.286  1.69
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP     STR    WEIGHT TIN
1.2183  19.8 0.322  0.502 11.06  12.05 192 1218.9 11139.   40. 1283.

STAGE    9
  WD    WB    WS    WN    WC    CL    RHOB  RHOD   AR
 17.    3.    3.   12.    3.    1.4 0.286 0.286  1.50
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP     STR    WEIGHT TIN
1.2053  19.8 0.311  0.438 11.12  11.99 195 1212.8  9726.   38. 1360.

 N STG  WEIGHT  LENGTH
    9   593.11   18.07

DUCT
 M NO   VEL   T TOT    P TOT    P STAT  AREA     GAM
0.300   544. 1436.   51236.   48231.    0.3874  1.3539

  PR     AD EF      PO      TO      HP
 9.4060  0.8700 51235.9  1435.6  33965.
  HI       HO      WI      CWI
 174.07  352.23  134.75   61.97

******************** TOTAL COMP WEIGHT IS   593.109

**********
*        *
*  PBUR  6  *
*        *
**********2



BURNER NUMBER    6
  RIN     ROUT      LENGTH      MACH      WSPEC
   9.414   13.363   18.000     0.055     4.596
  CAS WT   LIN WT   NOZ WT   INC WT     FRAME     WTOT
    26.0     42.5     17.9     18.3     162.2     266.8
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**********
*        *
*  HPT  7 *
*        *
**********2
DUCT
 M NO   VEL   T TOT    P TOT    P STAT  AREA     GAM
0.300   720. 2621.   46112.   43515.     0.6059  1.2968

  U TIP  STRESS      DEN   W/AREA    TR      H/T
 1045.1 15157.4    0.286    0.413    1.000    0.860

 TURBINE  7  MECHANICAL DESIGN
    H/T    N STG LOADING     AREA
  0.860    2.000    0.250    0.606
     UT     RTIP     RHUB    DEL H      RPM     TORQ
 1045.1     10.3      8.9    174.5 11590.1 184717.

STAGE     1
 DISK    BLADE   VANE    HWD     CASE    AR
   8.0     6.0    22.3    27.9     6.3   1.50
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB  U TIP   STR    WEIGHT  LENGTH
1.8453  87.3 0.300  0.606  8.89  10.33 101 1045.1 15157.    70.58    3.38

STAGE     2
 DISK    BLADE   VANE    HWD     CASE    AR
  10.2    12.7    46.7    37.0     9.2   1.50
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB  U TIP   STR    WEIGHT  LENGTH
2.0063  87.3 0.375  0.865  8.55  10.62  72 1073.8 21644.   115.79    4.84

 N STG  LENGTH  WEIGHT
    2     8.22  186.37

DUCT
 M NO   VEL   T TOT    P TOT    P STAT  AREA     GAM
0.450   947. 2028.   12436.   10910.     1.3959  1.3127

  PR       TR      AD EF     PO       TO      TO.1
 3.7081   1.2928   0.8600 12435.6   2027.7   2027.7
 H IN     H OUT     AREA    FLOW      HP
 699.28   524.74     5.17   137.56  33969.

****************** TOTAL TURB WEIGHT IS   186.369
```

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**********
*        *
*  LPT   8  *
*        *
**********2


DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.450   947. 2028.   12438.   10913.     1.3957  1.3127

  U TIP  STRESS      DEN   W/AREA    TR      H/T
  602.1 13984.5    0.286    1.275    1.000    0.526

 TURBINE  8  MECHANICAL DESIGN
    H/T    N STG LOADING     AREA
  0.526    3.000   0.250    1.396
     UT     RTIP     RHUB    DEL H      RPM     TORQ
  602.1      9.4      4.9     86.9   7335.4 145306.

STAGE    1
 DISK    BLADE  VANE    HWD     CASE    AR
   1.3    48.1  142.1    20.0    13.2  2.00
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB  U TIP   STR    WEIGHT  LENGTH
1.2867  29.0 0.450  1.396  4.95   9.41  39  602.1 13984.   224.80    7.82

STAGE    2
 DISK    BLADE  VANE    HWD     CASE    AR
   1.0    49.2  145.3    12.3    11.1  3.00
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB  U TIP   STR    WEIGHT  LENGTH
1.3044  29.0 0.483  1.656  4.30   9.72  50  622.1 16596.   218.77    6.33

STAGE    3
 DISK    BLADE  VANE    HWD     CASE    AR
   0.5    61.8  182.6     6.7    10.9  4.00
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB  U TIP   STR    WEIGHT  LENGTH
1.3246  29.0 0.517  2.001  3.26  10.12  55  647.6 20051.   262.58    6.02

FRAME WT  =  102.56


 N STG  LENGTH  WEIGHT
    3    26.90  808.72

DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.550 1062. 1722.    5594.    4600.     2.4638  1.3249

  PR       TR      AD EF     PO       TO      TO.1
 2.2236  1.1779  0.8600  5593.7  1721.5  1721.5
 H IN     H OUT     AREA    FLOW      HP
 524.77  437.87    16.80  137.56  16912.

****************** TOTAL TURB WEIGHT IS   808.718
```

```
************
*          *
*  AUG  10 *
*          *
************2
BURNER NUMBER   10
  RIN     ROUT      LENGTH      MACH      WSPEC
   0.0     22.068    54.000     0.172    14.214

  CAS WT    LIN WT    NOZ WT    INC WT    WTOT
    22.3     123.5     278.8       0.0     424.7

************
*          *
*  NOZ  11 *
*          *
************2
NOZZLE   11
WEIGHT=    476.27 LENGTH=    44.136 TR WT=     0.0


************
*          *
*  DUCT  4 *
*          *
************2
DUCT ,   4
RH=    16.53 RT=    16.53 LENG=    71.19
AREA=    0.0    RHO=.168
      CAS WT       INC WT       WTOT
     15.5346      15.5346      31.0693


************
*          *
*  SHAF 12 *
*          *
************2
SHAFT  12
   DO      DI    LENG      DN      WT
  2.76    0.0    44.29    0.51   75.57


************
*          *
*  SHAF 13 *
*          *
************2
SHAFT  13
   DO      DI    LENG      DN      WT
  3.76    3.16   18.00    1.11   16.79


************
*          *
*  ACCS WT *
*          *
************2

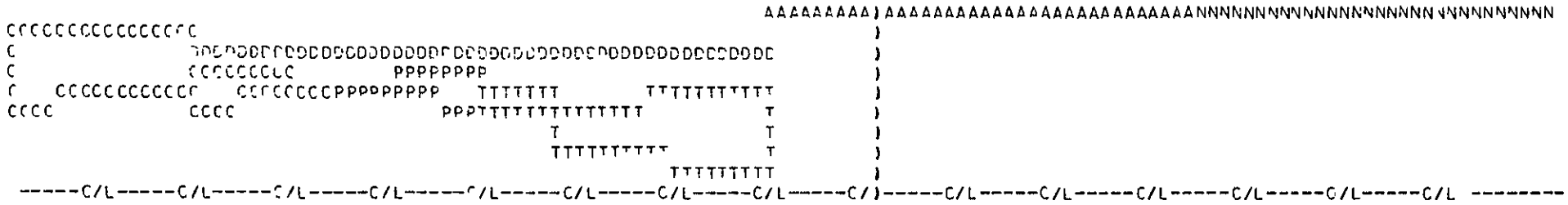
   ACCS WT= 334.358
```

WEIGHT INPUT DATA IN ENGL UNITS
WEIGHT OUTPUT DATA IN ENGL UNITS

COMP NO	WT EST	COMP LEN	ACCU LEN	UPSTREAM RADIUS RI	UPSTREAM RADIUS RO	RI	RO	DOWNSTREAM RADIUS RI	DOWNSTREAM RADIUS RO	RI	RO	NSTAGE
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0
2	940.	24.	24.	9.	20.	0.	0.	13.	18.	0.	0.	3
3	0.	0.	24.	0.	0.	0.	0.	13.	16.	16.	18.	0
4	31.	71.	96.	17.	17.	0.	0.	17.	17.	0.	0.	0
5	593.	18.	43.	9.	13.	0.	0.	11.	12.	0.	0.	9
6	267.	18.	61.	9.	13.	0.	0.	9.	13.	0.	0.	0
7	186.	8.	69.	9.	10.	0.	0.	8.	11.	0.	0.	2
8	809.	27.	96.	5.	9.	0.	0.	0.	11.	0.	0.	3
9	0.	0.	96.	0.	15.	15.	21.	0.	21.	0.	0.	0
10	425.	54.	150.	0.	22.	0.	0.	0.	22.	0.	0.	0
11	476.	44.	194.	0.	22.	0.	0.	0.	20.	0.	0.	0
12	76.	0.	0.	9.	20.	9.	10.	0.	0.	0.	0.	0
13	17.	0.	0.	9.	13.	0.	0.	0.	0.	0.	0.	0

TOTAL BARE ENGINE WEIGHT= 3820. ACCESSORIES= 334.36

ESTIMATED TOTAL LENGTH= 194. ESTIMATED MAXIMUM RADIUS= 22.



UPDATED INPUT DATA TO REFLECT CALCULATED INPUT

COMPONENT

NO.	TYPE	DATINP1	DATINP2	DATINP3	DATINP4	DATINP5	DATINP6	DATINP7	DATINP8	DATINP9
1	INLET	0.23850D 03	0.0	0.14696D 02	0.0	0.0	0.90000D 00	0.0	0.0	0.0
2	COMPRESR	0.18000D 01	0.0	0.40000D 04	0.37610D 04	0.26590D 03	0.37620D 04	0.10113D 01	0.37630D 04	0.99222D 00
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	0.13000D 01	0.26000D-01	0.51455D 04	0.37070D 04	0.61418D 02	0.37080D 04	0.90909D 00	0.37090D 04	0.13246D 01
6	DUCT B	0.10000D 00	0.0	0.0	0.26500D 04	0.94000D 00	0.18300D 05	0.0	0.0	0.0
7	TURBINE	0.40000D 01	0.10000D 01	0.46733D 00	0.38010D 04	0.70645D 00	0.38020D 04	0.96727D 00	0.90244D 00	0.10000D 01
8	TURBINE	0.25000D 01	0.0	0.38577D 00	0.38030D 04	0.72633D 00	0.38040D 04	0.94012D 00	0.81558D 00	0.10000D 01
9	MIXER	0.70773D 03	0.63925D 03	0.24000D 00	0.0	0.0	0.0	0.0	0.0	0.0
10	DUCT B	0.60000D-01	0.0	0.0	0.0	0.90000D 00	0.18300D 05	0.0	0.0	0.0
11	NOZZLE	0.47288D 03	0.10000D 01	0.0	0.0	0.98000D 00	0.10000D 01	0.0	0.0	0.10000D 01
12	SHAFT	0.40000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
13	SHAFT	0.60000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01

CASE IDENTIFICATION SIMPLE MODEL

STATION PROPERTY OUTPUT DATA

FLOW STATION	WEIGHT FLOW STATP1	TOTAL PRESSURE STATP2	TOTAL TEMPERATURE STATP3	FUEL/AIR RATIO STATP4	REFERRED FLOW STATP5	MACH NUMBER STATP6	STATIC PRESSURE STATP7	INTERFACE CORRECTED FLOW ERROR STATP8
1	0.23850D 03	0.14696D 02	0.51867D 03	0.0	0.23850D 03	0.0	0.0	0.0
2	0.23850D 03	0.13226D 02	0.51867D 03	0.0	0.26499D 03	0.0	0.0	0.0
4	0.23850D 03	0.37828D 02	0.72687D 03	0.0	0.10969D 03	0.0	0.0	0.0
5	0.13475D 03	0.37828D 02	0.72687D 03	0.0	0.61970D 02	0.0	0.0	0.0
6	0.13124D 03	0.35581D 03	0.14356D 04	0.0	0.90183D 01	0.0	0.0	0.0
7	0.35034D 01	0.35581D 03	0.14356D 04	0.0	0.0	0.0	0.0	0.0
8	0.13405D 03	0.32022D 03	0.26500D 04	0.21425D-01	0.13906D 02	0.0	0.0	0.0
9	0.13756D 03	0.86376D 02	0.20278D 04	0.20868D-01	0.46276D 02	0.0	0.0	0.0
10	0.13756D 03	0.38849D 02	0.17216D 04	0.20868D-01	0.94801D 02	0.24000D 00	0.37401D 02	0.0
11	0.10375D 03	0.37828D 02	0.72687D 03	0.0	0.47717D 02	0.0	0.0	0.0
12	0.24131D 03	0.37401D 02	0.13157D 04	0.11790D-01	0.15101D 03	0.0	0.0	0.0
13	0.24131D 03	0.35157D 02	0.13157D 04	0.11790D-01	0.16065D 03	0.10000D 01	0.18780D 02	0.0
14	0.24131D 03	0.35157D 02	0.13157D 04	0.11790D-01	0.16065D 03	0.11729D 01	0.14696D 02	0.0
15	0.10375D 03	0.37828D 02	0.72687D 03	0.0	0.47717D 02	0.12734D 00	0.37401D 02	0.0

COMPONENT OUTPUT DATA

COMPONENT NO.	TYPE	DATOUT1	DATOUT2	DATOUT3	DATOUT4	DATOUT5	DATOUT6	DATOUT7	DATOUT8	DATOUT9
1	INLET	0.0	0.0	0.0	0.10000D 01	0.10000D 01	0.0	0.90000D 00	0.10000D 01	0.0
2	COMPRESR	-0.16912D 05	0.40000D 04	0.0	0.18000D 01	0.40000D 04	0.10000D 01	0.26590D 03	0.87000D-00	0.28600D 01
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	-0.33969D 05	0.60000D 04	0.0	0.13000D 01	0.51455D 04	0.98500D 00	0.61418D 02	0.87000D 00	0.94060D 01
6	DUCT B	0.0	0.10000D 00	0.0	0.21425D-01	0.0	0.10123D 05	0.0	0.94000D 00	0.26500D 04
7	TURBINE	0.33969D 05	0.60000D 04	0.10000D 01	0.40000D 01	0.46733D 00	0.56800D 04	0.70645D 00	0.86000D 00	0.37073D 01
8	TURBINE	0.16912D 05	0.40000D 04	0.10000D 01	0.25000D 01	0.38577D 00	0.52440D 04	0.72633D 00	0.86000D 00	0.22234D 01
9	MIXER	0.70773D 03	0.63925D 03	0.10387D 01	0.10114D 01	0.47274D 03	0.16773D 03	0.0	0.94950D-16	0.10000D 01
10	DUCT B	0.0	0.60000D-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	NOZZLE	0.13785D 05	0.18379D 04	0.23923D 01	0.48393D 03	0.47288D 03	0.10000D 01	0.98000D 00	0.18721D 01	0.23923D 01
12	SHAFT	0.0	0.40000D 04	0.40000D 04	0.40000D 04	0.0	0.0	0.0	0.0	0.0
13	SHAFT	0.0	0.60000D 04	0.60000D 04	0.60000D 04	0.0	0.0	0.0	0.0	0.0

MACH= 0.0 ALTITUDE= 0. RECOVERY= 0.9000 0 ITERATIONS 2 PASSES

AIRFLOW (LB/SEC)	238.50	GROSS THRUST	13785.01	FUEL FLOW (LB/HR)	10122.81
NET THRUST	13785.01	TSFC	0.7343	NET THRUST/AIRFLOW	57.7988
TOTAL INLET DRAG	0.0	TOTAL BRAKE SHAFT HP	0.0	BOATTAIL DRAG	0.0
INSTALLED THRUST	13785.01	INSTALLED TSFC	0.7343	SPILLAGE + LIP DRAG	0.0

SIMPLE MODEL
&D LONG=F,DRAW=F,BOAT=T,SPILL=T,AMINDS=1.6 &END

TABLE DATA INPUT SUMMARY 16 TABLES

TABLE NUMBER	REFERENCE NUMBER	ARRAY LOCATION
1	3761	1
2	3762	1075
3	3763	2149
4	3704	3223
5	3705	4297
6	3706	5371
7	3707	6445
8	3708	7681
9	3709	8917
10	3801	10153
11	3802	10606
12	3803	11203
13	3804	11656
14	3901	12397
15	3902	12799
16	3903	13213

DATA STORAGE ALLOCATION 20000
DATA STORAGE NOT USED 6385

```
&D MODE=1,
IWT=T,
KONFIG(1,1)='INLT',1,0,2,0,SPEC(1,1)=238.5,4*0,0.9,
KONFIG(1,2)='COMP',2,0,4,0,SPEC(1,2)=1.8,0,1,3761,1,3762,1,3763,1,0,0,.87,2.86,
1,
KONFIG(1,4)='DUCT',11,0,15,0,SPEC(1,4)=6*0,
KONFIG(1,3)='SPLT',4,0,5,11,SPEC(1,3)=.77,
KONFIG(1,5)='COMP',5,0,6,7,SPEC(1,5)=1.3,.026,1,3707,1,3708,1,3709,1,0,0,.87,
9.406,.985,
KONFIG(1,6)='DUCT',6,0,8,0,SPEC(1,6)=.10,0,0,2650,.94,18300,
KONFIG(1,7)='TURB',8,7,9,0,SPEC(1,7)=4,1,1,3801,1,3802,1,1,1,1,.86,5680,1,
KONFIG(1,8)='TURB',9,0,10,0,SPEC(1,8)=2.5,0,1,3803,1,3804,1,1,1,1,.86,5244,1,
KONFIG(1,9)='MIXR',10,15,12,0,SPEC(1,9)=0,0,.24,
KONFIG(1,10)='DUCT',12,0,13,0,SPEC(1,10)=.06,3*0,.90,18300,
KONFIG(1,11)='NOZZ',13,0,14,0,SPEC(1,11)=0,1,0,0,.98,1,0,0,1,
KONFIG(1,12)='SHFT',2,8,0,0,SPEC(1,12)=4000,8*1,
KONFIG(1,13)='SHFT',5,7,0,0,SPEC(1,13)=6000,8*1,
KONFIG(1,14)='CNTL',SPCNTL(1,14)=1,8,'STAP',8,13,0,1,
KONFIG(1,15)='CNTL',SPCNTL(1,15)=1,7,'STAP',8,9,0,1,
KONFIG(1,16)='CNTL',SPCNTL(1,16)=1,5,'STAP',8,8,0,1,
KONFIG(1,17)='CNTL',SPCNTL(1,17)=1,3,'DOUT',8,9,0,1,
KONFIG(1,18)='CNTL',SPCNTL(1,18)=1,2,'STAP',8,5,0,1,
KONFIG(1,19)='CNTL',SPCNTL(1,19)=1,1,'STAP',8,2,0,1,
KONFIG(1,20)='CNTL',SPCNTL(1,20)=1,12,'DOUT',8,12,0,1,
KONFIG(1,21)='CNTL',SPCNTL(1,21)=1,13,'DOUT',8,13,0,1,
&END
```

THE FOLLOWING REPRESENTS THE CONFIGURATION FOR MODE= 1
SIMPLE MODEL
CONFIGURATION DATA 15 STATIONS 21 COMPONENTS

COMPONENT NUMBER	NKIND	COMPONENT TYPE	UPSTREAM STATIONS		DOWNSTREAM STATIONS	
1	1	INLET	1	0	2	0
2	4	COMPRESR	2	0	4	0
3	7	SPLITTER	4	0	5	11
4	2	DUCT B	11	0	15	0
5	4	COMPRESR	5	0	6	7
6	2	DUCT B	6	0	8	0
7	5	TURBINE	8	7	9	0
8	5	TURBINE	9	0	10	0
9	8	MIXER	10	15	12	0
10	2	DUCT B	12	0	13	0
11	9	NOZZLE	13	0	14	0
12	11	SHAFT	2	8	0	0
13	11	SHAFT	5	7	0	0
14	12	CONTROL	13	0	8	0
15	12	CONTROL	9	0	7	0
16	12	CONTROL	8	0	5	0
17	12	CONTROL	9	0	3	0
18	12	CONTROL	5	0	2	0
19	12	CONTROL	2	0	1	0
20	12	CONTROL	12	0	12	0
21	12	CONTROL	13	0	13	0

CONTROL INFORMATION

14 VARY DATINP 1 OF COMPONENT 8 SO THAT STATP 8 OF FLOW STATION 13 EQUALS 0.0
15 VARY DATINP 1 OF COMPONENT 7 SO THAT STATP 8 OF FLOW STATION 9 EQUALS 0.0
16 VARY DATINP 1 OF COMPONENT 5 SO THAT STATP 8 OF FLOW STATION 8 EQUALS 0.0
17 VARY DATINP 1 OF COMPONENT 3 SO THAT DATOUT 8 OF COMPONENT 9 EQUALS 0.0
18 VARY DATINP 1 OF COMPONENT 2 SO THAT STATP 8 OF FLOW STATION 5 EQUALS 0.0
19 VARY DATINP 1 OF COMPONENT 1 SO THAT STATP 8 OF FLOW STATION 2 EQUALS 0.0
20 VARY DATINP 1 OF COMPONENT 12 SO THAT DATOUT 8 OF COMPONENT 12 EQUALS 0.0
21 VARY DATINP 1 OF COMPONENT 13 SO THAT DATOUT 8 OF COMPONENT 13 EQUALS 0.0

CASE IDENTIFICATION SIMPLE MODEL

INPUT DATA

COMPONENT NO.	TYPE	DATINP1	DATINP2	DATINP3	DATINP4	DATINP5	DATINP6	DATINP7	DATINP8	DATINP9
1	INLET	0.238500D 03	0.0	0.0	0.0	0.0	0.90000D 00	0.0	0.0	0.0
2	COMPRESR	0.180000D 01	0.0	0.10000D 01	0.37610D 04	0.10000D 01	0.37620D 04	0.10000D 01	0.37630D 04	0.10000D 01
3	SPLITTER	0.770000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	0.13000D 01	0.26000D-01	0.10000D 01	0.37070D 04	0.10000D 01	0.37080D 04	0.10000D 01	0.37090D 04	0.10000D 01
6	DUCT B	0.10000D 00	0.0	0.0	0.26500D 04	0.94000D 00	0.18300D 05	0.0	0.0	0.0
7	TURBINE	0.40000D 01	0.10000D 01	0.10000D 01	0.38010D 04	0.10000D 01	0.38020D 04	0.10000D 01	0.10000D 01	0.10000D 01
8	TURBINE	0.25000D 01	0.0	0.10000D 01	0.38030D 04	0.10000D 01	0.38040D 04	0.10000D 01	0.10000D 01	0.10000D 01
9	MIXER	0.0	0.0	0.24000D 00	0.0	0.0	0.0	0.0	0.0	0.0
10	DUCT B	0.60000D-01	0.0	0.0	0.0	0.90000D 00	0.18300D 05	0.0	0.0	0.0
11	NOZZLE	0.0	0.10000D 01	0.0	0.0	0.98000D 00	0.10000D 01	0.0	0.0	0.10000D 01
12	SHAFT	0.40000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
13	SHAFT	0.60000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
14	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
15	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
16	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
17	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
18	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
19	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
20	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
21	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01

```
MODE    1 NOW BEING USED
&W
IPLT=T,
ISII=F,
ISIO=F,
IOUTCD=2,
ILENG(1)=2,3,5,6,7,8,9,10,11,
IWMEC(1,2)='FAN ',1,1,4,3*0,
IWMEC(1,3)='SPLT',6*0,
IWMEC(1,4)='DUCT',3,5*0,
IWMEC(1,5)='HPC ',1,2,4*0,
IWMEC(1,6)='PBUR',1,5*0,
IWMEC(1,7)='HPT ',0,5,-5,3*0,
IWMEC(1,8)='LPT ',1,2,7,3*0,
IWMEC(1,9)='MIX ',6*0,
IWMEC(1,10)='AUG ',6*0,
IWMEC(1,11)='NOZ ',2,-10,4*0,
IWMEC(1,12)='SHAF',1,8,3*0,2,
IWMEC(1,13)='SHAF',2,7,3*0,5,
DESVAL(1,2)=.524,1.7,.45,1.5,3.5,2.5,.45,0.,0.,1.,0.,2.,1.,0,1.1,
DESVAL(1,3)=14*0.,1.1,
DESVAL(1,4)=.45,2*0.,11.,10*0.,1.1,
DESVAL(1,5)=.45,1.35,.70,1.2,2.,1.5,.3,0.,0.,1.,0.,2.,1.,0,1.1,
DESVAL(1,6)=100.,.015,0.,5.,10*0.,1.1,
DESVAL(1,7)=.5,.28,1.5,1.5,1.5,.55,150000.,3.,1.,5*0.,1.1,
DESVAL(1,8)=.55,.243,1.5,2.,3.,.6,150000.,3.,1.,5*0.,1.1,
DESVAL(1,9)=14*0.,1.1,
DESVAL(1,10)=250.,.016,12*0.,1.1,
DESVAL(1,12)=50000.,.3,.85,11*0.,1.1,
DESVAL(1,11)=1.,13*0.,1.1,
DESVAL(1,13)=50000.,.3,12*0.,1.1,
&END

**********
*        *
*  FAN   2  *
*        *
**********2
DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.524   570.   519.    1905.    1579.     6.9517  1.4005

  U TIP   STRESS      DEN   W/AREA    TR      H/T
 1258.9 26757.6    0.168    2.339    1.800    0.450

 COMPRESSOR  2 MECHANICAL DESIGN

 LOADING    N STG    DIAM  U TIP C     RPM    C RPM
   0.874     3.00    39.98  1258.9   7216.9   7216.9

FRAME WT  =    95.67
```

```
STAGE    1
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 65.   59.   59.    0.   26.    7.4 0.168 0.168  3.50
  PR   DEL H  MACH   AREA  R HUB  R TIP   NB U TIP     STR    WEIGHT TIN
1.4789  16.7 0.524  6.952  8.99  19.99   59 1258.9 26758.   209.   519.

STAGE    2
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 91.   34.   34.   51.   21.    6.2 0.168 0.168  3.00
  PR   DEL H  MACH   AREA  R HUB  R TIP   NB U TIP     STR    WEIGHT TIN
1.4155  16.7 0.499  5.180 11.02  18.95   67 1193.2 20191.   231.   588.

STAGE    3
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 97.   23.   23.   46.   19.    5.7 0.168 0.168  2.50
  PR   DEL H  MACH   AREA  R HUB  R TIP   NB U TIP     STR    WEIGHT TIN
1.3671  16.7 0.475  4.017 12.17  18.23   70 1148.1 15768.   208.   658.

FRAME WT  =  285.15


 N STG  WEIGHT  LENGTH
    3  1028.68   28.80

DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.450  582.  727.   5447.   4743.    3.2206  1.3951

  PR    AD EF     PO     TO     HP
 2.8600  0.8700  5447.2   726.9  16910.
  HI      HO     WI     CWI
 123.95  174.07  238.50  265.00

********** TOTAL COMP WEIGHT IS  1028.680

**********
*        *
*  HPC   5  *
*        *
**********2
DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.450  582.  727.   5447.   4743.    1.8196  1.3951

  U TIP  STRESS     DEN  W/AREA   TR     H/T
 1285.1 23331.5   0.168   0.687   1.200   0.700

 COMPRESSOR  5 MECHANICAL DESIGN

 LOADING   N STG   DIAM  U TIP C    RPM   C RPM
   0.651   10.00   25.58  1085.6 11515.5  9727.5

FRAME WT  =  118.22
```

STAGE 1

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
24.	14.	14.	36.	10.	4.5	0.168	0.168	2.00

PR	DEL H	MACH	AREA R HUB	R TIP	NB U TIP	STR	WEIGHT	TIN
1.3603	17.8	0.450	1.820	8.95	12.79	50 1285.1	23331.	99. 727.

STAGE 2

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
20.	9.	9.	29.	8.	3.6	0.168	0.168	1.94

PR	DEL H	MACH	AREA R HUB	R TIP	NB U TIP	STR	WEIGHT	TIN
1.3241	17.8	0.435	1.442	9.42	12.45	60 1250.7	18516.	75. 800.

STAGE 3

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
16.	6.	6.	25.	7.	3.0	0.168	0.168	1.89

PR	DEL H	MACH	AREA R HUB	R TIP	NB U TIP	STR	WEIGHT	TIN
1.2948	17.8	0.420	1.171	9.75	12.19	70 1225.3	15048.	59. 873.

STAGE 4

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
13.	4.	4.	21.	6.	2.6	0.168	0.168	1.83

PR	DEL H	MACH	AREA R HUB	R TIP	NB U TIP	STR	WEIGHT	TIN
1.2704	17.8	0.405	0.970	9.98	12.00	81 1206.2	12477.	49. 946.

STAGE 5

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
11.	3.	3.	18.	5.	2.2	0.168	0.168	1.78

PR	DEL H	MACH	AREA R HUB	R TIP	NB U TIP	STR	WEIGHT	TIN
1.2499	17.8	0.390	0.818	10.15	11.86	93 1191.5	10527.	41. 1017.

STAGE 6

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
10.	3.	3.	16.	4.	2.0	0.168	0.168	1.72

PR	DEL H	MACH	AREA R HUB	R TIP	NB U TIP	STR	WEIGHT	TIN
1.2324	17.8	0.375	0.701	10.28	11.74	104 1180.1	9018.	36. 1089.

STAGE 7

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
9.	2.	2.	14.	4.	1.8	0.168	0.168	1.67

PR	DEL H	MACH	AREA R HUB	R TIP	NB U TIP	STR	WEIGHT	TIN
1.2173	17.8	0.360	0.608	10.39	11.65	115 1171.0	7829.	32. 1159.

STAGE 8

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
16.	3.	3.	13.	3.	1.6	0.286	0.286	1.61

PR	DEL H	MACH	AREA R HUB	R TIP	NB U TIP	STR	WEIGHT	TIN
1.2042	17.8	0.345	0.534	10.47	11.58	126 1163.6	11712.	39. 1229.

STAGE 9

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
15.	3.	3.	12.	3.	1.5	0.286	0.286	1.56

PR	DEL H	MACH	AREA R HUB	R TIP	NB U TIP	STR	WEIGHT	TIN
1.1926	17.8	0.330	0.475	10.53	11.52	136 1157.7	10407.	36. 1299.

STAGE 10

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
15.	2.	2.	11.	3.	1.4	0.286	0.286	1.50

PR	DEL H	MACH	AREA R HUB	R TIP	NB U TIP	STR	WEIGHT	TIN
1.1824	17.8	0.315	0.426	10.59	11.47	146 1152.8	9343.	33. 1367.

N STG	WEIGHT	LENGTH
10	616.48	25.43

```
DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.300   544.  1436.   51236.   48231.     0.3874  1.3539

  PR     AD EF      PO      TO      HP
 9.4060   0.8700 51235.9   1435.6   33965.
  HI       HO       WI      CWI
 174.07   352.23   134.75    61.97

******************** TOTAL COMP WEIGHT IS    616.477

*************
*           *
*  PBUR  6  *
*           *
*************2
BURNER NUMBER     6
   RIN      ROUT      LENGTH      MACH      WSPEC
    8.758    12.909    18.000     0.055     4.596
  CAS WT    LIN WT    NOZ WT    INC WT     FRAME     WTOT
    24.2      40.4      17.8      16.4     151.3     250.2



*************
*           *
*  HPT   7  *
*           *
*************2
DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.500  1186.  2621.   46112.   39327.     0.3977  1.2968

  U TIP   STRESS      DEN   W/AREA    TR      H/T
 1106.0   9819.5    0.286    0.246    1.000    0.922

 TURBINE  7  MECHANICAL DESIGN
    H/T    N STG LOADING     AREA
  0.922    2.000    0.280    0.398
     UT      RTIP     RHUB    DEL H      RPM     TORQ
 1106.0     11.0     10.1    174.5 11515.5 185913.

STAGE     1
 DISK    BLADE   VANE    HWD     CASE    AR
   6.4     2.3     8.4    21.7     4.0   1.50
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB  U TIP   STR    WEIGHT  LENGTH
1.8453  87.3 0.500  0.398 10.14  11.01 180 1106.0  9820.    42.84    2.02

STAGE     2
 DISK    BLADE   VANE    HWD     CASE    AR
  10.8     6.4    23.7    35.5     6.8   1.50
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB  U TIP   STR    WEIGHT  LENGTH
2.0063  87.3 0.525  0.666 10.14  11.55 116 1160.9 16456.    83.19    3.29

 N STG  LENGTH  WEIGHT
    2     5.31  126.03
```

```
DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.550 1149.  2028.   12436.   10243.     1.2074   1.3127

  PR       TR      AD EF     PO       TO      TO.1
 3.7081   1.2928   0.8600 12435.6   2027.7   2027.7
 H IN     H OUT     AREA    FLOW      HP
 699.28   524.74     5.17   137.56   33969.

******************** TOTAL TURB WEIGHT IS    126.028.


*************
*           *
*  LPT   8  *
*           *
*************2
DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.550 1149.  2028.   12438.   10245.     1.2072   1.3127

  U TIP   STRESS      DEN   W/AREA    TR      H/T
  727.0 11708.5    0.286    0.777   1.000    0.765

 TURBINE   8  MECHANICAL DESIGN
    H/T    N STG LOADING     AREA
  0.765    2.000    0.243    1.207
     UT     RTIP     RHUB    DEL H      RPM     TORQ
  727.0     11.5      8.8     86.9   7216.9 147693.

STAGE     1
 DISK    BLADE   VANE    HWD     CASE    AR
   5.0    22.4    66.0    38.9     9.9   2.00
  PR   DEL H   MACH   AREA   R HUB   R TIP   NB   U TIP    STR    WEIGHT   LENGTH
1.4669   43.4 0.550   1.207   8.83   11.54   80   727.0 11709.   142.18     4.77

STAGE     2
 DISK    BLADE   VANE    HWD     CASE    AR
   6.9    27.6    81.4    34.0     9.3   3.00
  PR   DEL H   MACH   AREA   R HUB   R TIP   NB   U TIP    STR    WEIGHT   LENGTH
1.5156   43.4 0.575   1.652   8.83   12.39   98   780.6 16019.   159.21     4.17

FRAME WT  =  167.79


 N STG   LENGTH   WEIGHT
    2     13.41   469.18

DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.600 1154.  1722.    5594.    4436.     2.3313   1.3249

  PR       TR      AD EF     PO       TO      TO.1
 2.2236   1.1779   0.8600  5593.7   1721.5   1721.5
 H IN     H OUT     AREA    FLOW      HP
 524.77   437.87    16.80   137.56   16912.
```

```
****************** TOTAL TURB WEIGHT IS   469.184


************
*          *
*  AUG  10 *
*          *
************2
BURNER NUMBER    10
  RIN     ROUT      LENGTH      MACH      WSPEC
   0.0     24.120    48.000      0.143    11.899
  CAS WT   LIN WT    NOZ WT    INC WT     WTOT
    23.7     120.0     296.1       0.0     439.8

************
*          *
*  NOZ  11 *
*          *
************2
NOZZLE   11
WEIGHT=    568.95 LENGTH=    48.239 TR WT=     0.0


************
*          *
*  DUCT  4 *
*          *
************2
DUCT ,    4
RH=    15.78 RT=    17.69 LENG=    62.16
AREA=    1.401 RHO=.168
       CAS WT        INC WT        WTOT
     15.5408       13.8556       29.3964



************
*          *
*  SHAF 12 *
*          *
************2
SHAFT  12
   DO      DI    LENG      DN      WT
  3.54    3.01   48.74    0.65   40.03



************
*          *
*  SHAF 13 *
*          *
************2
SHAFT  13
   DO      DI    LENG      DN      WT
  4.35    3.94   18.00    1.27   14.33

************
*          *
*  ACCS WT *
*          *
************2

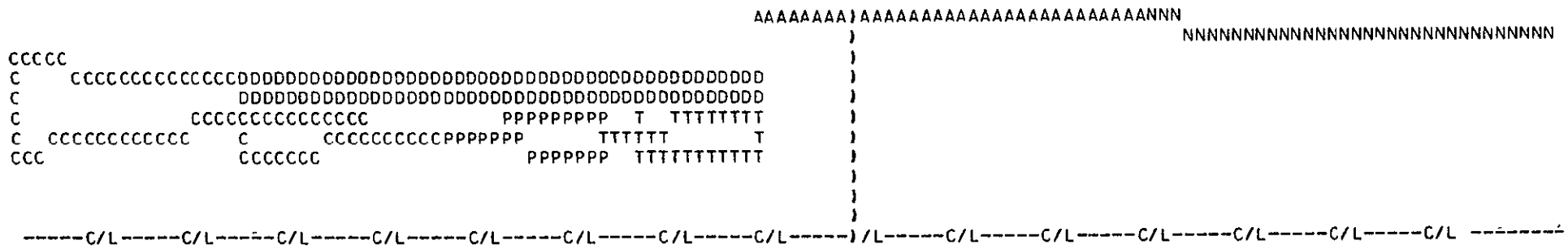
   ACCS WT= 301.414
```

WEIGHT INPUT DATA IN ENGL UNITS
WEIGHT OUTPUT DATA IN ENGL UNITS

COMP NO	WT EST	COMP LEN	ACCU LEN	UPSTREAM RADIUS RI	UPSTREAM RADIUS RO	RI	RO	DOWNSTREAM RADIUS RI	DOWNSTREAM RADIUS RO	RI	RO	NSTAGE
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0
2	1132.	29.	29.	9.	20.	0.	0.	13.	18.	0.	0.	3
3	0.	0.	29.	0.	0.	0.	0.	13.	16.	16.	18.	0
4	32.	62.	91.	16.	18.	0.	0.	16.	18.	0.	0.	0
5	678.	25.	54.	9.	13.	0.	0.	11.	11.	0.	0.	10
6	275.	18.	72.	9.	13.	0.	0.	9.	13.	0.	0.	0
7	139.	5.	78.	10.	11.	0.	0.	10.	13.	0.	0.	2
8	516.	13.	91.	9.	12.	0.	0.	9.	14.	0.	0.	2
9	0.	0.	91.	4.	16.	16.	21.	4.	21.	0.	0.	0
10	484.	48.	139.	0.	24.	0.	0.	0.	24.	0.	0.	0
11	626.	48.	187.	0.	24.	0.	0.	0.	22.	0.	0.	0
12	44.	0.	0.	9.	20.	10.	11.	0.	0.	0.	0.	0
13	16.	0.	0.	9.	13.	0.	0.	0.	0.	0.	0.	0

TOTAL BARE ENGINE WEIGHT= 3941. ACCESSORIES= 301.41

ESTIMATED TOTAL LENGTH= 187. ESTIMATED MAXIMUM RADIUS= 24.



UPDATED INPUT DATA TO REFLECT CALCULATED INPUT

COMPONENT

NO.	TYPE	DATINP1	DATINP2	DATINP3	DATINP4	DATINP5	DATINP6	DATINP7	DATINP8	DATINP9
1	INLET	0.23850D 03	0.0	0.14696D 02	0.0	0.0	0.90000D 00	0.0	0.0	0.0
2	COMPRESR	0.18000D 01	0.0	0.40000D 04	0.37610D 04	0.26590D 03	0.37620D 04	0.10113D 01	0.37630D 04	0.99222D 00
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	0.13000D 01	0.26000D-01	0.51455D 04	0.37070D 04	0.61418D 02	0.37080D 04	0.90909D 00	0.37090D 04	0.13246D 01
6	DUCT B	0.10000D 00	0.0	0.0	0.26500D 04	0.94000D 00	0.18300D 05	0.0	0.0	0.0
7	TURBINE	0.40000D 01	0.10000D 01	0.46733D 00	0.38010D 04	0.70645D 00	0.38020D 04	0.96727D 00	0.90244D 00	0.10000D 01
8	TURBINE	0.25000D 01	0.0	0.38577D 00	0.38030D 04	0.72633D 00	0.38040D 04	0.94012D 00	0.81558D 00	0.10000D 01
9	MIXER	0.70773D 03	0.63925D 03	0.24000D 00	0.0	0.0	0.0	0.0	0.0	0.0
10	DUCT B	0.60000D-01	0.0	0.0	0.0	0.90000D 00	0.18300D 05	0.0	0.0	0.0
11	NOZZLE	0.47288D 03	0.10000D 01	0.0	0.0	0.98000D 00	0.10000D 01	0.0	0.0	0.10000D 01
12	SHAFT	0.40000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
13	SHAFT	0.60000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01

CASE IDENTIFICATION SIMPLE MODEL

STATION PROPERTY OUTPUT DATA

FLOW STATION	WEIGHT FLOW STATP1	TOTAL PRESSURE STATP2	TOTAL TEMPERATURE STATP3	FUEL/AIR RATIO STATP4	REFERRED FLOW STATP5	MACH NUMBER STATP6	STATIC PRESSURE STATP7	INTERFACE CORRECTED FLOW ERROR STATP8
1	0.23850D 03	0.14696D 02	0.51867D 03	0.0	0.23850D 03	0.0	0.0	0.0
2	0.23850D 03	0.13226D 02	0.51867D 03	0.0	0.26499D 03	0.0	0.0	0.0
4	0.23850D 03	0.37828D 02	0.72687D 03	0.0	0.10969D 03	0.0	0.0	0.0
5	0.13475D 03	0.37828D 02	0.72687D 03	0.0	0.61970D 02	0.0	0.0	0.0
6	0.13124D 03	0.35581D 03	0.14356D 04	0.0	0.90183D 01	0.0	0.0	0.0
7	0.35034D 01	0.35581D 03	0.14356D 04	0.0	0.0	0.0	0.0	0.0
8	0.13405D 03	0.32022D 03	0.26500D 04	0.21425D-01	0.13906D 02	0.0	0.0	0.0
9	0.13756D 03	0.86376D 02	0.20278D 04	0.20868D-01	0.46276D 02	0.0	0.0	0.0
10	0.13756D 03	0.38849D 02	0.17216D 04	0.20868D-01	0.94801D 02	0.24000D 00	0.37401D 02	0.0
11	0.10375D 03	0.37828D 02	0.72687D 03	0.0	0.47717D 02	0.0	0.0	0.0
12	0.24131D 03	0.37401D 02	0.13157D 04	0.11790D-01	0.15101D 03	0.0	0.0	0.0
13	0.24131D 03	0.35157D 02	0.13157D 04	0.11790D-01	0.16065D 03	0.10000D 01	0.18780D 02	0.0
14	0.24131D 03	0.35157D 02	0.13157D 04	0.11790D-01	0.16065D 03	0.11729D 01	0.14696D 02	0.0
15	0.10375D 03	0.37828D 02	0.72687D 03	0.0	0.47717D 02	0.12734D 00	0.37401D 02	0.0

COMPONENT OUTPUT DATA

COMPONENT NO.	TYPE	DATOUT1	DATOUT2	DATOUT3	DATOUT4	DATOUT5	DATOUT6	DATOUT7	DATOUT8	DATOUT9
1	INLET	0.0	0.0	0.0	0.10000D 01	0.10000D 01	0.0	0.90000D 00	0.10000D 01	0.0
2	COMPRESR	-0.16912D 05	0.40000D 04	0.0	0.18000D 01	0.40000D 04	0.10000D 01	0.26590D 03	0.87000D 00	0.28600D 01
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	-0.33969D 05	0.60000D 04	0.0	0.13000D 01	0.51455D 04	0.98500D 00	0.61418D 02	0.87000D 00	0.94060D 01
6	DUCT B	0.0	0.10000D 00	0.0	0.21425D-01	0.0	0.10123D 05	0.0	0.94000D 00	0.26500D 04
7	TURBINE	0.33969D 05	0.60000D 04	0.10000D 01	0.40000D 01	0.46733D 00	0.56800D 04	0.70645D 00	0.86000D 00	0.37073D 01
8	TURBINE	0.16912D 05	0.40000D 04	0.10000D 01	0.25000D 01	0.38577D 00	0.52440D 04	0.72633D 00	0.86000D 00	0.22234D 01
9	MIXER	0.70773D 03	0.63925D 03	0.10387D 01	0.10114D 01	0.47274D 03	0.16773D 03	0.0	0.94990D-16	0.10000D 01
10	DUCT B	0.0	0.60000D-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	NOZZLE	0.13785D 05	0.18379D 04	0.23923D 01	0.48393D 03	0.47288D 03	0.10000D 01	0.98000D 00	0.18721D 01	0.23923D 01
12	SHAFT	0.0	0.40000D 04	0.40000D 04	0.40000D 04	0.0	0.0	0.0	0.0	0.0
13	SHAFT	0.0	0.60000D 04	0.60000D 04	0.60000D 04	0.0	0.0	0.0	0.0	0.0

MACH= 0.0 ALTITUDE= 0. RECOVERY= 0.9000 0 ITERATIONS 2 PASSES

AIRFLOW (LB/SEC)	238.50	GROSS THRUST	13785.01	FUEL FLOW (LB/HR)	10122.81
NET THRUST	13785.01	TSFC	0.7343	NET THRUST/AIRFLOW	57.7988
TOTAL INLET DRAG	0.0	TOTAL BRAKE SHAFT HP	0.0	BOATTAIL DRAG	0.0
INSTALLED THRUST	13785.01	INSTALLED TSFC	0.7343	SPILLAGE + LIP DRAG	0.0

SIMPLE MODEL
&D LONG=F,DRAW=F,BOAT=T,SPILL=T,AMINDS=1.6 &END

TABLE DATA INPUT SUMMARY 16 TABLES

TABLE NUMBER	REFERENCE NUMBER	ARRAY LOCATION
1	3761	1
2	3762	1075
3	3763	2149
4	3704	3223
5	3705	4297
6	3706	5371
7	3707	6445
8	3708	7681
9	3709	8917
10	3801	10153
11	3802	10606
12	3803	11203
13	3804	11656
14	3901	12397
15	3902	12799
16	3903	13213

DATA STORAGE ALLOCATION 20000
DATA STORAGE NOT USED 6385

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&D MODE=1,
IWT=T,
KONFIG(1,1)='INLT',1,0,2,0,SPEC(1,1)=238.5,4*0,0.9,
KONFIG(1,2)='COMP',2,0,4,0,SPEC(1,2)=1.8,0,1,3761,1,3762,1,3763,1,0,0,.87,2.86,
1,
KONFIG(1,4)='DUCT',11,0,15,0,SPEC(1,4)=6*0,
KONFIG(1,3)='SPLT',4,0,5,11,SPEC(1,3)=.77,
KONFIG(1,5)='COMP',5,0,6,7,SPEC(1,5)=1.3,.026,1,3707,1,3708,1,3709,1,0,0,.87,
9.406,.985,
KONFIG(1,6)='DUCT',6,0,8,0,SPEC(1,6)=.10,0,0,2650,.94,18300,
KONFIG(1,7)='TURB',8,7,9,0,SPEC(1,7)=4,1,1,3801,1,3802,1,1,1,1,.86,5680,1,
KONFIG(1,8)='TURB',9,0,10,0,SPEC(1,8)=2.5,0,1,3803,1,3804,1,1,1,1,.86,5244,1,
KONFIG(1,9)='MIXR',10,15,12,0,SPEC(1,9)=0,0,.24,
KONFIG(1,10)='DUCT',12,0,13,0,SPEC(1,10)=.06,3*0,.90,18300,
KONFIG(1,11)='NOZZ',13,0,14,0,SPEC(1,11)=0,1,0,0,.98,1,0,0,1,
KONFIG(1,12)='SHFT',2,8,0,0,SPEC(1,12)=4000,8*1,
KONFIG(1,13)='SHFT',5,7,0,0,SPEC(1,13)=6000,8*1,
KONFIG(1,14)='CNTL',SPCNTL(1,14)=1,8,'STAP',8,13,0,1,
KONFIG(1,15)='CNTL',SPCNTL(1,15)=1,7,'STAP',8,9,0,1,
KONFIG(1,16)='CNTL',SPCNTL(1,16)=1,5,'STAP',8,8,0,1,
KONFIG(1,17)='CNTL',SPCNTL(1,17)=1,3,'DOUT',8,9,0,1,
KONFIG(1,18)='CNTL',SPCNTL(1,18)=1,2,'STAP',8,5,0,1,
KONFIG(1,19)='CNTL',SPCNTL(1,19)=1,1,'STAP',8,2,0,1,
KONFIG(1,20)='CNTL',SPCNTL(1,20)=1,12,'DOUT',8,12,0,1,
KONFIG(1,21)='CNTL',SPCNTL(1,21)=1,13,'DOUT',8,13,0,1,
&END

 THE FOLLOWING REPRESENTS THE CONFIGURATION FOR MODE=   1
 SIMPLE MODEL
         CONFIGURATION DATA   15 STATIONS   21 COMPONENTS

  COMPONENT  NKIND COMPONENT      UPSTREAM        DOWNSTREAM
    NUMBER            TYPE       STATIONS         STATIONS
```

1	1	INLET	1	0	2	0
2	4	COMPRESR	2	0	4	0
3	7	SPLITTER	4	0	5	11
4	2	DUCT B	11	0	15	0
5	4	COMPRESR	5	0	6	7
6	2	DUCT B	6	0	8	0
7	5	TURBINE	8	7	9	0
8	5	TURBINE	9	0	10	0
9	8	MIXER	10	15	12	0
10	2	DUCT B	12	0	13	0
11	9	NOZZLE	13	0	14	0
12	11	SHAFT	2	8	0	0
13	11	SHAFT	5	7	0	0
14	12	CONTROL	13	0	8	0
15	12	CONTROL	9	0	7	0
16	12	CONTROL	8	0	5	0
17	12	CONTROL	9	0	3	0
18	12	CONTROL	5	0	2	0
19	12	CONTROL	2	0	1	0
20	12	CONTROL	12	0	12	0
21	12	CONTROL	13	0	13	0

CONTROL INFORMATION

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14        VARY DATINP  1 OF COMPONENT  8 SO THAT STATP  8 OF FLOW STATION 13 EQUALS  0.0
15        VARY DATINP  1 OF COMPONENT  7 SO THAT STATP  8 OF FLOW STATION  9 EQUALS  0.0
16        VARY DATINP  1 OF COMPONENT  5 SO THAT STATP  8 OF FLOW STATION  8 EQUALS  0.0
17        VARY DATINP  1 OF COMPONENT  3 SO THAT DATOUT 8 OF COMPONENT  9 EQUALS  0.0
18        VARY DATINP  1 OF COMPONENT  2 SO THAT STATP  8 OF FLOW STATION  5 EQUALS  0.0
19        VARY DATINP  1 OF COMPONENT  1 SO THAT STATP  8 OF FLOW STATION  2 EQUALS  0.0
20        VARY DATINP  1 OF COMPONENT 12 SO THAT DATOUT 8 OF COMPONENT 12 EQUALS  0.0
21        VARY DATINP  1 OF COMPONENT 13 SO THAT DATOUT 8 OF COMPONENT 13 EQUALS  0.0

CASE IDENTIFICATION    SIMPLE MODEL
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INPUT DATA

COMPONENT NO.	TYPE	DATINP1	DATINP2	DATINP3	DATINP4	DATINP5	DATINP6	DATINP7	DATINP8	DATINP9
1	INLET	0.23850D 03	0.0	0.0	0.0	0.0	0.90000D 00	0.0	0.0	0.0
2	COMPRESR	0.18000D 01	0.0	0.10000D 01	0.37610D 04	0.10000D 01	0.37620D 04	0.10000D 01	0.37630D 04	0.10000D 01
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT 8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	0.13000D 01	0.26000D-01	0.10000D 01	0.37070D 04	0.10000D 01	0.37080D 04	0.10000D 01	0.37090D 04	0.10000D 01
6	DUCT 8	0.10000D 00	0.0	0.0	0.26500D 04	0.94000D 00	0.18300D 05	0.0	0.0	0.0
7	TURBINE	0.40000D 01	0.10000D 01	0.10000D 01	0.38010D 04	0.10000D 01	0.38020D 04	0.10000D 01	0.10000D 01	0.10000D 01
8	TURBINE	0.25000D 01	0.0	0.10000D 01	0.38030D 04	0.10000D 01	0.38040D 04	0.10000D 01	0.10000D 01	0.10000D 01
9	MIXER	0.0	0.0	0.24000D 00	0.0	0.0	0.0	0.0	0.0	0.0
10	DUCT 8	0.60000D-01	0.0	0.0	0.0	0.90000D 00	0.18300D 05	0.0	0.0	0.0
11	NOZZLE	0.0	0.10000D 01	0.0	0.0	0.98000D 00	0.10000D 01	0.0	0.0	0.10000D 01
12	SHAFT	0.40000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
13	SHAFT	0.60000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
14	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
15	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
16	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
17	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
18	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
19	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
20	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
21	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01

```
MODE     1 NOW BEING USED
&W
IPLT=T,
ISII=F,
ISIO=F,
IOUTCD=2,
ILENG(1)=2,3,5,6,7,8,9,10,11,
IWMEC(1,2)='FAN ',0,2,4,
IWMEC(1,3)='SPLT',6*0,
IWMEC(1,4)='DUCT',3,5*0,
IWMEC(1,5)='HPC ',1,0,0,
IWMEC(1,6)='PBUR',0,5*0,
IWMEC(1,7)='HPT ',0,5, 0,3*0,
IWMEC(1,8)='LPT ',1,2,7,3*0,
IWMEC(1,9)='FMIX',6*0,
IWMEC(1,10)='DBUR',6*0,
IWMEC(1,11)='NOZ ',1,5*0,
IWMEC(1,12)='SHAF',1,8,3*0,2,
IWMEC(1,13)='SHAF',2,7,3*0,5,
DESVAL(1,2)=.524,1.7,.45,1.5,3.5,2.5,.45,0.,0.,1.1,.1,1.,1.,0.,0.,
DESVAL(1,3)=15*0.,
DESVAL(1,4)=.45,2*0.,-1.,11*0.,
DESVAL(1,5)=.45,1.35,.70,1.2,2.,1.5,.3,900.,1400.,1.,0.,3.,1.1,1200.,0.,
DESVAL(1,6)=100.,.015,20.,12*0.,
DESVAL(1,7)=.5,.28,1.5,1.5,1.5,.55,150000.,1.,1.,6*0.,
DESVAL(1,8)=.55,.243,1.5,2.,3.,.6,150000.,2.,1.,6*0.,
DESVAL(1,9)=7*0.,1.1,
DESVAL(1,10)=250.,.016,13*0.,
DESVAL(1,11)=1.,14*0.,
DESVAL(1,12)=50000.,.3,.85,12*0.,
DESVAL(1,13)=50000.,.3,13*0.,
&END

************
*          *
*  FAN   2 *
*          *
************2
DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.524   570.   519.    1905.    1579.     6.9517  1.4005

  U TIP   STRESS      DEN   W/AREA    TR      H/T
 1258.9 15927.2    0.100    1.393    1.800    0.450

 COMPRESSOR  2 MECHANICAL DESIGN

 LOADING    N STG    DIAM   U TIP C     RPM    C RPM
  0.874      3.00    39.98   1258.9   7216.9   7216.9

FRAME WT  =  236.83
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```
STAGE    1
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 48.   35.    0.    0.   11.    3.1 0.100 0.168  3.50
  PR   DEL H  MACH   AREA  R HUB  R TIP   NB U TIP    STR    WEIGHT TIN
1.4789  16.7 0.524  6.952  8.99  19.99  59 1258.9 19272.    95.  519.

STAGE    2
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 38.   24.    0.   24.    9.    2.9 0.100 0.168  3.00
  PR   DEL H  MACH   AREA  R HUB  R TIP   NB U TIP    STR    WEIGHT TIN
1.4155  16.7 0.499  5.180  8.99  17.84  57 1123.7 14439.    95.  588.

STAGE    3
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 31.   18.    0.   24.    9.    2.9 0.100 0.168  2.50
  PR   DEL H  MACH   AREA  R HUB  R TIP   NB U TIP    STR    WEIGHT TIN
1.3671  16.7 0.475  4.017  8.99  16.28  52 1025.3 11248.    81.  658.

FRAME WT  =  207.45


 N STG  WEIGHT  LENGTH
    3   715.32   13.51

DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.450  582.  727.   5447.   4743.    3.2206  1.3951

  PR    AD EF     PO     TO     HP
 2.8600  0.8700  5447.2   726.9  16910.
  HI      HO      WI     CWI
 123.95  174.07  238.50  265.00

******************** TOTAL COMP WEIGHT IS   715.323

************
*          *
*  HPC   5 *
*          *
************2
DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.450  582.  727.   5447.   4743.    1.8196  1.3951

  U TIP  STRESS     DEN  W/AREA   TR     H/T
 1413.6 28231.1   0.168   0.687   1.200   0.700

 COMPRESSOR  5 MECHANICAL DESIGN

 LOADING   N STG   DIAM  U TIP C    RPM   C RPM
   0.538   10.00   25.58  1194.1 12667.1 10700.2
```

STAGE 1

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
31.	14.	14.	36.	10.	4.5	0.168	0.168	2.00

PR	DEL H	MACH	AREA	R HUB	R TIP	NB U TIP	STR	WEIGHT TIN	
1.3603	17.8	0.450	1.820	8.95	12.79	50 1413.6	28231.	106.	727.

STAGE 2

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
32.	8.	8.	28.	8.	3.5	0.168	0.168	1.94

PR	DEL H	MACH	AREA	R HUB	R TIP	NB U TIP	STR	WEIGHT TIN	
1.3241	17.8	0.435	1.442	9.87	12.79	64 1413.6	22411.	85.	800.

STAGE 3

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
28.	6.	6.	23.	7.	2.9	0.168	0.168	1.89

PR	DEL H	MACH	AREA	R HUB	R TIP	NB U TIP	STR	WEIGHT TIN	
1.2948	17.8	0.420	1.171	10.48	12.79	78 1413.6	18215.	70.	873.

STAGE 4

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
24.	4.	4.	19.	6.	2.4	0.168	0.168	1.83

PR	DEL H	MACH	AREA	R HUB	R TIP	NB U TIP	STR	WEIGHT TIN	
1.2704	17.8	0.405	0.970	10.91	12.79	94 1413.6	15103.	58.	946.

STAGE 5

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
21.	3.	3.	17.	5.	2.1	0.168	0.168	1.78

PR	DEL H	MACH	AREA	R HUB	R TIP	NB U TIP	STR	WEIGHT TIN	
1.2499	17.8	0.390	0.818	11.23	12.79	109 1413.6	12743.	49.	1017.

STAGE 6

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
18.	3.	3.	15.	4.	1.8	0.168	0.168	1.72

PR	DEL H	MACH	AREA	R HUB	R TIP	NB U TIP	STR	WEIGHT TIN	
1.2324	17.8	0.375	0.701	11.46	12.79	125 1413.6	10916.	42.	1089.

STAGE 7

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
16.	2.	2.	13.	4.	1.6	0.168	0.168	1.67

PR	DEL H	MACH	AREA	R HUB	R TIP	NB U TIP	STR	WEIGHT TIN	
1.2173	17.8	0.360	0.608	11.65	12.79	140 1413.6	9476.	36.	1159.

STAGE 8

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
28.	3.	3.	12.	3.	1.4	0.286	0.286	1.61

PR	DEL H	MACH	AREA	R HUB	R TIP	NB U TIP	STR	WEIGHT TIN	
1.2042	17.8	0.345	0.534	11.79	12.79	155 1413.6	14176.	48.	1229.

STAGE 9

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
25.	2.	2.	11.	3.	1.3	0.286	0.286	1.56

PR	DEL H	MACH	AREA	R HUB	R TIP	NB U TIP	STR	WEIGHT TIN	
1.1926	17.8	0.330	0.475	11.91	12.79	170 1413.6	12596.	43.	1299.

STAGE 10

WD	WB	WS	WN	WC	CL	RHOB	RHOD	AR
23.	2.	2.	10.	3.	1.2	0.286	0.286	1.50

PR	DEL H	MACH	AREA	R HUB	R TIP	NB U TIP	STR	WEIGHT TIN	
1.1824	17.8	0.315	0.426	12.00	12.79	183 1413.6	11308.	40.	1367.

```
 N STG  WEIGHT  LENGTH
   10   576.84   22.71

DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.300  544. 1436.  51236.  48231.    0.3874  1.3539

  PR     AD EF      PO      TO      HP
 9.4060  0.8700 51235.9  1435.6  33965.
  HI       HO      WI      CWI
 174.07  352.23  134.75   61.97

******************** TOTAL COMP WEIGHT IS   576.837

*************
*           *
*  PBUR  6  *
*           *
*************2
BURNER NUMBER     6
  RIN     ROUT      LENGTH      MACH      WSPEC
  18.842   21.094    18.000     0.055     4.596
  CAS WT   LIN WT   NOZ WT    INC WT     FRAME     WTOT
    64.7     74.5     17.8      57.8       0.0     214.9



*************
*           *
*  HPT   7  *
*           *
*************2
DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.500 1186. 2621.  46112.  39327.    0.3977  1.2968

  U TIP  STRESS     DEN  W/AREA   TR      H/T
 1564.2 11881.4   0.286   0.189   1.000   0.953

 TURBINE  7  MECHANICAL DESIGN
    H/T    N STG LOADING     AREA
  0.953    1.000   0.280    0.398
     UT     RTIP    RHUB    DEL H      RPM     TORQ
 1564.2     14.2    13.5    174.5 12667.1 169012.

STAGE    1
 DISK    BLADE  VANE   HWD    CASE   AR
  18.3     1.7    6.4   29.4     3.9  1.50
  PR   DEL H  MACH  AREA  R HUB  R TIP  NB  U TIP   STR   WEIGHT  LENGTH
3.6978 174.5 0.500  0.398 13.49  14.15 303 1564.2 11881.   59.66    1.54

 N STG  LENGTH  WEIGHT
    1     1.54   59.66

DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.550 1149. 2028.  12436.  10243.    1.2074  1.3127

  PR       TR      AD EF     PO       TO      TO.1
 3.7081  1.2928  0.8600 12435.6  2027.7  2027.7
 H IN     H OUT     AREA    FLOW      HP
 699.28  524.74     5.17   137.56  33969.
```

```
****************** TOTAL TURB WEIGHT IS    59.662


************
*          *
*  LPT   8 *
*          *
***********2
DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.550 1149. 2028.  12438.  10245.    1.2072  1.3127

  U TIP  STRESS     DEN  W/AREA   TR      H/T
  727.0 11708.5   0.286   0.777   1.000   0.765

 TURBINE  8  MECHANICAL DESIGN
    H/T   N STG LOADING    AREA
  0.765   2.000   0.243   1.207
     UT    RTIP    RHUB   DEL H     RPM    TORQ
  727.0    11.5     8.8    86.9  7216.9 147693.

STAGE    1
 DISK   BLADE  VANE   HWD    CASE   AR
   5.0   22.4   66.0   38.9    9.9  2.00
  PR  DEL H  MACH  AREA  R HUB  R TIP  NB  U TIP   STR   WEIGHT  LENGTH
1.4669  43.4 0.550  1.207  8.83  11.54  80  727.0 11709.  142.18    4.77

STAGE    2
 DISK   BLADE  VANE   HWD    CASE   AR
   5.6   29.3   86.6   31.1    9.4  3.00
  PR  DEL H  MACH  AREA  R HUB  R TIP  NB  U TIP   STR   WEIGHT  LENGTH
1.5156  43.4 0.575  1.652  8.23  11.98  90  754.3 16019.  162.04    4.38

FRAME WT  =  144.40


 N STG  LENGTH  WEIGHT
    2    13.73  448.62

DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.600 1154. 1722.   5594.   4436.    2.3313  1.3249

  PR      TR     AD EF    PO      TO     TO.1
 2.2236  1.1779  0.8600  5593.7  1721.5  1721.5
 H IN    H OUT    AREA   FLOW     HP
 524.77  437.87   16.80  137.56  16912.

****************** TOTAL TURB WEIGHT IS   448.624


************
*          *
*  FMIX  9 *
*          *
***********2
LENGTH=  29.28 WEIGHT =  218.11
```

```
**********
*        *
*  DBUR 10  *
*        *
**********2
BURNER NUMBER    10
  RIN     ROUT      LENGTH      MACH      WSPEC
   0.0     24.120    48.000     0.143    11.899
  CAS WT    LIN WT    NOZ WT    INC WT    WTOT
    23.7     120.0     296.1       0.0     439.8

**********
*        *
*  NOZ  11  *
*        *
**********2
NOZZLE   11
WEIGHT=    206.89 LENGTH=    48.239 TR WT=     0.0


**********
*        *
*  DUCT  4  *
*        *
**********2
DUCT ,   4
RH=    12.76 RT=    15.07 LENG=    55.98
APEA=    1.401 RHO=.168
       CAS WT       INC WT       WTOT
     10.1546        8.6000       18.7546


**********
*        *
*  SHAF 12  *
*        *
**********2
SHAFT  12
   DO      DI    LENG      DN      WT
  3.54    3.01   42.26    0.65   34.71


**********
*        *
*  SHAF 13  *
*        *
**********2
SHAFT  13
   DO      DI    LENG      DN      WT
  4.32    3.94   18.00    1.39   13.04


**********
*        *
*  ACCS WT  *
*        *
**********2

  ACCS WT= 273.972
```

WEIGHT INPUT DATA IN ENGL UNITS
WEIGHT OUTPUT DATA IN ENGL UNITS

COMP NO	WT EST	COMP LEN	ACCU LEN	UPSTREAM RADIUS RI	UPSTREAM RADIUS RO			DOWNSTREAM RADIUS RI	DOWNSTREAM RADIUS RO			NSTAGE
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0
2	715.	14.	14.	9.	20.	0.	0.	9.	15.	0.	0.	3
3	0.	0.	14.	0.	0.	0.	0.	9.	13.	13.	15.	0
4	19.	56.	69.	13.	15.	0.	0.	13.	15.	0.	0.	0
5	577.	23.	36.	9.	13.	0.	0.	12.	13.	0.	0.	10
6	215.	18.	54.	19.	21.	0.	0.	19.	21.	0.	0.	0
7	60.	2.	56.	13.	14.	0.	0.	12.	14.	0.	0.	1
8	449.	14.	69.	9.	12.	0.	0.	7.	13.	0.	0.	2
9	218.	29.	99.	0.	15.	15.	21.	0.	21.	0.	0.	0
10	440.	48.	147.	0.	24.	0.	0.	0.	24.	0.	0.	0
11	207.	48.	195.	0.	24.	0.	0.	0.	22.	0.	0.	0
12	35.	0.	0.	9.	20.	13.	14.	0.	0.	0.	0.	0
13	13.	0.	0.	9.	13.	0.	0.	0.	0.	0.	0.	0

TOTAL BARE ENGINE WEIGHT= 2947. ACCESSORIES= 273.97

ESTIMATED TOTAL LENGTH= 195. ESTIMATED MAXIMUM RADIUS= 24.

UPDATED INPUT DATA TO REFLECT CALCULATED INPUT

COMPONENT

NO.	TYPE	DATINP1	DATINP2	DATINP3	DATINP4	DATINP5	DATINP6	DATINP7	DATINP8	DATINP9
1	INLET	0.23850D 03	0.0	0.14696D 02	0.0	0.0	0.90000D 00	0.0	0.0	0.0
2	COMPRESR	0.18000D 01	0.0	0.40000D 04	0.37610D 04	0.26590D 03	0.37620D 04	0.10113D 01	0.37630D 04	0.99222D 00
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	0.13000D 01	0.26000D-01	0.51455D 04	0.37070D 04	0.61418D 02	0.37080D 04	0.90909D 00	0.37090D 04	0.13246D 01
6	DUCT B	0.10000D 00	0.0	0.0	0.26500D 04	0.94000D 00	0.18300D 05	0.0	0.0	0.0
7	TURBINE	0.40000D 01	0.10000D 01	0.46733D 00	0.38010D 04	0.70645D 00	0.38020D 04	0.96727D 00	0.90244D 00	0.10000D 01
8	TURBINE	0.25000D 01	0.0	0.38577D 00	0.38030D 04	0.72633D 00	0.38040D 04	0.94012D 00	0.81558D 00	0.10000D 01
9	MIXER	0.70773D 03	0.63925D 03	0.24000D 00	0.0	0.0	0.0	0.0	0.0	0.0
10	DUCT B	0.60000D-01	0.0	0.0	0.0	0.90000D 00	0.18300D 05	0.0	0.0	0.0
11	NOZZLE	0.47288D 03	0.10000D 01	0.0	0.0	0.98000D 00	0.10000D 01	0.0	0.0	0.10000D 01
12	SHAFT	0.40000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
13	SHAFT	0.60000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01

CASE IDENTIFICATION SIMPLE MODEL

STATION PROPERTY OUTPUT DATA

FLOW STATION	WEIGHT FLOW STATP1	TOTAL PRESSURE STATP2	TOTAL TEMPERATURE STATP3	FUEL/AIR RATIO STATP4	REFERRED FLOW STATP5	MACH NUMBER STATP6	STATIC PRESSURE STATP7	INTERFACE CORRECTED FLOW ERROR STATP8
1	0.23850D 03	0.14696D 02	0.51867D 03	0.0	0.23850D 03	0.0	0.0	0.0
2	0.23850D 03	0.13226D 02	0.51867D 03	0.0	0.26499D 03	0.0	0.0	0.0
4	0.23850D 03	0.37828D 02	0.72687D 03	0.0	0.10969D 03	0.0	0.0	0.0
5	0.13475D 03	0.37828D 02	0.72687D 03	0.0	0.61970D 02	0.0	0.0	0.0
6	0.13124D 03	0.35581D 03	0.14356D 04	0.0	0.90183D 01	0.0	0.0	0.0
7	0.35034D 01	0.35581D 03	0.14356D 04	0.0	0.0	0.0	0.0	0.0
8	0.13405D 03	0.32022D 03	0.26500D 04	0.21425D-01	0.13906D 02	0.0	0.0	0.0
9	0.13756D 03	0.86376D 02	0.20278D 04	0.20868D-01	0.46276D 02	0.0	0.0	0.0
10	0.13756D 03	0.38849D 02	0.17216D 04	0.20868D-01	0.94801D 02	0.24000D 00	0.37401D 02	0.0
11	0.10375D 03	0.37828D 02	0.72687D 03	0.0	0.47717D 02	0.0	0.0	0.0
12	0.24131D 03	0.37401D 02	0.13157D 04	0.11790D-01	0.15101D 03	0.0	0.0	0.0
13	0.24131D 03	0.35157D 02	0.13157D 04	0.11790D-01	0.16065D 03	0.10000D 01	0.18780D 02	0.0
14	0.24131D 03	0.35157D 02	0.13157D 04	0.11790D-01	0.16065D 03	0.11729D 01	0.14696D 02	0.0
15	0.10375D 03	0.37828D 02	0.72687D 03	0.0	0.47717D 02	0.12734D 00	0.37401D 02	0.0

COMPONENT OUTPUT DATA

COMPONENT NO.	TYPE	DATOUT1	DATOUT2	DATOUT3	DATOUT4	DATOUT5	DATOUT6	DATOUT7	DATOUT8	DATOUT9
1	INLET	0.0	0.0	0.0	0.10000D 01	0.10000D 01	0.0	0.90000D 00	0.10000D 01	0.0
2	COMPRESR	-0.16912D 05	0.40000D 04	0.0	0.18000D 01	0.40000D 04	0.10000D 01	0.26590D 03	0.87000D 00	0.28600D 01
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT 8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	-0.33969D 05	0.60000D 04	0.0	0.13000D 01	0.51455D 04	0.98500D 00	0.61418D 02	0.87000D 00	0.94060D 01
6	DUCT 8	0.0	0.10000D 00	0.0	0.21425D-01	0.0	0.10123D 05	0.0	0.94000D 00	0.26500D 04
7	TURBINE	0.33969D 05	0.60000D 04	0.10000D 01	0.40000D 01	0.46733D 00	0.56800D 04	0.70645D 00	0.86000D 00	0.37073D 01
8	TURBINE	0.16912D 05	0.40000D 04	0.10000D 01	0.25000D 01	0.38577D 00	0.52440D 04	0.72633D 00	0.86000D 00	0.22234D 01
9	MIXER	0.70773D 03	0.63925D 03	0.10387D 01	0.10114D 01	0.47274D 03	0.16773D 03	0.0	0.94990D-16	0.10000D 01
10	DUCT 8	0.0	0.60000D-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	NOZZLE	0.13785D 05	0.18379D 04	0.23923D 01	0.48393D 03	0.47288D 03	0.10000D 01	0.98000D 00	0.18721D 01	0.23923D 01
12	SHAFT	0.0	0.40000D 04	0.40000D 04	0.40000D 04	0.0	0.0	0.0	0.0	0.0
13	SHAFT	0.0	0.60000D 04	0.60000D 04	0.60000D 04	0.0	0.0	0.0	0.0	0.0

MACH= 0.0 ALTITUDE= 0. RECOVERY= 0.9000 0 ITERATIONS 2 PASSES

AIRFLOW (LB/SEC)	238.50	GROSS THRUST	13785.01	FUEL FLOW (LB/HR)	10122.81
NET THRUST	13785.01	TSFC	0.7343	NET THRUST/AIRFLOW	57.7988
TOTAL INLET DRAG	0.0	TOTAL BRAKE SHAFT HP	0.0	BOATTAIL DRAG	0.0
INSTALLED THRUST	13785.01	INSTALLED TSFC	0.7343	SPILLAGE + LIP DRAG	0.0

SIMPLE MODEL
&D LONG=F,DRAW=F,BOAT=T,SPILL=T,AMINDS=1.6 &END

TABLE DATA INPUT SUMMARY 16 TABLES

TABLE NUMBER	REFERENCE NUMBER	ARRAY LOCATION
1	3761	1
2	3762	1075
3	3763	2149
4	3704	3223
5	3705	4297
6	3706	5371
7	3707	6445
8	3708	7681
9	3709	8917
10	3801	10153
11	3802	10606
12	3803	11203
13	3804	11656
14	3901	12397
15	3902	12799
16	3903	13213

DATA STORAGE ALLOCATION 20000
DATA STORAGE NOT USED 6385

```
&D MODE=1,
IWT=T,
KONFIG(1,1)='INLT',1,0,2,0,SPEC(1,1)=238.5,4*0,0.9,
KONFIG(1,2)='COMP',2,0,4,0,SPEC(1,2)=1.8,0,1,3761,1,3762,1,3763,1,0,0,.87,2.86,
1,
KONFIG(1,4)='DUCT',11,0,15,0,SPEC(1,4)=6*0,
KONFIG(1,3)='SPLT',4,0,5,11,SPEC(1,3)=.77,
KONFIG(1,5)='COMP',5,0,6,7,SPEC(1,5)=1.3,.026,1,3707,1,3708,1,3709,1,0,0,.87,
9.406,.985,
KONFIG(1,6)='DUCT',6,0,8,0,SPEC(1,6)=.10,0,0,2650,.94,18300,
KONFIG(1,7)='TURB',8,7,9,0,SPEC(1,7)=4,1,1,3801,1,3802,1,1,1,1,.86,5680,1,
KONFIG(1,8)='TURB',9,0,10,0,SPEC(1,8)=2.5,0,1,3803,1,3804,1,1,1,1,.86,5244,1,
KONFIG(1,9)='MIXR',10,15,12,0,SPEC(1,9)=0,0,.24,
KONFIG(1,10)='DUCT',12,0,13,0,SPEC(1,10)=.06,3*0,.90,18300,
KONFIG(1,11)='NOZZ',13,0,14,0,SPEC(1,11)=0,1,0,0,.98,1,0,0,1,
KONFIG(1,12)='SHFT',2,8,0,0,SPEC(1,12)=4000,8*1,
KONFIG(1,13)='SHFT',5,7,0,0,SPEC(1,13)=6000,8*1,
KONFIG(1,14)='CNTL',SPCNTL(1,14)=1,8,'STAP',8,13,0,1,
KONFIG(1,15)='CNTL',SPCNTL(1,15)=1,7,'STAP',8,9,0,1,
KONFIG(1,16)='CNTL',SPCNTL(1,16)=1,5,'STAP',8,8,0,1,
KONFIG(1,17)='CNTL',SPCNTL(1,17)=1,3,'DOUT',8,9,0,1,
KONFIG(1,18)='CNTL',SPCNTL(1,18)=1,2,'STAP',8,5,0,1,
KONFIG(1,19)='CNTL',SPCNTL(1,19)=1,1,'STAP',8,2,0,1,
KONFIG(1,20)='CNTL',SPCNTL(1,20)=1,12,'DOUT',8,12,0,1,
KONFIG(1,21)='CNTL',SPCNTL(1,21)=1,13,'DOUT',8,13,0,1,
&END

 THE FOLLOWING REPRESENTS THE CONFIGURATION FOR MODE=   1
 SIMPLE MODEL
         CONFIGURATION DATA   15 STATIONS   21 COMPONENTS

  COMPONENT  NKIND COMPONENT      UPSTREAM        DOWNSTREAM
    NUMBER           TYPE         STATIONS         STATIONS
```

1	1	INLET	1	0	2	0
2	4	COMPRESR	2	0	4	0
3	7	SPLITTER	4	0	5	11
4	2	DUCT B	11	0	15	0
5	4	COMPRESR	5	0	6	7
6	2	DUCT B	6	0	8	0
7	5	TURBINE	8	7	9	0
8	5	TURBINE	9	0	10	0
9	8	MIXER	10	15	12	0
10	2	DUCT B	12	0	13	0
11	9	NOZZLE	13	0	14	0
12	11	SHAFT	2	8	0	0
13	11	SHAFT	5	7	0	0
14	12	CONTROL	13	0	8	0
15	12	CONTROL	9	0	7	0
16	12	CONTROL	8	0	5	0
17	12	CONTROL	9	0	3	0
18	12	CONTROL	5	0	2	0
19	12	CONTROL	2	0	1	0
20	12	CONTROL	12	0	12	0
21	12	CONTROL	13	0	13	0

CONTROL INFORMATION

14 VARY DATINP 1 OF COMPONENT 8 SO THAT STATP 8 OF FLOW STATION 13 EQUALS 0.0
15 VARY DATINP 1 OF COMPONENT 7 SO THAT STATP 8 OF FLOW STATION 9 EQUALS 0.0
16 VARY DATINP 1 OF COMPONENT 5 SO THAT STATP 8 OF FLOW STATION 8 EQUALS 0.0
17 VARY DATINP 1 OF COMPONENT 3 SO THAT DATOUT 8 OF COMPONENT 9 EQUALS 0.0
18 VARY DATINP 1 OF COMPONENT 2 SO THAT STATP 8 OF FLOW STATION 5 EQUALS 0.0
19 VARY DATINP 1 OF COMPONENT 1 SO THAT STATP 8 OF FLOW STATION 2 EQUALS 0.0
20 VARY DATINP 1 OF COMPONENT 12 SO THAT DATOUT 8 OF COMPONENT 12 EQUALS 0.0
21 VARY DATINP 1 OF COMPONENT 13 SO THAT DATOUT 8 OF COMPONENT 13 EQUALS 0.0

CASE IDENTIFICATION SIMPLE MODEL

COMPONENT NO.	TYPE	DATINP1	DATINP2	DATINP3	DATINP4	DATINP5	DATINP6	DATINP7	DATINP8	DATINP9
1	INLET	0.23850D 03	0.0	0.0	0.0	0.0	0.90000D 00	0.0	0.0	0.0
2	COMPRESR	0.18000D 01	0.0	0.10000D 01	0.37610D 04	0.10000D 01	0.37620D 04	0.10000D 01	0.37630D 04	0.10000D 01
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	0.13000D 01	0.26000D-01	0.10000D 01	0.37070D 04	0.10000D 01	0.37080D 04	0.10000D 01	0.37090D 04	0.10000D 01
6	DUCT B	0.10000D 00	0.0	0.0	0.26500D 04	0.94000D 00	0.18300D 05	0.0	0.0	0.0
7	TURBINE	0.40000D 01	0.10000D 01	0.10000D 01	0.38010D 04	0.10000D 01	0.38020D 04	0.10000D 01	0.10000D 01	0.10000D 01
8	TURBINE	0.25000D 01	0.0	0.10000D 01	0.38030D 04	0.10000D 01	0.38040D 04	0.10000D 01	0.10000D 01	0.10000D 01
9	MIXER	0.0	0.0	0.24000D 00	0.0	0.0	0.0	0.0	0.0	0.0
10	DUCT B	0.60000D-01	0.0	0.0	0.0	0.90000D 00	0.18300D 05	0.0	0.0	0.0
11	NOZZLE	0.0	0.10000D 01	0.0	0.0	0.98000D 00	0.10000D 01	0.0	0.0	0.10000D 01
12	SHAFT	0.40000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
13	SHAFT	0.60000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
14	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
15	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
16	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
17	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
18	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
19	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.80000D 01	0.0	0.0	0.10000D 01
20	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01
21	CONTROL	0.0	0.0	0.0	0.10000D 01	0.0	0.0	0.80000D 01	0.0	0.10000D 01

```
MODE    1 NOW BEING USED
&W
IPLT=T,
ISII=F,
ISIO=F,
IOUTCD=2,
ILENG(1)=2,3,5,6,7,8,9,10,11,
IWMEC(1,2)='FAN ',1,1,4,3*0,
IWMEC(1,3)='SPLT',6*0,
IWMEC(1,4)='DUCT',0,5*0,
IWMEC(1,5)='LPC ',1,2,4*0,
IWMEC(1,6)='PBUR',1,5*0,
IWMEC(1,7)='HPT ',0,5,-5,3*0,
IWMEC(1,8)='LPT ',1,2,7,3*0,
IWMEC(1,9)='MIX ',6*0,
IWMEC(1,10)='DUCT',2,4*0,
IWMEC(1,11)='NOZ ',1,10,4*0,
IWMEC(1,12)='SHAF',1,8,3*0,2,
IWMEC(1,13)='SHAF',2,7,3*0,5,
DESVAL(1,2)=.524,1.7,.45,1.5,3.5,2.5,.45,0.,0.,1.,0.,2.,1.,
DESVAL(1,3)=15*0.,
DESVAL(1,4)=.45,2*0.,11.,11*0.,
DESVAL(1,5)=.45,1.35,.70,1.2,2.,1.5,.3,0.,0.,1.,0.,2.,1.,
DESVAL(1,6)=100.,.015,
DESVAL(1,7)=.5,.28,1.5,1.5,1.5,.55,150000.,3.,1.,6*0.,
DESVAL(1,8)=.55,.243,1.5,2.,3.,.6,150000.,3.,1.,6*0.,
DESVAL(1,9)=15*0.,
DESVAL(1,10)=.1,2.,
DESVAL(1,11)=1.,14*0.,
DESVAL(1,12)=50000.,.3,.85,12*0.,
DESVAL(1,13)=50000.,.3,13*0.,
&END

**************
*            *
*  FAN   2   *
*            *
*************2
DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.524   570.   519.    1905.    1579.     6.9517  1.4005

  U TIP   STRESS      DEN   W/AREA    TR      H/T
 1258.9 26757.6    0.168    2.339    1.800    0.450

 COMPRESSOR  2 MECHANICAL DESIGN

 LOADING    N STG    DIAM   U TIP C     RPM     C RPM
   0.874     3.00    39.98   1258.9   7216.9   7216.9

FRAME WT  =    95.67
```

```
STAGE    1
  WD    WB    WS    WN    WC    CL    RHOB  RHOD   AR
 65.   59.   59.    0.   26.    7.4 0.168 0.168  3.50
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP    STR   WEIGHT TIN
1.4789  16.7 0.524  6.952  8.99  19.99  59 1258.9 26758.  209.  519.

STAGE    2
  WD    WB    WS    WN    WC    CL    RHOB  RHOD   AR
 91.   34.   34.   51.   21.    6.2 0.168 0.168  3.00
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP    STR   WEIGHT TIN
1.4155  16.7 0.499  5.180 11.02  18.95  67 1193.2 20191.  231.  588.

STAGE    3
  WD    WB    WS    WN    WC    CL    RHOB  RHOD   AR
 97.   23.   23.   46.   19.    5.7 0.168 0.168  2.50
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB U TIP    STR   WEIGHT TIN
1.3671  16.7 0.475  4.017 12.17  18.23  70 1148.1 15768.  208.  658.

FRAME WT  =  285.15


 N STG  WEIGHT  LENGTH
    3  1028.68   28.80

DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.450  582.  727.   5447.   4743.    3.2206  1.3951

  PR     AD EF      PO      TO      HP
 2.8600  0.8700  5447.2   726.9  16910.
  HI       HO      WI      CWI
 123.95  174.07  238.50  265.00

******************** TOTAL COMP WEIGHT IS  1028.680

**********
*        *
*  LPC  5*
*        *
**********2
DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.450  582.  727.   5447.   4743.    1.8196  1.3951

  U TIP  STRESS     DEN  W/AREA   TR     H/T
 1285.1 23331.5  0.168   0.687   1.200  0.700

 COMPRESSOR  5 MECHANICAL DESIGN

 LOADING   N STG   DIAM  U TIP C    RPM   C RPM
   0.651   10.00   25.58  1085.6 11515.5  9727.5

FRAME WT  =  118.22
```

```
STAGE    1
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 24.   14.   14.   36.   10.    4.5 0.168 0.168  2.00
  PR   DEL H  MACH   AREA  R HUB  R TIP   NB U TIP     STR    WEIGHT TIN
1.3603  17.8 0.450  1.820  8.95  12.79  50 1285.1 23331.    99.  727.

STAGE    2
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 20.    9.    9.   29.    8.    3.6 0.168 0.168  1.94
  PR   DEL H  MACH   AREA  R HUB  R TIP   NB U TIP     STR    WEIGHT TIN
1.3241  17.8 0.435  1.442  9.42  12.45  60 1250.7 18516.    75.  800.

STAGE    3
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 16.    6.    6.   25.    7.    3.0 0.168 0.168  1.89
  PR   DEL H  MACH   AREA  R HUB  R TIP   NB U TIP     STR    WEIGHT TIN
1.2948  17.8 0.420  1.171  9.75  12.19  70 1225.3 15048.    59.  873.

STAGE    4
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 13.    4.    4.   21.    6.    2.6 0.168 0.168  1.83
  PR   DEL H  MACH   AREA  R HUB  R TIP   NB U TIP     STR    WEIGHT TIN
1.2704  17.8 0.405  0.970  9.98  12.00  81 1206.2 12477.    49.  946.

STAGE    5
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 11.    3.    3.   18.    5.    2.2 0.168 0.168  1.78
  PR   DEL H  MACH   AREA  R HUB  R TIP   NB U TIP     STR    WEIGHT TIN
1.2499  17.8 0.390  0.818 10.15  11.86  93 1191.5 10527.    41. 1017.

STAGE    6
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 10.    3.    3.   16.    4.    2.0 0.168 0.168  1.72
  PR   DEL H  MACH   AREA  R HUB  R TIP   NB U TIP     STR    WEIGHT TIN
1.2324  17.8 0.375  0.701 10.28  11.74 104 1180.1  9018.    36. 1089.

STAGE    7
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
  9.    2.    2.   14.    4.    1.8 0.168 0.168  1.67
  PR   DEL H  MACH   AREA  R HUB  R TIP   NB U TIP     STR    WEIGHT TIN
1.2173  17.8 0.360  0.608 10.39  11.65 115 1171.0  7829.    32. 1159.

STAGE    8
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 16.    3.    3.   13.    3.    1.6 0.286 0.286  1.61
  PR   DEL H  MACH   AREA  R HUB  R TIP   NB U TIP     STR    WEIGHT TIN
1.2042  17.8 0.345  0.534 10.47  11.58 126 1163.6 11712.    39. 1229.

STAGE    9
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 15.    3.    3.   12.    3.    1.5 0.286 0.286  1.56
  PR   DEL H  MACH   AREA  R HUB  R TIP   NB U TIP     STR    WEIGHT TIN
1.1926  17.8 0.330  0.475 10.53  11.52 136 1157.7 10407.    36. 1299.

STAGE   10
  WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR
 15.    2.    2.   11.    3.    1.4 0.286 0.286  1.50
  PR   DEL H  MACH   AREA  R HUB  R TIP   NB U TIP     STR    WEIGHT TIN
1.1824  17.8 0.315  0.426 10.59  11.47 146 1152.8  9343.    33. 1367.
```

```
 N STG  WEIGHT  LENGTH
   10   616.48   25.43

DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.300  544. 1436.  51236.  48231.    0.3874  1.3539

  PR    AD EF     PO      TO     HP
 9.4060  0.8700 51235.9  1435.6  33965.
  HI      HO     WI     CWI
 174.07  352.23  134.75   61.97

****************** TOTAL COMP WEIGHT IS   616.477

*************
*           *
*  PBUR  6  *
*           *
************2
BURNER NUMBER    6
  RIN    ROUT     LENGTH     MACH     WSPEC
   8.758  12.909   18.000    0.055    4.596
  CAS WT  LIN WT  NOZ WT   INC WT    FRAME    WTOT
    24.2    40.4    17.8     16.4    151.3    250.2



*************
*           *
*  HPT   7  *
*           *
************2
DUCT
 M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM
0.500 1186. 2621.  46112.  39327.    0.3977  1.2968

  U TIP  STRESS     DEN  W/AREA   TR     H/T
 1106.0  9819.5   0.286   0.246   1.000   0.922

 TURBINE  7  MECHANICAL DESIGN
    H/T   N STG LOADING    AREA
  0.922   2.000   0.280   0.398
     UT    RTIP    RHUB   DEL H     RPM    TORQ
 1106.0    11.0    10.1   174.5 11515.5 185913.

STAGE    1
 DISK   BLADE  VANE   HWD    CASE   AR
   6.4    2.3    8.4   21.7    4.0  1.50
  PR   DEL H  MACH  AREA  R HUB  R TIP  NB  U TIP   STR   WEIGHT  LENGTH
1.8453  87.3 0.500  0.398 10.14  11.01 180 1106.0  9820.   42.84    2.02

STAGE    2
 DISK   BLADE  VANE   HWD    CASE   AR
  10.8    6.4   23.7   35.5    6.8  1.50
  PR   DEL H  MACH  AREA  R HUB  R TIP  NB  U TIP   STR   WEIGHT  LENGTH
2.0063  87.3 0.525  0.666 10.14  11.55 116 1160.9 16456.   83.19    3.29

 N STG  LENGTH  WEIGHT
    2     5.31  126.03
```

```
DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.550 1149. 2028.   12436.   10243.     1.2074   1.3127

  PR       TR      AD EF     PO       TO      TO.1
 3.7081   1.2928   0.8600 12435.6   2027.7   2027.7
 H IN     H OUT     AREA    FLOW      HP
 699.28   524.74     5.17   137.56   33969.

******************** TOTAL TURB WEIGHT IS    126.028


*************
*           *
*  LPT   8  *
*           *
*************2
DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.550 1149. 2028.   12438.   10245.     1.2072   1.3127

  U TIP   STRESS      DEN   W/AREA    TR      H/T
  727.0 11708.5    0.286    0.777    1.000    0.765

 TURBINE   8  MECHANICAL DESIGN
    H/T    N STG LOADING     AREA
  0.765    2.000    0.243    1.207
     UT     RTIP     RHUB    DEL H      RPM     TORQ
  727.0     11.5      8.8     86.9   7216.9 147693.

STAGE     1
 DISK    BLADE   VANE    HWD     CASE    AR
   5.0    22.4    66.0    38.9     9.9   2.00
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB  U TIP   STR    WEIGHT  LENGTH
1.4669  43.4 0.550  1.207  8.83   11.54  80  727.0 11709.   142.18    4.77

STAGE     2
 DISK    BLADE   VANE    HWD     CASE    AR
   6.9    27.6    81.4    34.0     9.3   3.00
  PR   DEL H  MACH   AREA  R HUB  R TIP  NB  U TIP   STR    WEIGHT  LENGTH
1.5156  43.4 0.575  1.652  8.83   12.39  98  780.6 16019.   159.21    4.17

FRAME WT  =  167.79


 N STG  LENGTH  WEIGHT
    2    13.41  469.18

DUCT
 M NO   VEL   T TOT    P TOT    P STAT   AREA     GAM
0.600 1154. 1722.    5594.    4436.     2.3313   1.3249

  PR       TR      AD EF     PO       TO      TO.1
 2.2236   1.1779   0.8600  5593.7   1721.5   1721.5
 H IN     H OUT     AREA    FLOW      HP
 524.77   437.87    16.80   137.56   16912.
```

```
********** TOTAL TURB WEIGHT IS   469.184


************
*          *
*  DUCT 10 *
*          *
************2
DUCT ,  10
RH=    0.0  RT=   28.80 LENG=   57.60
AREA=  18.098 RHO=.286
      CAS WT       INC WT       WTOT
     45.8800       0.0          45.8800


************
*          *
*  NOZ  11 *
*          *
************2
NOZZLE   11
WEIGHT=   295.02 LENGTH=   57.604 TR WT=    0.0


************
*          *
*  DUCT  4 *
*          *
************2
DUCT ,   4
RH=   15.78 RT=   17.69 LENG=   62.16
AREA=   1.401 RHO=.168
      CAS WT       INC WT       WTOT
     15.5408       13.8556       29.3964


************
*          *
*  SHAF 12 *
*          *
************2
SHAFT  12
   DO      DI    LENG      DN      WT
  3.54    3.01   48.74    0.65   40.03


************
*          *
*  SHAF 13 *
*          *
************2
SHAFT  13
   DO      DI    LENG      DN      WT
  4.35    3.94   18.00    1.27   14.33

************
*          *
*  ACCS WT *
*          *
************2

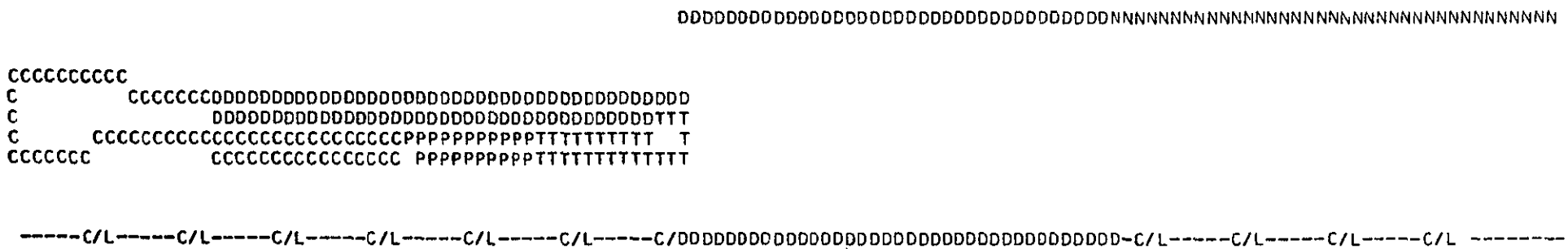
  ACCS WT= 262.021
```

WEIGHT INPUT DATA IN ENGL UNITS
WEIGHT OUTPUT DATA IN ENGL UNITS

COMP NO	WT EST	COMP LEN	ACCU LEN	UPSTREAM RADIUS RI	UPSTREAM RADIUS RO	RI	RO	DOWNSTREAM RADIUS RI	DOWNSTREAM RADIUS RO	RI	RO	NSTAGE
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0
2	1029.	29.	29.	9.	20.	0.	0.	13.	18.	0.	0.	3
3	0.	0.	29.	0.	0.	0.	0.	13.	16.	16.	18.	0
4	29.	62.	91.	16.	18.	0.	0.	16.	18.	0.	0.	0
5	616.	25.	54.	9.	13.	0.	0.	11.	11.	0.	0.	10
6	250.	18.	72.	9.	13.	0.	0.	9.	13.	0.	0.	0
7	126.	5.	78.	10.	11.	0.	0.	10.	13.	0.	0.	2
8	469.	13.	91.	9.	12.	0.	0.	9.	14.	0.	0.	2
9	0.	0.	91.	4.	16.	16.	21.	4.	21.	0.	0.	0
10	46.	58.	149.	0.	29.	0.	0.	0.	29.	0.	0.	0
11	295.	58.	206.	0.	29.	0.	0.	0.	27.	0.	0.	0
12	40.	0.	0.	9.	20.	10.	11.	0.	0.	0.	0.	0
13	14.	0.	0.	9.	13.	0.	0.	0.	0.	0.	0.	0

TOTAL BARE ENGINE WEIGHT= 2915. ACCESSORIES= 262.02

ESTIMATED TOTAL LENGTH= 206. ESTIMATED MAXIMUM RADIUS= 29.



UPDATED INPUT DATA TO REFLECT CALCULATED INPUT

COMPONENT NO.	TYPE	DATINP1	DATINP2	DATINP3	DATINP4	DATINP5	DATINP6	DATINP7	DATINP8	DATINP9
1	INLET	0.23850D 03	0.0	0.14696D 02	0.0	0.0	0.90000D 00	0.0	0.0	0.0
2	COMPRESR	0.18000D 01	0.0	0.40000D 04	0.37610D 04	0.26590D 03	0.37620D 04	0.10113D 01	0.37630D 04	0.992220 00
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT 8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	0.13000D 01	0.26000D-01	0.51455D 04	0.37070D 04	0.61418D 02	0.37080D 04	0.90909D 00	0.37090D 04	0.13246D 01
6	DUCT 8	0.10000D 00	0.0	0.0	0.26500D 04	0.94000D 00	0.18300D 05	0.0	0.0	0.0
7	TURBINE	0.40000D 01	0.10000D 01	0.46733D 00	0.38010D 04	0.70645D 00	0.38020D 04	0.96727D 00	0.90244D 00	0.10000D 01
8	TURBINE	0.25000D 01	0.0	0.38577D 00	0.38030D 04	0.72633D 00	0.38040D 04	0.94012D 00	0.81558D 00	0.10000D 01
9	MIXER	0.70773D 03	0.63925D 03	0.24000D 00	0.0	0.0	0.0	0.0	0.0	0.0
10	DUCT 8	0.60000D-01	0.0	0.0	0.0	0.90000D 00	0.18300D 05	0.0	0.0	0.0
11	NOZZLE	0.47288D 03	0.10000D 01	0.0	0.0	0.98000D 00	0.10000D 01	0.0	0.0	0.10000D 01
12	SHAFT	0.40000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01
13	SHAFT	0.60000D 04	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01	0.10000D 01

CASE IDENTIFICATION SIMPLE MODEL

STATION PROPERTY OUTPUT DATA

FLOW STATION	WEIGHT FLOW STATP1	TOTAL PRESSURE STATP2	TOTAL TEMPERATURE STATP3	FUEL/AIR RATIC STATP4	REFERRED FLOW STATP5	MACH NUMBER STATP6	STATIC PRESSURE STATP7	INTERFACE CORRECTED FLOW ERROR STATP8
1	0.23850D 03	0.14696D 02	0.51867D 03	0.0	0.23850D 03	0.0	0.0	0.0
2	0.23850D 03	0.13226D 02	0.51867D 03	0.0	0.26499D 03	0.0	0.0	0.0
4	0.23850D 03	0.37828D 02	0.72687D 03	0.0	0.10969D 03	0.0	0.0	0.0
5	0.13475D 03	0.37828D 02	0.72687D 03	0.0	0.61970D 02	0.0	0.0	0.0
6	0.13124D 03	0.35581D 03	0.14356D 04	0.0	0.90183D 01	0.0	0.0	0.0
7	0.35034D 01	0.35581D 03	0.14356D 04	0.0	0.0	0.0	0.0	0.0
8	0.13405D 03	0.32022D 03	0.26500D 04	0.21425D-01	0.13906D 02	0.0	0.0	0.0
9	0.13756D 03	0.86376D 02	0.20278D 04	0.20868D-01	0.46276D 02	0.0	0.0	0.0
10	0.13756D 03	0.38849D 02	0.17216D 04	0.20868D-01	0.94801D 02	0.24000D 00	0.37401D 02	0.0
11	0.10375D 03	0.37828D 02	0.72687D 03	0.0	0.47717D 02	0.0	0.0	0.0
12	0.24131D 03	0.37401D 02	0.13157D 04	0.11790D-01	0.15101D 03	0.0	0.0	0.0
13	0.24131D 03	0.35157D 02	0.13157D 04	0.11790D-01	0.16065D 03	0.10000D 01	0.18780D 02	0.0
14	0.24131D 03	0.35157D 02	0.13157D 04	0.11790D-01	0.16065D 03	0.11729D 01	0.14696D 02	0.0
15	0.10375D 03	0.37828D 02	0.72687D 03	0.0	0.47717D 02	0.12734D 00	0.37401D 02	0.0

COMPONENT OUTPUT DATA

COMPONENT NO.	TYPE	DATOUT1	DATOUT2	DATOUT3	DATOUT4	DATOUT5	DATOUT6	DATOUT7	DATOUT8	DATOUT9
1	INLET	0.0	0.0	0.0	0.10000D 01	0.10000D 01	0.0	0.90000D 00	0.10000D 01	0.0
2	COMPRESR	-0.16912D 05	0.40000D 04	0.0	0.18000D 01	0.40000D 04	0.10000D 01	0.26590D 03	0.87000D 00	0.28600D 01
3	SPLITTER	0.77000D 00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DUCT B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	COMPRESR	-0.33969D 05	0.60000D 04	0.0	0.13000D 01	0.51455D 04	0.98500D 00	0.61418D 02	0.87000D 00	0.94060D 01
6	DUCT B	0.0	0.10000D 00	0.0	0.21425D-01	0.0	0.10123D 05	0.0	0.94000D 00	0.26500D 04
7	TURBINE	0.33969D 05	0.60000D 04	0.10000D 01	0.40000D 01	0.46733D 00	0.56800D 04	0.70645D 00	0.86000D 00	0.37073D 01
8	TURBINE	0.16912D 05	0.40000D 04	0.10000D 01	0.25000D 01	0.38577D 00	0.52440D 04	0.72633D 00	0.86000D 00	0.22234D 01
9	MIXER	0.70773D 03	0.63925D 03	0.10387D 01	0.10114D 01	0.47274D 03	0.16773D 03	0.0	0.94990D-16	0.10000D 01
10	DUCT B	0.0	0.60000D-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	NOZZLE	0.13785D 05	0.18379D 04	0.23923D 01	0.48393D 03	0.47288D 03	0.10000D 01	0.98000D 00	0.18721D 01	0.23923D 01
12	SHAFT	0.0	0.40000D 04	0.40000D 04	0.40000D 04	0.0	0.0	0.0	0.0	0.0
13	SHAFT	0.0	0.60000D 04	0.60000D 04	0.60000D 04	0.0	0.0	0.0	0.0	0.0

MACH= 0.0 ALTITUDE= 0. RECOVERY= 0.9000 0 ITERATIONS 2 PASSES

AIRFLOW (LB/SEC)	238.50	GROSS THRUST	13785.01	FUEL FLOW (LB/HR)	10122.81
NET THRUST	13785.01	TSFC	0.7343	NET THRUST/AIRFLOW	57.7988
TOTAL INLET DRAG	0.0	TOTAL BRAKE SHAFT HP	0.0	BOATTAIL DRAG	0.0
INSTALLED THRUST	13785.01	INSTALLED TSFC	0.7343	SPILLAGE + LIP DRAG	0.0

APPENDIX B – Source Listing

By programming standards each routine starts with an extensive set of COMMENT cards which describe the subroutine purpose, use, required subroutines, history, and glossary of variable names and descriptions The listing of NNEP has been skipped to save space. The changes to NNEP necessary to append the weight estimating routines are.

1. Add calls to WTEST in MAIN and NEPCAL
2 Incorporate common WMECH in routine INPUT
3 Incorporate variables IWT and IPLT in namelist statement D in routine INPUT

```
C*************************************************************************
C
C SUBROUTINE(COMP)
C ----------------
C
C PURPOSE
C -------
C  THIS ROUTINE INITIALIZES THE INLET AND EXIT
C  CONDITIONS FOR ALL TYPES OF COMPRESSORS AND
C  CALLS THE MECHANICAL DESIGN ROUTINE.
C
C CALLING ROUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C  CMECH     DOES THE MECHANICAL DESIGN
C  DUCT      CALCULATES AREA BASED ON MACH
C  DUCT1     CALCULATES AREA BASED ON MACH OR
C            MACH BASED ON AREA
C  EFFD      CALCULATES POLYTROPIC EFFICIENCY FROM
C            ADIABATIC EFFICIENCY
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE       ID     ANALYST      DISCRIPTION
C     -------- -------- ----------- ---------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C --------
C
C
C   NAME      ORIGIN     USAGE      DISCRIPTION
C  ------     ------     -----    ----------------------------------------
C  ICOMP      ARG        L          COMPONENT NUMBER
C  IP                    O          PRINT INDICATOR
C  NCC                              COMPONENT NUMBER
C  NC                               COMPONENT TYPE
C                                   1= FAN
C                                   3= COMPRESSOR
C  NODEI                            INLET NODE
C  NODEO                            OUTLET NODE
C  WI                               AIRFLOW IN
C  PI                               PRESSURE IN
C  TI                               TEMPERATURE IN
C  PR                               PRESSURE RATIO
C  EF                               ADAIBATIC EFFICIENCY
C  PEF                              POLYTROPIC EFFICIENCY
```

```
C   IDES                                INPUT INDICATOR
C                                       1=DATA FROM DESVAL
C                                       2=DATA FROM DEFAUL
C   AI                                  MACH IN
C   ITYPE                               LOCATION INDICATOR FOR DEFAUL
C                                       1 THRU 5 =FAN
C                                       6 = LPC
C                                       7 = HPC
C   CW                                  CORRECTED AIRFLOW
C   PRC                                 PRESSURE RATIC
C   TID                                 DESIGN TEMPERATURE
C   H1                                  ENTHALPY IN
C   RP1                                 REL PRESSURE IN
C   RP3                                 REL PRESSURE OUT
C   T3                                  IDEAL TEMPERATURE OUT
C   H3                                  IDEAL ENTHALPY OUT
C   DHI                                 IDEAL DELTA ENTHALPY
C   DHA                                 DELTA ENTHALPY
C   H2                                  ENTHALPY OUT
C   TC                                  TEMPERATURE OUT
C   PO1                                 PRESSURE OUT
C   XM                                  MACH IN
C   AO                                  AREA OUT
C
C      FOR NON-ROTATING SPLITTERS
C   IFAN                                INDICATES FAN INNER
C                                       OR FAN OUTER
C   NFAN                                INDICATES FAN OUTER
C                                       OR FAN INNER
C   NODEIC                              NODE IN ON OUTER
C   NODEII                              NODE IN ON INNER
C   WAI                                 AIRFLOW IN ON INNER
C   WAO                                 AIRFLOW IN ON OUTER
C   PRC                                 PRESSURE RATIO OF OUTER
C   EFO                                 EFFICIENCY OF OUTER
C   PPI                                 PRESSURE RATIO OF INNER
C   EFI                                 EFFICIENCY OF INNER
C   NODEOC                              NODE OUT ON OUTER
C   NODEOI                              NODE OUT ON INNER
C   TOC                                 TEMPERATURE OUT ON OUTER
C   TOI                                 TEMPERATURE OUT ON INNER
C   WOC                                 AIRFLOW OUT ON OUTER
C   WOI                                 AIRFLOW OUT ON INNER
C   RPMT                                RPM OF COMPONENT
C
C       FOR ROTATING SPLITTERS
C
C   NFANI                               INNER COMPONENT NUMBER
C   NFANO                               OUTER COMPONENT NUMBER
C   PII                                 PRESSURE IN ON INNER
C   TII                                 TEMPERATURE IN ON INNER
C   WII                                 AIRFLOW IN ON INNER
C   PIO                                 PRESSURE IN ON OUTER
C   TIO                                 TEMPERATURE IN ON OUTER
C   WIO                                 AIRFLOW IN ON OUTER
C   FAI                                 F/A RATIO OF INNER
```

```
C   FAO                             F/A RATIO OF OUTER
C   XMII                            MACH IN ON INNER
C   XMIO                            MACH IN ON CUTER
C   GAI                             GAMMA INNER
C   GAO                             GAMMA OUTER
C   ATI                             TOTAL INLET AREA
C   ARI                             AREA RATIO IN - A OUTER/A TOTAL
C   PCI                             PRESSURE OUT ON INNER
C   TOI                             TEMPERATURE OUT ON INNER
C   WOI                             AIRFLOW OUT ON INNER
C   FOI                             F/A RATIO OUT ON INNER
C   POC                             PRESSURE OUT ON OUTER
C   TOO                             TEMPERATURE OUT ON OUTER
C   WOC                             AIRFLOW OUT ON OUTER
C   FOO                             F/A RATIO CUT ON OUTER
C   XMOI                            MACH OUT ON INNER
C   XMOO                            MACH OUT ON OUTER
C   GOI                             GAMMA OUT ON INNER
C   GCC                             GAMMA OUT ON OUTER
C   ATO                             TOTAL AREA OUT
C   ARO                             AREA RATIO OUT -A OUTER/A TOTAL
C   NFO                             OUTER FAN NUMBER
C
C
C*********************************************************************
C
C
      SUBROUTINE COMP (ICOMP)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C               ******************
C               * COMMON BLOCKS *
C               ******************
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
C
C               ********************
C               * DATA STATEMENTS *
C               ********************
C
      DATA TSTD,PSTD,FA/518.67,2116.22,0./
      DATA LLPC,LHPC,LFAN,LFO,LFI,LRSFO,LRSFI/4HLPC ,4HHPC ,4HFAN ,4HFO
     1 ,4HFI  ,4HRSFO,4HRSFI/
```

```
      IF (IOUTCD.GT.1) WRITE (10,330) IWMEC(1,ICOMP),ICOMP,IOUTCD
      IP=IOUTCD
      ISP=0
      NCC=ICOMP
      ITYPE=1
      NC=3
      IF (IWMEC(1,NCC).EQ.LFAN) NC=1
      IF (IWMEC(1,NCC).EQ.LFO) NC=1
      IF (IWMEC(1,NCC).EQ.LFI) NC=1
      IF (IWMEC(1,NCC).EQ.LRSFO) NC=4
      IF (IWMEC(1,NCC).EQ.LRSFI) NC=4
      IF (IWMEC(5,NCC).LE.-1) RETURN
      IF (NC.EQ.4) GO TO 170
      IF (NC.EQ.1.AND.IWMEC(5,NCC).NE.0) GO TO 40
      NODEI=JCONF(NCC,1)
      NODEO=JCONF(NCC,3)
      WI=WTF(NODEI)
      PII=TOPRES(NODEI)
      PI=PII*144.
      TI=TOTEMP(NODEI)
      PR=DATOUT(9,NCC)
      EF=DATOUT(8,NCC)
      IDES=1
      IF (DESVAL(1,NCC).EQ.0.) IDES=2
      GO TO (10,20),IDES
10    AI=DESVAL(1,NCC)
      GO TO 30
20    ITYPE=1
      IF (IWMEC(1,NCC).EQ.LLPC) ITYPE=6
      IF (IWMEC(1,NCC).EQ.LHPC) ITYPE=7
      AI=DEFAUL(1,ITYPE)
C
C CALCULATE CORRECTED COMPONENT INLET FLOW (CW)
C
30    CW=WI*SQRT(TI/TSTD)/PI*PSTD
C
C CHECK FOR BAD INLET TOTAL TEMPERATURE (TI)
C
      IF (TI.LT.200.) TI=200.
      IF (TI.GT.6000.) TI=6000.
C
C INITIALIZE DESIGN CASE VALUES
C
      PRD=PR
      TID=TI
      PEF=EF
C
C CALCULATE ADIABATIC (EF) OR POLYTROPIC (PEF) COMPONENT DESIGN
C EFFICIENCY
C
      CALL EFFD (TID,PRD,PEF,EF,FA)
C
C CALCULATE INLET ENTHALPY (H1), IDEAL EXIT ENTHALPY (H3), IDEAL DELTA
C ENTHALPY (DHI), ACTUAL DELTA ENTHALPY (DHA), ACTUAL EXIT ENTHALPY
C (H2) AND EXIT TOTAL TEMPERATURE (TO)
C
```

```
      H1=STHERM(4,TI,FA)
      RP1=STHERM(2,TI,FA)
      RP3=RP1*PR
      T3=STHERM(3,RP3,FA)
      H3=STHERM(4,T3,FA)
      DHI=H3-H1
      DHA=DHI/EF
      H2=DHA+H1
      TO=STHERM(1,H2,FA)
C
C CALCULATE  INLET DUCT AREA (AI)
C
      CALL DUCT (TI,PI,WI,AI,FA,XM,PS,Q,ISIO,IP)
C
C CALCULATE  DUCT EXIT TOTAL PRESSURE (PO1), COMPONENT EXIT FLOW
C (WO) AND COMPONENT WORK (WHP)
C
      PO1=PI*PR
      WO=WTF(NODEO)
      WHP=DHA*WI/.7068
C
C CALCULATE COMPONENT MECHANICAL DESIGN AND DIMENSIONS
C
      PO=PO1
      XMS=XM
      PEFS=PEF
      CALL CMECH (IP,IDES,NCC,NC,PR,RP1,TI,TO,DHA,DHI,H1,FA,AI,XMO,0.,0.
     1,PI,PO1,WI,WO,XMS,XME,PEFS,ITYPE,NODEI,NODEO)
C
C CALCULATE COMPONENT EXIT AREA (AO)
C
      AO=XME
      WT1=WATE(NCC)
      CALL DUCT (TO,PO1,WI,AO,FA,XME,PS1,QFEX,ISIO,IP)
C
C WRITE COMPONENT DATA
C
      IF (IP.NE.2) RETURN
      GO TO 270
C
C     CALCULATION FOR NON-ROTATING SPLITTER
C
C   INITIALIZE DESIGN VALUES
40    IFAN=1
      ITYPE=2
      IF (IWMEC(1,NCC).EQ.LFI) IFAN=2
      NFAN=IWMEC(5,NCC)
      IWMEC(5,NFAN)=-NCC
      IF (IFAN.EQ.1) NODEIO=JCONF(NCC,1)
      IF (IFAN.EQ.1) NODEII=JCONF(NFAN,1)
      IF (IFAN.EQ.2) NODEIO=JCONF(NFAN,1)
      IF (IFAN.EQ.2) NODEII=JCONF(NCC,1)
      PII=TOPRES(NODEIO)
      PI=PII*144.
      TI=TOTEMP(NODEIO)
      WAI=WTF(NODEII)
```

```
      WAO=WTF(NODEIO)
      WI=WAI+WAO
C
C   CALCULATE MASS WEIGHTED PR AND EF FOR STAGE CALC
C
      GO TO (50,60),IFAN
50    PRO=DATOUT(9,NCC)
      EFO=DATOUT(8,NCC)
      PRI=DATOUT(9,NFAN)
      EFI=DATOUT(8,NFAN)
      GO TO 70
60    PRO=DATOUT(9,NFAN)
      EFO=DATOUT(8,NFAN)
      PRI=DATOUT(9,NCC)
      EFI=DATOUT(8,NCC)
70    PR=(PRI*WAI+PRO*WAO)/WI
      EF=(EFI*WAI+EFO*WAO)/WI
      TID=TI
      PRD=PI
      PEF=EF
      CALL EFFD (TID,PRD,PEF,EF,FA)
      GO TO (80,90),IFAN
80    NODEOO=JCONF(NCC,3)
      NODEOI=JCONF(NFAN,3)
      GO TO 100
90    NODEOO=JCONF(NFAN,3)
      NODEOI=JCONF(NCC,3)
100   TOO=TOTEMP(NODEOO)
      TOI=TOTEMP(NODEOI)
      TO=(TOO*WAO+TOI*WAI)/WI
      WOO=WTF(NODEOO)
      WOI=WTF(NODEOI)
      WO=WOO+WOI
      IDES=1
      IF (DESVAL(1,NCC).EQ.0.) IDES=2
      GO TO (110,120),IDES
110   AI=DESVAL(1,NCC)
      GO TO 130
120   AI=DEFAUL(1,2)
C
C   CALCULATE INLET DUCT AREA (AI)
C
130   CALL DUCT (TI,PI,WI,AI,FA,XM,PS,Q,ISIO,IP)
C
C  CALCULATE INLET ENTHALPY AND WORK
C
      H1=STHERM(4,TI,FA)
      RP1=STHERM(2,TI,FA)
      RP3=RP1*PR
      T3=STHERM(3,RP3,FA)
      H3=STHERM(4,T3,FA)
      DHI=H3-H1
      DHA=DHI/EF
      H2=H1+DHA
      PO1=PI*PR
```

```
C    CALCULATE COMPRESSOR MECHANICAL DESIGN
C
       XMS=XM
       PEFS=PEF
       CALL CMECH (IP,IDES,NCC,NC,PR,RP1,TI,TO,DHA,DHI,H1,FA,AI,XMO,0.,0.
      1,PI,PO1,WI,WO,XMS,XME,PEFS,ITYPE,NODEIO,NODEOO)
       AO=XME
C
C    CALCULATE EXIT DUCT AREA (AO)
C
       CALL DUCT (TO,PO1,WO,AO,FA,XME,PSI,QFEX,ISIO,IP)
C
C    STORE WEIGHT AND DIMENSIONS FOR FAN
C
       RPMT(NFAN)=RPMT(NCC)
       GO TO (140,150),IFAN
140    WATE(NFAN)=WATE(NCC)*WAI/WI
       WATE(NCC)=WATE(NCC)-WATE(NFAN)
       ALENG(NFAN)=ALENG(NCC)
       RI(1,NODEII)=RI(1,NODEIO)
       RI(2,NODEOI)=RI(2,NODEOO)
       GO TO 160
150    WATE(NFAN)=WATE(NCC)*WAO/WI
       WT1=WATE(NCC)
       WATE(NCC)=WATE(NCC)-WATE(NFAN)
       ALENG(NFAN)=ALENG(NCC)
       RO(1,NODEIO)=RO(1,NODEII)
       RO(2,NODEOC)=RO(2,NODEOI)
160    RM=SQRT((RO(2,NODEIO)**2+RI(1,NODEII)**2*WAO/WAI)/(1.+WAO/WAI))
       RI(1,NODEIO)=RM
       RO(1,NODEII)=RM
       RM=SQRT((RO(2,NODEOO)**2+RI(2,NODEOI)**2*WAO/WAI)/(1.+WAO/WAI))
       RO(2,NODEOI)=RM
       RI(2,NODEOO)=RM
       IF (IP.NE.2) RETURN
       CW=CORFLO(NODEII)+CORFLO(NODEIO)
       CW=CW/1.54972555
       WHP=DHA*WI/.7068
       PO=PO1
       GO TO 270
C
C    CALCULATION FOR ROTATING SPLITTER
C    INITIALIZE DESIGN VALUES AND DETERMINE INNER AND OUTER FANS
C
170    ITYPE=4
       IFAN=2
       IF (IWMEC(1,NCC).EQ.LRSFO) IFAN=1
       GO TO (180,190),IFAN
180    NODEIO=JCONF(NCC,1)
       NODEOO=JCONF(NCC,3)
       NFANI=IWMEC(5,NCC)
       NFANO=NCC
       NODEII=JCONF(NFANI,1)
       NODEOI=JCONF(NFANI,3)
       IWMEC(5,NFANI)=-NCC
       GO TO 200
```

```
190     NODEII=JCONF(NCC,1)
        NODEOI=JCONF(NCC,3)
        NFANO=IWMEC(5,NCC)
        NFANI=NCC
        NODEIC=JCONF(NFANO,1)
        NODEOO=JCONF(NFANO,3)
        IWMEC(5,NFANO)=-NCC
200     PII=TOPRES(NODEII)*144.
        TII=TOTEMP(NODEII)
        WII=WTF(NODEII)
        PIO=TOPRES(NODEIO)*144.
        TIO=TOTEMP(NODEIO)
        WIO=WTF(NODEIO)
        FII=FAR(NODEII)
        FIO=FAR(NODEIO)
        IDES=1
        IF (DESVAL(1,NCC).EQ.0.) IDES=2
C
C   CALCULATE MACH IN AND MACH OUT FOR MECHANICAL DESIGN
C   AND CALCULATE OUTER TC TOTAL AREA RATIO FOR SPLITTER LOCATION
C
        GO TO (210,220),IDES
210     XMII=DESVAL(1,NFANI)
        XMIO=DESVAL(1,NFANO)
        GO TO 230
220     XMII=DEFAUL(1,5)
        XMIO=DEFAUL(1,4)
230     GII=STHERM(5,TII,FII)
        GIO=STHERM(5,TIO,FIO)
        AII=0.
        AIO=0.
        CALL DUCT1 (TII,PII,WII,GII,XMII,AII)
        CALL DUCT1 (TIO,PIO,WIO,GIO,XMIO,AIO)
        WI=WII+WIO
        ATI=AIO+AII
        TAT=-ATI
        CALL DUCT1 (TIO,PIO,WI,GIO,XMI,TAT)
        ARI=AIO/ATI
        POI=TOPRES(NODEOI)*144.
        TOI=TCTEMP(NODEOI)
        WOI=WTF(NODEOI)
        FOI=FAR(NODEOI)
        POC=TOPRES(NODEOO)*144.
        TOO=TOTEMP(NODEOO)
        WOO=WTF(NODEOO)
        FOO=FAR(NODEOO)
        GO TO (240,250),IDES
240     XMOI=DESVAL(7,NFANI)
        XMOO=DESVAL(7,NFANO)
        GO TO 260
250     XMOI=DEFAUL(7,5)
        XMOO=DEFAUL(7,4)
260     GOI=STHERM(5,TOI,FOI)
        GOO=STHERM(5,TOO,FOO)
        AOI=0.
        AOO=0.
```

```
      CALL DUCT1 (TCI,POI,WOI,GOI,XMOI,AOI)
      CALL DUCT1 (TOO,POO,WOO,GOO,XMOO,AOO)
      ATC=ACI+AOO
      TAO=-ATO
      WO=WOO+WOI
      CALL DUCT1 (TOO,POO,WC,GOC,XMO,TAO)
      ARC=AOO/ATO
      EF=DATOUT(8,NFANO)
      PR=DATOUT(9,NFANO)
      AI=ATI
      AO=ATO
      PRD=PR
      TID=TIO
      PEF=EF
      CALL EFFD (TID,PRD,PEF,EF,FIO)
      H1=STHERM(4,TIO,FIO)
      RP1=STHERM(2,TIC,FIC)
      RP3=RP1*PR
      T3=STHERM(3,RP3,FIO)
      H3=STHERM(4,T3,FIO)
      DHI=H3-H1
      DHA=DHI/EF
      WHP=DHA*WI/.7068
      H2=H1+DHA
      TO=STHERM(1,H2,FIO)
      TR=TO/TIO
      W1=WI
      PO1=PIO*PR
C
C    CALCULATE COMPRESSOR MECHANICAL DESIGN
C
      XMS=XMI
      TI=TIO
      PI=PIO
      PEFS=PEF
      NFO=NFANO
      CALL CMECH (IP,IDES,NFO,NC,PR,RP1,TI,TO,DHA,DHI,H1,FA,AI,XMO,ARO,A
     1RI,PI,PO1,WI,WO,XMS,XME,PEFS,ITYPE,NODEIO,NODEOO)
C
C    STORE FAN DIMENSIONS AND WEIGHT
C
      WT1=WATE(NFANO)
      RPMT(NFANI)=RPMT(NFANO)
      WATE(NFANI)=WATE(NFANO)*WII/WI
      WATE(NFANO)=WATE(NFANO)-WATE(NFANI)
      ALENG(NFANI)=ALENG(NFANO)
      RI(1,NODEII)=RI(1,NODEIO)
      RI(2,NODEOI)=RI(2,NODEOO)
      RM=SQRT(RO(1,NODEIO)**2-ARI*(RO(2,NODEIO)**2-RI(1,NODEII)**2))
      RI(1,NODEIO)=RM
      RO(1,NODEII)=RM
      RM=SQRT(RO(2,NODEOO)**2-ARO*(RO(2,NODEOO)**2-RI(2,NODEOI)**2))
      RI(2,NODEOO)=RM
      RO(2,NODEOI)=RM
      PO=PO1
      CW=0.
```

```
270   IF (IP.NE.2) GO TO 290
      WRITE (10,340)
      IF (ISIO) GO TO 280
      WRITE (10,350) PR,EF,PO,TO,WHP
      WRITE (10,360)
      WRITE (10,370) H1,H2,WI,CW
      GO TO 290
280   SPO=PO*CONVER(11)
      STC=TO*CONVER(8)
      SWHP=WHP*CONVER(10)
      SH1=H1*CONVER(9)
      SH2=H2*CONVER(9)
      SWI=WI*CONVER(3)
      SCW=CW*CONVER(3)
      WRITE (10,350) PR,EF,SPO,STO,SWHP
      WRITE (10,360)
      WRITE (10,370) SH1,SH2,SWI,SCW
290   IF (IWMEC(6,NCC).EQ.0) GO TO 320
      IGR=IWMEC(6,NCC)
      DO 300 I=1,4
      ILOC=I
      IF (NCC.EQ.JCONF(IGR,I)) GO TO 310
300   CONTINUE
310   ILCC=ILOC+1
      GR=DATINP(ILOC,IGR)
      RPM=RPMT(NCC)
      GBWT=WHP/RPM*(1.+GR)**3/GR*9.43
      RPMT(NCC)=RPM/GR
      IF (NC.EQ.1) RPMT(NFAN)=RPMT(NCC)
      IF (NC.EQ.4) RPMT(NFANI)=RPMT(NCC)
      IF (NC.EQ.4) RPMT(NFANO)=RPMT(NCC)
      WATE(NCC)=WATE(NCC)+GBWT
      IF (ISIC) GBWTS=GBWT*CONVER(3)
      IF (IOUTCD.GT.1) WRITE (10,380) GBWT
      IF (ISIO.AND.ICUTCD.GT.1) WRITE (10,380) GBWTS
      WT1=WT1+GBWT
320   IF (IP.NE.2) RETURN
      IF (ISIO) WT1=WT1*CONVER(3)
      WRITE (10,390) WT1
      RETURN
C
330   FORMAT (1H /14H ************/14H *           */4H *  ,A4,I3,3H  *
     1/14H *           */13H ************,I1)
340   FORMAT (35H    PR     AD EF      PO      TO      HP)
350   FORMAT (2F8.4,2F8.1,F8.0)
360   FORMAT (29H    HI       HO      WI      CWI )
370   FORMAT (5F8.2,//)
380   FORMAT (/,17H GEAR BOX WEIGHT=,3X,F6.2)
390   FORMAT (/,26H ****************** TOTAL,15H COMP WEIGHT IS,F10.3)
      END
```

```
C*************************************************************************
C
C SUBROUTINE(CMECH)
C ----------------
C
C PURPOSE
C -------
C THIS ROUTINE CALCULATES THE MECHANICAL DESIGN
C PARAMETERS OF THE COMPRESSORS AND FANS.EI NUMBER
C OF STAGES,RPM,DIAMETER.
C
C CALLING ROUTINES
C ----------------
C COMPRESSOR
C
C
C REQUIRED SUBROUTINES
C --------------------
C
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE       ID     ANALYST      DISCRIPTION
C     -------- -------- ----------- ---------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C --------
C
C
C   NAME      ORIGIN     USAGE      DISCRIPTION
C  ------     ------     -----    ----------------------------------------
C  IP         ARG                 PRINT INDICATOR
C  IDES       ARG                 INPUT INDICATOR
C  NCC        ARG                 COMPRESSOR INDICATOR
C  NC         ARG                 COMPRESSOR TYPE INDICATOR
C  PR         ARG                 PRESSURE RATIO
C  RP1        ARG                 PRESSURE IN
C  TI         ARG                 TOTAL TEMPERATURE IN
C  TO         ARG                 TOTAL TEMPERATURE OUT
C  DHA        ARG                 ACTUAL DELTA ENTHALPY
C  DHI        ARG                 IDEAL DELTA ENTHALPY
C  H1         ARG                 ENTHALPY IN
C  FA         ARG                 FUEL AIR RATIO
C  AI         ARG                 AREA IN
C  XMO        ARG                 MACH NUMBER OUT FOR ROTATING SPLITTERS
C  ARO        ARG                 AREA RATIO OUT
C  ARI        ARG                 AREA RATIO IN
C  PI         ARG                 PRESSURE IN
C  POI        ARG                 PRESURE OUT
```

```
C  WI          ARG          AIRFLOW IN
C  WO          ARG          AIRFLOW OUT
C  XMS         ARG          MACH NUMBER IN
C  XME         ARG          MACH NUMBER OUT
C  PEF         ARG          POLYTROPIC EFFICIENCY
C  ITYPE       ARG          LOCATION INDICATOR FOR DEFAULT
C  NI          ARG          NODE IN
C  NO          ARG          NODE OUT
C  ISTATR                   STATOR INDICATOR
C  PRM                      FIRST STAGE MAX. PRESSURE RATIO
C  HT                       HUB TIP RATIO IN
C  SOLC                     SOLIDITY
C  ARIC                     BLADE ASPECT RATIO IN
C  AROC                     BLADE ASPECT RATIO OUT
C  CCMN                     MACH NUMBER OUT
C  TMAXI                    MAX. TEMPERATURE IN
C  TMAXO                    MAX. TEMPERATURE OUT
C  RPMR                     SPEED RATIO NMAX/NDES
C  RHOM                     BLADE DENSITY
C  MODE                     1 CONSTANT HUB DESIGN COMPRESSOR
C                           2 CONSTANT MEAN DESIGN COMPRESSOR
C                           3 CONSTANT TIP DESIGN COMPRESSOR
C  SCC                      RPM SCALER FOR MATCHING A KNOWN SPEED
C  SN                       NUMBER STAGES
C  H2                       FIRST STAGE EXIT ENTHALPY
C  PR1                      FIRST STAGE PRESSURE RATIO
C  T2                       FIRST STAGE EXIT TEMPERATURE
C  RP2                      FIRST STAGE EXIT RELATIVE PRESSURE
C  CUTP                     CORRECTED TIP SPEED
C  RT                       FIRST STAGE TIP RADIUS - FT
C  RPM                      RPM OF THE SPOOL
C  DT                       FIRST STAGE TIP DIAMETER -IN
C  UTP                      FIRST STAGE TIP SPEED
C  NS                       NUMBER OF STAGES
C  TR                       BLADE TAPER RATIO
C  CLP                      COMPRESSOR LOADING
C  RMEAN                    MEAN RADIUS
C  RTB                      BLADE TIP RADIUS
C  RHB                      BLADE HUB RADIUS
C  RTFR                     FRONT FRAME RADIUS
C  DELMNS                   DELTA MACH NUMBER
C  DELAR                    DELTA ASPECT RATIO
C  DHAS                     DELTA ENTHALPY STAGE
C  DELARI                   DELTA AREA RATIO
C  POS                      PRESSURE INTO/OUTOF STAGE
C  EF                       POLYTROPIC EFFICIENCY
C  TTOS                     TEMPERATURE INTO/OUTOF STAGE
C  DELTM                    DELTA MAX. TEMPERATURE
C  HOS                      ENTHALPY INTO/OUTOF STAGE
C  XMCS                     MACH NUMBER INTO/OUTOF STAGE
C  AR                       ASPECT RATIO OF STAGE
C  ARII                     AREA RATIO OF STAGE
C  HIS                      ENTHALPY INTO STAGE
C  TTIS                     TEMPERATURE INTO STAGE
C  PIS                      PRESSURE INTO STAGE
C  CW                       CORRECTED AIRFLOW IN TO STAGE
```

```
C  BH                              BLADE HEIGHT - FT
C  NB                              NUMBER OF BLADES
C  RTBA                            TIP RADIUS OF BLADE
C  RTHBA                           HUB RADIUS OF BLADE
C  BHAI                            BLADE HEIGHT
C  HTI                             HUB/TIP OF BLADE
C  TSTRE                           TOTAL TEMPERATURE FOR STRESS CALCULATION
C  RHCB                            DENSITY OF BLADE MATERIAL
C  UTP1                            BLADE TIP SPEED
C  BLN                             NUMBER OF BLADES IN REAL NUMBER
C  RHOD                            DENSITY OF DISK MATERIAL
C  WT                              STAGE WEIGHT
C  CL                              STAGE LENGTH
C  WATE                            COMPRESSOR TOTAL WEIGHT
C  ALENG                           COMPRESSOR TOTAL LENGHT
C  RI                              INNER RADIUS - IN
C  RO                              OUTER RADIUS - IN
C
C
C*****************************************************************************
C
      SUBROUTINE CMECH (IP,IDES,NCC,NC,PR,RP1,TI,TO,DHA,DHI,H1,FA,AI,XMO
     1,ARO,ARI,PI,PO1,WI,WO,XMS,XME,PEF,ITYPE,NI,NO)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
      DIMENSION PRR(9), UTIP(9), PRS(20)
C
C                 ******************
C                 * COMMON BLOCKS *
C                 ******************
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     1C(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
C
C                 ********************
C                 * DATA STATEMENTS *
C                 ********************
C
      DATA TSTD,PSTD,PIE/518.67,2116.22,3.14159/
      DATA PRR/1.,1.18,1.36,1.43,1.503,1.581,1.667,1.775,1.9/
      DATA UTIP/600.,885.,1100.,1200.,1300.,1400.,1500.,1600.,1700./
      WTFF=0.
      WTRF=0.
      CIMN=XMS
      ISTATR=IWMEC(2,NCC)
```

```
      GO TO (10,20),IDES
10    PRM=DESVAL(2,NCC)
      HT=DESVAL(3,NCC)
      SOLC=DESVAL(4,NCC)
      ARIC=DESVAL(5,NCC)
      AROC=DESVAL(6,NCC)
      COMN=DESVAL(7,NCC)
      IF (ITYPE.EQ.4) COMN=XMO
      TMAXI=DESVAL(8,NCC)
      TMAXO=DESVAL(9,NCC)
      RPMR=DESVAL(10,NCC)
      RHOM=DESVAL(11,NCC)
      MODE=IFIX(DESVAL(12,NCC)+.01)
      SCC=DESVAL(13,NCC)
      TMET=DESVAL(14,NCC)
      GO TO 30
20    PRM=DEFAUL(2,ITYPE)
      HT=DEFAUL(3,ITYPE)
      SOLC=DEFAUL(4,ITYPE)
      ARIC=DEFAUL(5,ITYPE)
      AROC=DEFAUL(6,ITYPE)
      COMN=DEFAUL(7,ITYPE)
      IF (ITYPE.EQ.4) COMN=XMO
      TMAXI=DEFAUL(8,ITYPE)
      TMAXO=DEFAUL(9,ITYPE)
      RPMR=DEFAUL(10,ITYPE)
      RHOM=DEFAUL(11,ITYPE)
      MODE=IFIX(DEFAUL(12,ITYPE)+.01)
      SCC=DEFAUL(13,ITYPE)
      TMET=DEFAUL(14,ITYPE)
30    IF (.NOT.ISII) GO TO 40
      TMET=TMET/CONVER(8)
      TMAXO=TMAXO/CONVER(8)
      TMAXI=TMAXI/CONVER(8)
      RHOM=RHOM/CONVER(5)
C
C FOR DESIGN CASE: CALCULATE NUMBER OF STAGES BASED ON ENTHALPY
C CHANGE PER STAGE AND MAXIMUM PRESSURE RATIO
C
40    IFLAG=1
      XME=CCMN
      SN=0.
      PR1=PR
50    SN=SN+1.
      IF (SN.GT.20.) WRITE (10,220) NCC
      IF (SN.GT.20.) GO TO 80
C
C CALCULATE PRESSURE RATIO (PR1) ACROSS THE COMPONENT
C
      IF (IWMEC(7,NCC).NE.0) SN=IWMEC(7,NCC)
      H2=H1+DHI/SN
      T2=STHERM(1,H2,FA)
      RP2=STHERM(2,T2,FA)
      PR1=RP2/RP1
      IF (IWMEC(7,NCC).NE.0) GO TO 80
      IF (PR1.GT.PRM) GO TO 50
```

```
C
C CALCULATE CORRECTED TIP SPEED (CUTP), TIP
C RADIUS (RT), CORRECTED ROTOR SPEED (CRPM), AND ROTOR SPEED (RPM)
C
      NOUT=KKINDS(11,1)+1
      DO 60 I=2,NOUT
      NT=KKINDS(11,I)
      DO 60 J=2,4
      N1=JCONF(NT,J-1)
      N2=JCONF(NT,J)
      IF (N2.EQ.NCC) GO TO 70
60    CONTINUE
      GO TO 80
70    RPM=RPMT(N1)
      RPMT(NCC)=RPM
      RT=SQRT(AI/PIE/(1.-HT**2))
      CRPM=RPM/SQRT(TI/TSTD)
      CUTP=CRPM/60.*2.*RT*PIE
      GO TO 110
80    DO 90 I=2,9
      IF (PR1.LT.PRR(I)) GO TO 100
90    CONTINUE
      I=9
100   DX=PRR(I)-PRR(I-1)
      DY=UTIP(I)-UTIP(I-1)
      CUTP=(DY/DX*(PR1-PRR(I-1))+UTIP(I-1))*SCC
      RT=SQRT(AI/PIE/(1.-HT*HT))
      CRPM=CUTP*60./(2.*RT*PIE)
      RPM=CRPM*SQRT(TI/TSTD)
      RPMT(NCC)=RPM
C
C CALCULATE TIP DIAMETER (DT) IN INCHES, TIP SPEED (UTP),
C AND NUMBER OF STAGES (NS)
C
110   DT=RT*24.
      UTP=CUTP*SQRT(TI/TSTD)
      NS=IFIX(SN+.01)
      SND=SN
C
C INITIALIZE BLADE TAPER RATIO (TR) AND CALCULATE BLADE STRESS (ST)
C AND LOADING PARAMETER (CLP)
C
      TR=1.8
      IF (NC.EQ.3) TR=1.2
      RHO1=RHOM
      CALL STRESS (RT,TI,UTP,HT,RPM,ST,TR,NC,IP,RHO1,TMET)
      CLP=200412./UTP*(H2-H1)/UTP/(HT+1.)**2
C
C CHECK FOR PRINT FORMAT
C
      IF (IP.NE.2) GO TO 130
C
C WRITE COMPRESSOR DESIGN DATA
C
      WRITE (10,230) NCC
      WRITE (10,240)
```

```
      IF (ISIO) GO TO 120
      WRITE (10,250) CLP,SN,DT,CUTP,RPM,CRPM
      GO TO 130
120   SDT=DT*CONVER(1)
      SCUTP=CUTP*CONVER(2)
      WRITE (10,250) CLP,SN,SDT,SCUTP,RPM,CRPM
130   RMEAN=RT*SQRT(0.5*(1.+HT*HT))
      RTB=RT
      RHB=RTB*HT
      RTFR=RT*12.
      WTFF=0.
      IF (IWMEC(3,NCC).NE.0.) CALL FRAME (RTFR,IWMEC(3,NCC),WTFF,IP)
      RO(1,NI)=RTFR
      RI(1,NI)=RHB*12.
      DELMNS=(CIMN-CGMN)
      IF (DELMNS.NE.0.) DELMNS=DELMNS/SN
      DELAR=ARIC-ARCC
      IF (SN.GT.1.) DELAR=DELAR/(SN-1.)
      DHAS=DHA/SN
      DELARI=ARI-ARO
      IF (DELARI.NE.0.) DELARI=DELARI/SN
C
C INITIALIZE DESIGN VALUES FOR STAGE-BY-STAGE COMPRESSOR DESIGN
C
      WT=0.
      CL=0.
      POS=PI
      EF=-PEF
      TTOS=TI
      DELTM=(TMAXO-TMAXI)/SN
      HOS=H1
      XMCS=CIMN+DELMNS
      AR=ARIC+DELAR
      ARII=ARI+DELARI
      NSTAG(NCC)=NS
      NST=NS+1
C
C BEGIN STAGE-BY-STAGE COMPRESSOR DESIGN
C
      DO 190 I=1,NST
C
C INITIALIZE STAGE INLET VALUES: MACH (XMCS), ENTHALPY (HIS), TOTAL
C TEMPERATURE (TTIS), TOTAL PRESSURE (PIS) AND ASPECT RATIO (AR)
C
      XMCS=XMCS-DELMNS
      IF (XMCS.LE.0.) GO TO 210
      HIS=HOS
      TTIS=TTOS
      PIS=POS
      ARII=ARII-DELARI
      IF (AR.NE.0.) AR=AR-DELAR
C
C
C CALCULATE STAGE INLET GAMMA (GA), STAGE EXIT ENTHALPY (HOS) AND
C TOTAL TEMPERATURE (TTOS)
C
```

```
      GA=STHERM(5,TTIS,FA)
      HOS=HIS+DHAS
      TTOS=STHERM(1,HOS,FA)
C
C CALCULATE AVERAGE TOTAL TEMPERATURE (TGAM), GAMMA (GAV) AND PRESSURE
C RATIO (PRS) ACROSS THE STAGE AND STAGE EXIT TOTAL PRESSURE (POS)
C
      TGAM=(TTIS+TTOS)/2.
      GAV=STHERM(5,TGAM,FA)
      TOS1=EF*ALOG(TTOS/TTIS)
      TOS2=EXP(TOS1)
      PRS(I)=TOS2**(GAV/(GAV-1.))
      POS=PIS*PRS(I)
C
C CALCULATE STAGE INLET CORRECTED FLOW (CW) AND STAGE INLET AREA (A1C)
C
      W1=WI
      CW=W1*SQRT(TTIS/TSTD)/PIS*PSTD
      A1C=0.
      CALL DUCT1 (TTIS,PIS,W1,GA,XMCS,A1C)
      GO TO (140,150,160),MODE
C
C     CALCULATE RTB FOR CONSTANT HUB
C
140   RTB=SQRT(RHB*RHB+A1C/PIE)
      GO TO 170
C
C CHECK FOR MEANINGLESS STAGE AND BLADE PARAMETERS. CALCULATE BLADE
C HEIGHT (BH) AND NUMBER OF BLADES (NB)
C
150   CHECKA=RMEAN*RMEAN-A1C/(2.*PIE)
      IF (CHECKA.LE.0.) GO TO 210
      RTB=SQRT(RMEAN*RMEAN+A1C/(2.*PIE))
      RHB=SQRT(CHECKA)
      GO TO 170
C
C     CALCULATE RHB FOR CONSTANT TIP
C
160   RHB=RTB*RTB-A1C/PIE
      IF (RHB.LE.0.) GO TO 210
      RHB=SQRT(RHB)
170   BH=RTB-RHB
      NB=IFIX(PIE*2.*RTB*SOLC*AR/BH)
C
C CALCULATE BLADE TIP RADIUS (RTBA), HUB RADIUS (RHBA) AND HEIGHT
C (BHAI) IN INCHES
C
      RTBA=RTB*12.
      RHBA=RHB*12.
      IF (I.GE.NST) GO TO 190
      BHAI=BH*12.
      HT1=RHBA/RTBA
C
C CALCULATE BLADE TIP SPEED (UTP1) AND STRESS (ST1)
C
      IF (TMAXO.EQ.0.) TSTRES=TTIS
```

```
      IF (TMAXO.NE.0..AND.I.EQ.1) TSTRES=TMAXI-DELTM
      IF (TMAXO.NE.0.) TSTRES=TSTRES+DELTM
      RHOB=RHOM
      UTP1=RPM*2.*PIE/60.*RTB
      UTIP1=UTP1
      IF (RPMR.NE.0.) UTIP1=UTIP1*RPMR
      CALL STRESS (RTB,TSTRES,UTIP1,HT1,RPM,ST1,TR,NC,0,RHOB,TMET)
      BLN=FLOAT(NB)
C
C CALCULATE STAGE WEIGHT (WTT) AND LENGTH (CLT) AND TOTAL COMPONENT
C WEIGHT (WT) AND LENGTH (CL)
C
      RHOD=.168
      IF (TSTRES.GT.TMET) RHOD=.286
      RM=0.
      IF (ITYPE.EQ.4) RM=SQRT(RTBA**2-ARII*(RTBA**2-RHBA**2))
      IF (ITYPE.EQ.4) ST1=ST1+2.*PIE/BLN*RHOB*(RM/RTBA)**2*UTIP1**2
      IF (IP.EQ.2) WRITE (10,300) I
      CALL CWT (AR,BHAI,RHOB,RHOD,NB,ST1,RHBA,WTT,CLT,NC,I,ISTATR,HT1,RM
     1)
      IF (IP.EQ.2) WRITE (10,280)
      WT=WT+WTT
      CL=CL+CLT
      IF (IP.NE.2) GO TO 190
      IF (ISIO) GO TO 180
      WRITE (10,290) PRS(I),DHAS,XMCS,A1C,RHBA,RTBA,NB,UTP1,ST1,WTT,TTIS
      GO TO 190
180   SDH=DHAS*CONVER(9)
      SAI=A1C*CONVER(4)
      SRTB=RTBA*CONVER(1)
      SRHB=RHBA*CONVER(1)
      SUTP=UTP1*CONVER(2)
      SST=ST1*CONVER(6)
      SWT=WTT*CONVER(3)
      STTI=TTIS*CONVER(8)
      WRITE (10,290) PRS(I),SDH,XMCS,SAI,SRHB,SRTB,NB,SUTP,SST,SWT,STTI
190   CONTINUE
      WTFR=0.
      IF (IWMEC(4,NCC).NE.0) CALL FRAME (RTBA,IWMEC(4,NCC),WTFR,IP)
      WT=WT+WTFR+WTFF
      RF=0.
      FF=0.
      IF (IWMEC(3,NCC).NE.0) FF=CL/(2.*NS)
      IF (IWMEC(4,NCC).NE.0) RF=CL/NS
      CL=CL+FF+RF
      WATE(NCC)=WT
      ALENG(NCC)=CL
      RI(2,NO)=RHBA
      RO(2,NO)=RTBA
      IF (IP.NE.2) RETURN
C
C WRITE TOTAL COMPONENT WEIGHT AND LENGTH
C
      WRITE (10,260)
      IF (ISIO) GO TO 200
      WRITE (10,270) NS,WT,CL
```

```
      RETURN
200   SWT=WT*CONVER(3)
      SCL=CL*CONVER(1)
      WRITE (10,270) NS,SWT,SCL
      RETURN
210   WRITE (10,310) NCC
      RETURN
C
220   FORMAT (11H COMPRESSOR,I3,28H PRESSURE RATIO IS TOO HIGH )
230   FORMAT (12H  COMPRESSOR,I3,19H MECHANICAL DESIGN ,/)
240   FORMAT (49H  LOADING   N STG   DIAM  U TIP C    RPM   C RPM )
250   FORMAT (F9.3,2F8.2,3F8.1)
260   FORMAT (/,24H  N STG  WEIGHT  LENGTH )
270   FORMAT (I6,F9.2,F8.2,/)
280   FORMAT (42H   PR  DEL H  MACH  AREA  R HUB  R TIP  NB,26H U TIP
     1 STR   WEIGHT TIN)
290   FORMAT (F7.4,F6.1,F6.3,F7.3,F6.2,F7.2,I4,F7.1,F7.0,2F6.0)
300   FORMAT (/,7H STAGE ,I4)
310   FORMAT (11H COMPRESSOR,I3,28H  STAGE AND BLADE PARAMETERS,13H MEAN
     1INGLESS )
      END
```

```
C*******************************************************************
C
C SUBROUTINE(CWT)
C ---------------
C
C PURPOSE
C -------
C THIS ROUTINE CALCULATES THE WEIGHT AND LENGTH
C OF FANS AND COMPRESSORS.
C
C
C CALLING ROUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE       ID     ANALYST      DISCRIPTION
C    -------- -------- ----------- ---------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C --------
C
C
C   NAME      ORIGIN     USAGE      DISCRIPTION
C  ------     ------     -----    ----------------------------------------
C
C  AR          ARG                 ASPECT RATIO
C  BH          ARG                 BLADE HEIGHT
C  RHOB        ARG                 BLADE DENSITY
C  RHOD        ARG                 DISK DENSITY
C  NB          ARG                 NUMBER OF BLADES
C  ST          ARG                 BLADE ROOT STRESS
C  RHB         ARG                 BLADE HUB RADIUS
C  WT                              STAGE WEIGHT
C  CL                              STAGE LENGTH
C  NC          ARG                 COMPONENT TYPE
C  I           ARG                 STAGE NUMBER
C  NST         ARG                 STATOR INDICATOR
C  HTR         ARG                 HUB-TIP RATIO
C  RM          ARG                 SPLITTER RADIUS
C  VB                              BLADE VOLUME
C  SF                              STRESS FACTOR
C  VD                              DISK VOLUME
C  WTD                             DISK WEIGHT
```

```
C   WTB                             BLADE WEIGHT
C   WTS                             STATOR WEIGHT
C   WTNB                            NUTS AND BLOTS WEIGHT
C   WTCASE                          CASE WEIGHT
C
C
C*****************************************************************
C
C CALCULATE TOTAL BLADE AND STATOR WEIGHT
C
      SUBROUTINE CWT (AR,BH,RHOB,RHOD,NB,ST,RHB,WT,CL,NC,I,NST,HTR,RM)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C               ******************
C               * COMMON BLOCKS *
C               ******************
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
      IF (I.NE.1) GO TO 10
C
C   CALCULATE STAGE LENGTH AND BLADE AND STATOR WEIGHT
C
      RHI=RHB
10    CL=2.*BH/AR
      XCL=.17*CL
      IF (NST.GT.0) CL=XCL+CL
      IF (NST.LE.0) CL=CL/2.
      VB=.12*BH**3/AR**2
      IF (NC.EQ.1) VB=.055*BH**3/AR**2
      IF (HTR.GT..8) VB=(1.2+(HTR-.8)*4.)*.1*BH**3/AR**2
      BN=NB
      WTB=VB*RHOB*NB+.2*3.1415*BH**2/AR**2*RHOB*RM
      WTS=WTB
C
C CALCULATE DISK WEIGHT
C
      SF=ST*RHB/100000.
      IF (RHOD.GT..2) GO TO 30
      VD=(.11+(.00789*SF))*(RHB*2.)**2
      IF (SF.GT..4) VD=(.16262-.2138542*SF+.23954613*SF**2-.03515625*SF*
     1*3)*(RHB*2.)**2
      IF (SF.GT.2.4) VD=(-.2326+.3199*SF)*(RHB*2.)**2
      IF (NC.EQ.1.AND.I.GT.3) GO TO 20
```

```
      IF(NC.EQ.1)VD=(.11+.4496*SF)*(RHB*2.)**2
      IF (NC.EQ.1.AND.SF.GT.2.4.AND.SF.LT.5.2) VD=(.9458+.1014*SF)*(RHB*
     12.)**2
20    GO TO 40
30    VD=(.11+.003875*SF)*(RHB*2.)**2
      IF (SF.GT..8) VD=(.172121-.1543155*SF+.10808*SF**2-.0090774*SF**3)
     1*(RHB*2.)**2
      IF (SF.GT.4.) VD=(-.5015+.3*SF)*(RHB*2.)**2
40    WTD=VD*RHOD
      WTNB=(RHI*.75)*2.*3.1416*.075*CL*.286*RHI
      IF (NC.EQ.1.AND.I.EQ.1) WTNB=0.
      IF (NST.LE.0) WTS=0.
      WTCASE=(RHB+BH)*2.*3.1416*CL*.1*.286
      WT=WTD+WTS+WTB+WTNB+WTCASE
      IF (IOUTCD.NE.2) RETURN
      IF (ISIC) GO TO 50
      WRITE (10,60)
      WRITE (10,70) WTD,WTB,WTS,WTNB,WTCASE,CL,RHOB,RHOD,AR
      RETURN
50    WTD=WTD*CONVER(3)
      WTS=WTS*CONVER(3)
      WTB=WTB*CONVER(3)
      WTNB=WTNB*CONVER(3)
      WTCASE=WTCASE*CONVER(3)
      SCL=CL*CONVER(1)
      SRHOB=RHOB*CONVER(5)
      SRHOD=RHOD*CONVER(5)
      WRITE (10,60)
      WRITE (10,80) WTD,WTB,WTS,WTNB,WTCASE,SCL,SRHOB,SRHOD,AR
      RETURN
C
60    FORMAT (48H    WD    WB    WS    WN    WC    CL    RHOB  RHOD    AR)
70    FORMAT (5F5.0,F6.1,F6.3,F6.3,F6.2)
80    FORMAT (5F5.1,F6.3,2F6.5,F6.2)
      END
```

```
C*****************************************************************
C
C SUBROUTINE(COMBWT)
C ----------------
C
C PURPOSE
C -------
C THIS ROUTINE CALCULATES THE WEIGHT AND LENGTH
C OF PRIMARY BURNERS,DUCT BURNERS AND AUGMENTERS.
C
C
C CALLING ROUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE       ID     ANALYST      DISCRIPTION
C     -------- -------- ----------- --------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C --------
C
C
C   NAME      CRIGIN     USAGE      DISCRIPTION
C  ------     ------     -----    ----------------------------------------
C
C  ICOMP      ARG        I/O      COMPONENT NUMBER
C  ITYPE                          BURNER TYPE
C  VR                             THROUGH FLOW VELOCITY
C  TR                             RESENDENCY TIME
C  WC                             CORRECTED AIRFLOW
C  PO                             PRESSURE IN
C  TC                             TEMPERATURE IN
C  FA                             F/A RATIO IN
C  DM                             MEAN DIAMETER IN IN
C  RTR                            REF TIP RADIUS FOR DM
C  RHR                            REF HUB RADIUS FOR DM
C  GAMB                           GAMMA
C  AMACH                          MACH NUMBER
C  WSP                            FLOW PER UNIT AREA
C  R                              HUB TIP RATIO
C  DH                             INNER DIAMETER
C  DT                             OUTER DIAMETER
C  RT                             OUTER RADIUS
```

```
C  RH                              INNER RADIUS
C  BLEN                            LENGTH
C  WTCASE                          OUTER CASE WEIGHT
C  WTLIN                           LINNER WEIGHT
C  NN                              NUMBER OF FUEL NOZZLES
C  WTN                             FUEL NOZZLE WEIGHT
C  WTICAS                          INNER CASE WEIGHT
C  WTOT                            TOTAL WEIGHT
C
C
C*********************************************************************
C
      SUBROUTINE COMBWT (ICOMP)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C               ******************
C               * COMMON BLOCKS *
C               ******************
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
      DATA LPBUR,LAUG/4HPBUR,4HAUG /
      IF (IOUTCD.GT.1) WRITE (10,120) IWMEC(1,ICOMP),ICOMP,IOUTCD
C
C     INITIALIZE INPUTS
C
      ITYPE=11
      IF (IWMEC(1,ICOMP).EQ.LPBUR) ITYPE=10
      IF (IWMEC(1,ICOMP).EQ.LAUG) ITYPE=13
      VR=DEFAUL(1,ITYPE)
      TR=DEFAUL(2,ITYPE)
      IDES=1
      IF (DESVAL(1,ICOMP).EQ.0.) IDES=2
      IF (IDES.EQ.2) GO TO 10
      VR=DESVAL(1,ICOMP)
      TR=DESVAL(2,ICOMP)
10    NODEI=JCONF(ICOMP,1)
      NODEO=JCONF(ICOMP,3)
      WC=CORFLO(NODEI)
      WC=WC/1.54972555
      PO=TOPRES(NODEI)
      PO=PO*144.
      TO=TOTEMP(NODEI)
      FA=FAR(NODEI)
```

```
      DM=0.
      IF (ITYPE.EQ.13) GO TO 60
      IF (DEFAUL(3,ITYPE).NE.0.) DM=2.*DEFAUL(3,ITYPE)
      IF (DESVAL(3,ICOMP).NE.0.) DM=2.*DESVAL(3,ICOMP)
      IF (ISII) DM=DM/CONVER(1)
      IF (IDES.EQ.1.AND.DESVAL(4,ICOMP).EQ.0..AND.DESVAL(3,ICOMP).EQ.0.)
     1 NDI=NODEI
      IF (IDES.EQ.1.AND.DESVAL(4,ICOMP).EQ.0..AND.DESVAL(3,ICOMP).EQ.0.)
     1 GO TO 40
      IF (IDES.EQ.2.AND.DEFAUL(4,ITYPE).EQ.0..AND.DEFAUL(3,ITYPE).EQ.0.)
     1 NDI=NODEI
      IF (IDES.EQ.2.AND.DEFAUL(4,ITYPE).EQ.0..AND.DEFAUL(3,ITYPE).EQ.0.)
     1 GO TO 40
      IF (DESVAL(4,ICOMP).NE.0.) GO TO 30
      IF (DEFAUL(4,ITYPE).NE.0.) GO TO 20
      GO TO 50
20    IDI=IFIX(DEFAUL(4,ITYPE)+.01)
      NDI=JCONF(IDI,3)
      GO TO 40
30    IDI=IFIX(DESVAL(4,ICOMP)+.01)
      NDI=JCONF(IDI,3)
40    RTR=RO(2,NDI)
      RHR=RI(2,NDI)
      DM=RTR+RHR
50    DM=DM/12.
60    IF (ISII) VR=VR/CONVER(2)
C
C     CALCULATE MACH NUMBER AND FLOW PER UNIT AREA
C
C
      GAMB=STHERM(5,TO,FA)
      AMACH=VR/SQRT(GAMB*32.17*53.3*TO-(GAMB-1.)/2.*VR**2)
      WSP=PO*AMACH*SQRT(GAMB/(53.3*TO)*32.2)*(1./(1.+(GAMB-1.)/2.*AMACH*
     1*2))**((GAMB+1.)/2./(GAMB-1.))
      WSP=WSP*2116.22/PO*SQRT(TO/518.67)
      IF (ITYPE.EQ.13) GO TO 70
C
C     CALCULATE BURNER DIMENSIONS
C
      R=(1.-2.*WC/WSP/3.1415/DM**2)
      IF (R.LE.0.) R=0.
      R=SQRT(R)
      DH=R*DM*12.
70    IF (ITYPE.EQ.13) DH=0.
      DT=SQRT(DH**2/144.+4.*WC/WSP/3.1415)*12.
      RT=DT/2.
      RH=DH/2.
      BLEN=VR*TR*12.
C
C     CALCULATE WEIGHT
C
      WTCASE=3.1415*PO/144.*DT**2*BLEN*.3/166000.
      WTLIN=.055*3.1415*BLEN*.3*(DH+DT)
      NN=IFIX(3.1415*(DT+DH)/(.6*(DT-DH)))
      WTN=.009*BLEN*3.1415/4.*(DT-DH)**2/4.*.3*NN
      WTICAS=3.1415*PO/144.*DT*BLEN*.3*DH/166000.
```

```
      WTOT=WTCASE+WTLIN+WTN+WTICAS
C
C    CALCULATE FRAME WEIGHT FOR PRI BURNERS
C
      WTFRAM=0.
      IF (ITYPE.EQ.10.AND.IWMEC(2,ICOMP).EQ.1) CALL FRAME (RT,4,WTFRAM,0
     1)
      WTOT=WTOT+WTFRAM
C
C     STORE OUTPUT
C
      WATE(ICOMP)=WTOT
      ALENG(ICOMP)=BLEN
      RI(1,NODEI)=RH
      RO(1,NODEI)=RT
      RI(2,NODEO)=RH
      RO(2,NODEO)=RT
C
C     WRITE OUTPUT
C
      IF (ISIC.AND.IOUTCD.EQ.2) GO TO 90
      IF (IOUTCD.NE.2) RETURN
      IF (ITYPE.NE.10) GO TO 80
      WRITE (10,150) ICOMP
      WRITE (10,180)
      WRITE (10,130) RH,RT,BLEN,AMACH,WSP
      WRITE (10,160)
      WRITE (10,170) WTCASE,WTLIN,WTN,WTICAS,WTFRAM,WTOT
      GO TO 110
80    WRITE (10,150) ICOMP
      WRITE (10,180)
      WRITE (10,130) RH,RT,BLEN,AMACH,WSP
      WRITE (10,190)
      WRITE (10,200) WTCASE,WTLIN,WTN,WTICAS,WTOT
      GO TO 110
90    RT=RT*CONVER(1)
      RH=RH*CONVER(1)
      WSP=WSP*CONVER(7)
      WTLIN=WTLIN*CONVER(3)
      WTN=WTN*CONVER(3)
      WTICAS=WTICAS*CONVER(3)
      WTFRAM=WTFRAM*CONVER(3)
      WTOT=WTOT*CONVER(3)
      WTCASE=WTCASE*CONVER(3)
      IF (ITYPE.NE.10) GO TO 100
      WRITE (10,150) ICOMP
      WRITE (10,180)
      WRITE (10,140) RH,RT,BLEN,AMACH,WSP
      WRITE (10,160)
      WRITE (10,170) WTCASE,WTLIN,WTN,WTICAS,WTFRAM,WTOT
      GO TO 110
100   WRITE (10,150) ICOMP
      WRITE (10,180)
      WRITE (10,140) RH,RT,BLEN,AMACH,WSP
      WRITE (10,160)
      WRITE (10,200) WTCASE,WTLIN,WTN,WTICAS,WTOT
```

```
110    RETURN
C
120    FORMAT (1H /14H **************/14H *                    */4H *   ,A4,I3,3H   *
      1/14H *              */13H *************,I1)
130    FORMAT (5F9.3)
140    FORMAT (5F9.3)
150    FORMAT (15H BURNER NUMBER I4)
160    FORMAT (53H    CAS WT    LIN WT    NOZ WT    INC WT     FRAME     WTOT)
170    FORMAT (6F9.1,//)
180    FORMAT (44H    RIN     ROUT      LENGTH      MACH      WSPEC)
190    FORMAT (43H    CAS WT    LIN WT    NOZ WT    INC WT    WTOT)
200    FORMAT (6F9.1,//)
       END
```

```
C*****************************************************************
C
C SUBROUTINE(DUCTWT)
C ----------------
C
C PURPOSE
C -------
C THIS ROUTINE CALCULATES THE WEIGHT AND LENGTH
C OF THE DUCTS.
C
C
C CALLING ROUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE      ID    ANALYST     DISCRIPTION
C    -------- -------- ---------- ---------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
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C GLOSSARY
C --------
C
C
C   NAME     ORIGIN    USAGE     DISCRIPTION
C  ------    ------    -----   ----------------------------------------
C
C  ICOMP     ARG       I/O     COMPONENT NUMBER
C  NODEI                       NODE IN
C  NODEO                       NODE OUT
C  TLH                         LENGTH TO HEIGHT RATIO
C  AM                          MACH NUMBER IN
C  NODER                       REF COMPONENT NUMBER FOR DM
C  RHR                         REF HUB RADIUS
C  RTR                         REF TIP RADIUS
C  WA                          AIRFLOW
C  PO                          PRESSURE IN
C  TO                          TEMPERATURE IN
C  FAI                         F/A RATIO IN
C  DM                          MEAN DIAMETER IN IN
C  GAMB                        GAMMA
C  RHO                         MATERIAL DENSITY
C  STR                         REF STRESS
C  R                           HUB TIP RATIO
C  DH                          INNER DIAMETER
```

```
C   DT                              OUTER DIAMETER
C   RT                              OUTER RADIUS
C   RH                              INNER RADIUS
C   BLENG                           LENGTH
C   WTCASE                          OUTER DUCT WEIGHT
C   WTICAS                          INNER DUCT WEIGHT
C   WTOT                            TOTAL WEIGHT
C
C
C*****************************************************************************
C
      SUBROUTINE DUCTW (ICOMP)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C               *****************
C               * COMMON BLOCKS *
C               *****************
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
      IF (IOUTCD.GT.1) WRITE (10,130) IWMEC(1,ICOMP),ICOMP,IOUTCD
      NODEI=JCONF(ICOMP,1)
      NODEO=JCONF(ICOMP,3)
      TLH=0.
      IF (IWMEC(2,ICOMP).EQ.1) GO TO 10
      IF (IWMEC(2,ICOMP).EQ.2) GO TO 20
      GO TO 40
10    WATE(ICOMP)=0.
      ALENG(ICOMP)=0.
      RO(1,NODEI)=RO(2,NODEI)
      RI(1,NODEI)=RI(2,NODEI)
      RO(2,NODEO)=RO(2,NODEI)
      RI(2,NODEO)=RI(2,NODEI)
      RETURN
20    IF (DESVAL(2,ICOMP).EQ.0.) GO TO 30
      TLH=DESVAL(2,ICOMP)
      GO TO 50
30    TLH=DEFAUL(2,12)
      GO TO 50
40    BLEN=TLENG(NODEO)-TLENG(NODEI)
50    IF (DESVAL(1,ICOMP).EQ.0.) GO TO 70
      AM=DESVAL(1,ICOMP)
      IF (DESVAL(4,ICOMP).LT.0.) NODER=JCONF(ICOMP,1)
      IF (DESVAL(4,ICOMP).LT.0.) GO TO 90
```

```
      IF (DESVAL(3,ICOMP).EQ.0..AND.DESVAL(4,ICOMP).NE.0.) GO TO 60
      DM=2.*DESVAL(3,ICOMP)/12.
      IF (ISII) DM=DM/CONVER(1)
      GO TO 100
60    NODER=IFIX(DESVAL(4,ICOMP)+.01)
      GO TO 90
70    AM=DEFAUL(4,12)
      IF (DEFAUL(4,12).LT.0.) NODER=JCONF(ICOMP,1)
      IF (DEFAUL(4,12).LT.0.) GO TO 90
      IF (DEFAUL(3,12).EQ.0..AND.DEFAUL(4,12).NE.0.) GO TO 80
      DM=2.*DEFAUL(3,12)/12.
      IF (ISII) DM=DM/CONVER(1)
      GO TO 100
80    NODER=IFIX(DEFAUL(4,12)+.01)
90    RHR=RI(2,NODER)
      RTR=RO(2,NODER)
      DM=(RHR+RTR)/12.
100   WA=WTF(NODEI)
      PO=TOPRES(NODEI)
      PO=PO*144.
      TO=TOTEMP(NODEI)
      FAI=FAR(NODEI)
      GAMB=STHERM(5,TO,FAI)
      AD=0.DO
      CALL DUCT1 (TO,PO,WA,GAMB,AM,AD)
      R=0.
      IF (DM.NE.0.) R=(1.-2.*AD/3.1415/DM**2)
      IF (R.LE.0.) R=0.
      R=SQRT(R)
      DH=R*DM*12.
      DT=SQRT(DH**2/144.+4.*AD/3.1415)*12.
      IF (TLH.NE.0.) BLEN=TLH*(DT-DH)/2.
      RHO=.168
      STR=50000.
      IF (TO.GT.1160.) RHO=.286
      IF (TO.GT.1160.) STR=70000.
      WTCASE=3.1415*PO/144.*DT**2*BLEN*RHO/(2.*STR)
      WTICAS=3.1415*PO/144.*DT*BLEN*DH*RHO/(2.*STR)
      WTOT=WTCASE+WTICAS
      RH=DH/2.
      RT=DT/2.
      WATE(ICOMP)=WTOT
      ALENG(ICOMP)=BLEN
      RO(1,NODEI)=RT
      RI(1,NODEI)=RH
      RO(2,NODEO)=RT
      RI(2,NODEO)=RH
      IF (IOUTCD.NE.2) RETURN
      WRITE (10,210) ICOMP
      IF (ISIG) GO TO 110
      WRITE (10,140) RH,RT,BLEN
      WRITE (10,150) AD,RHO
      WRITE (10,160)
      WRITE (10,200) WTCASE,WTICAS,WTOT
      GO TO 120
110   SRH=RH*CONVER(1)
```

```
      SRT=RT*CONVER(1)
      SBLEN=BLEN*CONVER(1)
      SAD=AD*CONVER(4)
      SRHC=RHO*CONVER(5)
      SWTCAS=WTCASE*CONVER(3)
      SWTICA=WTICAS*CONVER(3)
      SWTOT=WTOT*CONVER(3)
      WRITE (10,170) SRH,SRT,SBLEN
      WRITE (10,180) SAD,SRHO
      WRITE (10,190) SWTCAS,SWTICA,SWTOT
120   RETURN
C
130   FORMAT (1H /14H ************/14H *            */4H *  ,A4,I3,3H  *
     1/14H *             */13H ***********,I1)
140   FORMAT (4H RH=,F8.2,4H RT=,F8.2,6H LENG=,F8.2)
150   FORMAT (6H AREA=,F8.3,5H RHO=,F4.3)
160   FORMAT (35H        CAS WT       INC WT       WTOT)
170   FORMAT (4H RH=,F8.4,4H RT=,F8.4,6H LENG=,F8.4)
180   FORMAT (6H AREA=,F8.4,5H RHO=,F8.7)
190   FORMAT (12H OUTER CASE=,F7.4,12H INNER CASE=,F7.4,7H TOTAL=,F7.4)
200   FORMAT (3F13.4,//)
210   FORMAT (7H DUCT ,I4)
      END
```

```
C*****************************************************************
C
C SUBROUTINE(DUCT)
C ----------------
C
C PURPOSE
C -------
C THIS ROUTINE CALCULATES INLET AND EXIT AREAS
C AND MACH NUMBERS FOR VARIOUS COMPONENTS AND
C THEIR STAGES.
C
C CALLING ROUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE      ID    ANALYST     DISCRIPTION
C    -------- -------- ---------- ---------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C --------
C
C
C   NAME     ORIGIN    USAGE     DISCRIPTION
C  ------    ------    -----   ---------------------------------------
C
C  TI         ARG               TEMPERATURE IN
C  PI         ARG               PRESSURE IN
C  WI         ARG               AIRFLOW IN
C  A          ARG               MACH NUMBER  INPUT
C                               AREA  OUTPUT
C  FA         ARG               F/A RATIO
C  XM2        ARG               MACH NUMBER
C  PS         ARG               STATIC PRESSURE
C  Q          ARG               DYNAMIC PRESSURE
C  IP         ARG               PRINT INDICATOR
C  TS                           STATIC TEMPERATURE
C  HI                           ENTHALPY
C  V                            VELOCITY
C
C
C*****************************************************************
C
C               ******************
```

```
C               * COMMON BLOCKS *
C               ****************
C
      SUBROUTINE DUCT (TI,PI,WI,A,FA,XM2,PS,V,ISIO,IP)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL ISIO
      IF (TI.LT.200.) TI=200.
      IF (TI.GT.6000.) TI=6000.
C
C CHECK FOR DUMMY DUCT.  CALCULATE MACH NUMBER (XM2) OR AREA (A)
C
      XM2=A
      IF (A.GT.0.) GO TO 10
      A=0.
      XM2=0.
      V=0.
10    IF (A.EQ.0.) GO TO 20
      GA=STHERM(5,TI,FA)
      CALL DUCT1 (TI,PI,WI,GA,XM2,A)
C
C CALCULATE STATIC TEMPERATURE (TS) AND PRESSURE (PS)
C
      C2=1.+(GA-1.)/2.*XM2*XM2
      TS=TI/C2
      PS=PI/C2**(GA/(GA-1.))
C
C CALCULATE ENTHALPY (HI) AND VELOCITY (V)
C
      HI=STHERM(4,TI,FA)
      IF (TS.GT.TI) TS=TI
      V=SQRT((2.*GA/(GA-1.))*53.34*32.174*(TI-TS))
C
C CALCULATE DYNAMIC PRESSURE (Q)
C
      Q=PS/53.34*V/2.*V/TS/53.34
20    IF (IP.NE.2) RETURN
C
C WRITE DUCT DATA
C
      IF (.NOT.ISIO) GO TO 30
      VSI=V*CONVER(2)
      TISI=TI/1.8
      PISI=PI*CONVER(11)
      PSSI=PS*CONVER(11)
      ASI=A*CONVER(4)
      WRITE (10,40)
      WRITE (10,50)
      WRITE (10,60) XM2,VSI,TISI,PISI,PSSI,ASI,GA
      RETURN
30    WRITE (10,40)
      WRITE (10,50)
      WRITE (10,60) XM2,V,TI,PI,PS,A,GA
      RETURN
C
40    FORMAT (6H DUCT )
```

```
50    FORMAT (48H  M NO  VEL  T TOT   P TOT   P STAT  AREA    GAM)
60    FORMAT (F6.3,2F6.0,F8.0,F8.0,F10.4,F8.4,/)
      END
```

```
C*************************************************************************
C
C SUBROUTINE(DUCT1)
C ----------------
C
C PURPOSE
C -------
C THIS ROUTINE CALCULATES THE INLET AND EXIT
C AREAS FOR THE STAGE BY STAGE ANALYSIS.
C
C
C CALLING ROUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE       ID     ANALYST      DISCRIPTION
C     -------- -------- ----------- ---------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C --------
C
C
C   NAME      ORIGIN     USAGE      DISCRIPTION
C  ------     ------     -----    ----------------------------------------
C
C  T          ARG                 TEMPERATURE IN
C  P          ARG                 PRESSURE IN
C  W          ARG                 AIRFLOW IN
C  A          ARG                 AREA  IF AREA IS NEGATIVE
C                                 MACH IS CALCULATED
C  GA                             GAMMA
C  XM                             MACH NUMBER
C  PM                             FLOW PER UNIT AREA
C  TM                             TEST MACH NUMBER
C
C
C*************************************************************************
C
C
      SUBROUTINE DUCT1 (T,P,W,GA,XM,A)
      DATA R,G/53.34,32.174/
      IF (A.LT.0.) GO TO 10
      GO TO 30
```

```
C
C CALCULATE MASS FLOW PARAMETER (PM) AND CONSTANTS
C
10     K=0
       A=ABS(A)
       PM=W*SQRT(T)/(P*A)
       XM=PM*20./17.
       CON1=SQRT(GA*G/R)
       GP1=GA+1.
       GM1=GA-1.
C
C FOR OFF-DESIGN CASE: ITERATE TO A MACH NUMBER (XM)
C
20     K=K+1
       CON2=1.+(GM1/2.)*XM*XM
       TM=XM*CON1*CON2**(-GP1/(2.*GM1))
       IF (ABS(PM-TM).LE..0004) RETURN
       IF (K.GT.30) WRITE (10,40)
       IF (K.GT.30) RETURN
       SL=CON1*CON2**(-GP1/(2.*GM1))-XM*XM*(GP1/2.)*CON1*CON2**((-3.*GA+1
      1.)/(2.*GM1))
       IF (SL.EQ.0.) RETURN
       XN=XM+((PM-TM)/SL)
       IF (XN.GE.1.) XN=1.
       IF (XN.LE.0.) XN=.001
       IF (XN.EQ..001.AND.XM.EQ..001) RETURN
       IF (XN.EQ.1..AND.XM.EQ.1.) RETURN
       XM=XN
       GO TO 20
C
C FOR DESIGN CASE: CALCULATE AN AREA (A)
C
30     IF (XM.LE.0.) RETURN
       A=W/XM*SQRT(R/GA*G*T)/P*(1.+(GA-1.)/2.*XM*XM)**((GA+1.)/(GA-1.)/2.
      1)/G
       RETURN
C
40     FORMAT (25H  DUCT IS NOT CONVERGING )
       END
```

```
C*****************************************************************
C
C SUBROUTINE(EFFD)
C ----------------
C
C PURPOSE
C -------
C THIS ROUTINE CONVERTS ADIABATIC EFFICIENCIES
C TO POLYTROPIC EFFICIENCIES.
C
C
C CALLING ROUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE      ID    ANALYST     DISCRIPTION
C    -------- -------- ---------- ---------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C --------
C
C
C   NAME     ORIGIN    USAGE     DISCRIPTION
C  ------    ------    -----   ---------------------------------------
C  TI        ARG               TEMPERATURE
C  PR        ARG               PRESSURE RATIO
C  PEFD      ARG               POLYTROPIC EFFICIENCY
C  EF        ARG               ADIABATIC EFFICIENCY
C  FA        ARG               F/A RATIO
C
C*****************************************************************
C
C THIS ROUTINE CONVERTS ADIABATIC TO POLYTROPIC
C EFFICIENCIES. A (+) DESIGNATES ADIABATIC AND A
C (-) DESIGNATES POLYTROPIC.
      SUBROUTINE EFFD (TI,PR,PEFD,EF,FA)
      IF (PR.EQ.1.) RETURN
      GA=STHERM(5,TI,FA)
      IF (PR.LE.0.) GO TO 10
      IF (PEFD.GE.0.) PEFD=ALOG(PR**((GA-1.)/GA))/ALOG(1.+(PR**((GA-1.)/
     1GA)-1.)/PEFD)
      IF (PEFD.LE.0.) PEFD=-PEFD
      EF=(PR**((GA-1.)/GA)-1.)/(PR**((GA-1.)/GA/PEFD)-1.)
```

```
      GO TO 20
10    PR=-1./PR
      IF (PEFD.GE.0.) PEFD=ALOG(1.-PEFD*(1.-PR**((GA-1.)/GA)))/ALOG(PR**
     1((GA-1.)/GA))
      IF (PEFD.LE.0.) PEFD=-PEFD
      EF=(1.-PR**(PEFD/GA*(GA-1.)))/(1.-PR**((GA-1.)/GA))
20    PEFD=-PEFD
      RETURN
      END
```

```
C*****************************************************************
C
C SUBROUTINE(FRAME)
C ---------------
C
C PURPOSE
C -------
C THIS ROUTINE CALCULATES THE WEIGHT OF FRONT,
C INTERMEDIATE ,PRIMARY BURNER FRAMES AND TURBINE
C EXIT FRAMES.
C
C CALLING ROUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE       ID     ANALYST      DISCRIPTION
C     -------- -------- ----------- ---------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C    E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLCSSARY
C --------
C
C
C    NAME      ORIGIN     USAGE      DISCRIPTION
C   ------     ------     -----    ----------------------------------------
C
C   RT         ARG          I      TIP RADIUS
C   NTYPE      ARG          I      TYPE OF FRAME
C   WT         ARG          O      WEIGHT
C   IP         ARG          O      PRINT INDICATOR
C   RT2                     L      TIP RADIUS SQUARED
C
C
C*****************************************************************
C
      SUBROUTINE FRAME (RT,NTYPE,WT,IP)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TCLT,TOLTT,DEPV,DTOL,PERPF
C
C                ******************
C                * COMMON BLOCKS *
C                ******************
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
```

```
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
C    THIS ROUTINE CALCULATES FRAME WEIGHT
C    NTYPE= THE TYPE OF FRAME
C          1 IS FOR SINGLE BEARING FRAME FOR TF OR TJ W/O PT
C          2 IS FOR SINGLE BEARING FRAME FOR SINGLE SPOOL TJ
C          3 IS FOR TURBINE EXIT FRAMES
C          4 IS FOR INTERMEDIATE FRAMES
C
      RT2=(RT/12.)**2
      GO TO (10,20,30,40),NTYPE
C TYPE 1 FRAME - TJ/TF W/O PTO
10    WT=34.48*RT2
      IF (RT2.GT.2.9) WT=47.869*RT2-38.82
      GO TO 50
C TYPE 2 FRAME -TJ W PTO
20    WT=104.1*RT2
      IF (RT2.GT.1.95) WT=40.99*RT2+123.1
      GO TO 50
C TYPE 3 FRAME - TURB EX
30    WT=130.77*RT2
      IF (RT2.GT.2.1) WT=49.71*RT2+167.61
      GO TO 50
C TYPE 4 FRAME - INTERM W PTO $ TWO BEARINGS
40    WT=130.77*RT2
      IF (RT2.GT.5.8) WT=29.02*RT2+567.68
50    IF (IP.NE.2) RETURN
      WTT=WT
      IF (ISIO) WTT=WTT*CONVER(3)
      WRITE (10,60) WTT
      RETURN
C
60    FORMAT (/,12H FRAME WT  =,F8.2,//)
      END
```

```
C*****************************************************************
C
C SUBROUTINE(STRESS)
C ----------------
C
C PURPOSE
C -------
C THIS ROUTINE CALCULATES BLADE ROOT STRESS FOR
C THE COMPRESSORS AND THE TURBINES.
C
C
C CALLING ROUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE       ID     ANALYST      DISCRIPTION
C    -------- -------- ----------- ---------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C --------
C
C
C   NAME      ORIGIN     USAGE      DISCRIPTION
C  ------     ------     -----    ----------------------------------------
C  RT         ARG                 TIP RADIUS
C  TI         ARG                 TEMPERATURE IN
C  TS         ARG                 TIP SPEED
C  HTR        ARG                 HUB-TIP RATIO
C  RPM        ARG                 RPM
C  ST         ARG                 BLADE ROOT STRESS
C  TR         ARG                 BLADE TAPER RATIO
C  NC         ARG                 COMPONENT INDICATOR
C  IP         ARG                 PRINT INDICATOR
C  RHO        ARG                 BLADE DENSITY
C  TMET       ARG                 METAL CHANGE TEMP
C  R                              HUB-TIP RATIO FOR S
C  A                              BASE AREA
C  VAR                            CORRECTION FACTOR FOR LOCATION
C  D                              CORRECTION FACTOR FOR TAPER RATIO
C  W                              WEIGHT PER UNIT AREA
C  F                              PULL FORCE
C  XKT                            SCALER ON STRESS
C
```

```
C
C*****************************************************************
C
      SUBROUTINE STRESS (RT,TI,TS,HTR,RPM,ST,TR,NC,IP,RHO,TMET)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C               *****************
C               * COMMON BLOCKS *
C               *****************
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
     140),FAR(40),COPFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     1C(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL ISIO
C THIS RCUTINE CALCULATES THE CENTRIFUGAL ROOT
C STRESS FOR THE FIRST BLADE OF EACH COMPONENT
      IF (TS.EQ.0.) TS=2.*3.1416/60.*RPM*RT
      PCBH=0.
      XKT=1.
      IF (TMET.EQ.0.) TMET=1160.
      IF (RHO.NE.0.) GO TO 10
      DEN=.168
      IF (TI.GT.TMET) DEN=.286
      GO TO 20
10    DEN=RHO
20    R=(1.-PCBH/100.)*HTR+PCBH/100.
      A=1.+(TR-1.)*((1.-R)/(1.-HTR))**2
      VAR=(1.-R)**3/(1.-HTR)**2
      D=(1.-R**2)/2.+(TR-1.)/12.*VAR*(1.+3.*R)
      W=DEN*(1.-R+(TR-1.)/3.*VAR)*RT*12.
      F=DEN/386.*(TS*12.)**2*D
      ST=F/A*XKT
      RHO=DEN
      IF (IP.NE.2) RETURN
      WRITE (10,40)
      IF (ISIO) GO TO 30
      WRITE (10,50) TS,ST,DEN,W,TR,HTR
      RETURN
30    STS=TS*CONVER(2)
      SST=ST*CONVER(6)
      DEN=DEN*CONVER(5)
      W=W*CONVER(7)
      WRITE (10,50) STS,SST,DEN,W,TR,HTR
      RETURN
C
40    FORMAT (45H   U TIP   STRESS     DEN   W/AREA    TR      H/T)
50    FORMAT (2F8.1,4F8.3,/)
      END
```

```
C*******************************************************************************
C
C SUBROUTINE(SHAFT)
C ----------------
C
C PURPOSE
C -------
C THIS ROUTINE CALCULATES THE WEIGHT OF THE SHAFTS
C
C
C CALLING ROUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE       ID     ANALYST      DISCRIPTION
C     -------- -------- ----------- ---------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C --------
C
C
C   NAME      ORIGIN     USAGE      DISCRIPTION
C  ------     ------     -----    ----------------------------------------
C
C  ICCMP      ARG        I/O      COMPONENT NUMBER
C  POWER                          HORSEPOWER
C  NT                             TURBINE COUNTER
C  NTURB                          TURBINE NUMBER FOR POWER SUMMATION
C  NCOM                           COMPERSSOR NUMBER FOR LENGTH
C  TLEN                           SHAFT LENGTH
C  TRPM                           TURBINE RPM
C  CRPM                           COMPRESSOR RPM
C  SPEED                          MIN. RPM
C  STRE                           REF. STRESS
C  RHO                            MATERIAL DENSITY
C  R                              HUB-TIP RATIO
C  ILCC                           LOCATION INDICATOR
C  DO3                            OUTER DIA. CUBED
C  DO                             OUTER DIAMETER
C  DI                             INNER DIAMETER
C  DOA                            GUESS ON DO
C  DELD                           DELTA ON DO
C  WT                             WEIGHT
```

```
C  DN                              DN NUMBER OF BEARING
C
C
C*********************************************************************
C
      SUBROUTINE SHAFT (ICOMP)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TCL,TCLT,TOLTT,DEPV,DTOL,PERPF
C
C               ******************
C               * COMMON BLOCKS *
C               ******************
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTCL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
      IF (IOUTCD.GT.1) WRITE (10,120) IWMEC(1,ICOMP),ICOMP,IOUTCD
C
C   DETERMINE TOTAL SHAFT POWER
C
      POWER=0.
      NT=3
10    NTURB=IWMEC(NT,ICOMP)
      POWER=DATOUT(1,NTURB)+POWER
      NT=NT+1
      IF (NT.EQ.6) GO TO 20
      IF (IWMEC(NT,ICOMP).NE.0.) GO TO 10
20    NCOM=IWMEC(7,ICOMP)
C
C   DETERMINE SHAFT LENGTH AND MIN. SPEED
C
      NTF=JCONF(NTURB,1)
      NCR=JCONF(NCOM,3)
      TLEN=TLENG(NTF)-TLENG(NCR)
      TRPM=RPMT(NTURB)
      CRPM=RPMT(NCOM)
      SPEED=AMIN1(TRPM,CRPM)
C
C    INPUT DESIGN DATA
C
      IF (DESVAL(1,ICOMP).EQ.0.) GO TO 30
      STRE=DESVAL(1,ICOMP)
      RHO=DESVAL(2,ICOMP)
      R=DESVAL(3,ICOMP)
      GO TO 40
30    STRE=DEFAUL(1,14)
```

```
      RHC=DEFAUL(2,14)
      R=DEFAUL(3,14)
40    IF (.NOT.ISII) GO TO 50
      STRE=STRE/CONVER(6)
      RHO=RHO/CONVER(5)
50    ILCC=IWMEC(2,ICOMP)
C
C   DETERMINE SHAFT LOCATION  1 IS INNER SHAFT
C
      IF (ILOC.NE.1) GO TO 60
      DO3=454048.43*POWER/(SPEED*STRE*(1.-R**4))
      DO=DO3**(1./3.)
      DI=DO*R
      GO TO 90
C
C   CALCULATION FOR OUTER SHAFTS
C
C        **********************
C  NEWTON-RAPHSON INTERATION FOR SHAFT OUTER DIAMETER
C        ******************
60    DI=DSHAF(ILOC-1)+.4
      DNEW=DI
      B=-DI**4
      A=-454048.*POWER/STRE/SPEED
      DO 70 I=1,50
      A1=DNEW**4+A*DNEW+B
      A2=4.*DNEW**3+A
      DOLD=DNEW
      DNEW=DOLD-A1/A2
      IF (ABS(DNEW-DOLD).LE..01) GO TO 80
      DNEW=AMAX1(DI,AMIN1(100.,DNEW))
70    CONTINUE
      WRITE (10,130) ICOMP
      DNEW=5.
80    DO=DNEW
90    DSHAF(ILOC)=DO
      DN=DO*SPEED*25.4/1000000.
      WT=.7853981*RHO*TLEN*(DO**2-DI**2)
      WATE(ICOMP)=WT
C
C   WRITE OUTPUT
C
      IF (IOUTCD.NE.2) RETURN
      WRITE (10,140) ICOMP
      IF (ISIC) GO TO 100
      WRITE (10,150) DO,DI,TLEN,DN,WT
      IF (DN.GT.2.) WRITE (10,170) DN
      GO TO 110
100   DO=DO*CONVER(1)
      DI=DI*CONVER(1)
      TLEN=TLEN*CONVER(1)
      WT=WT*CONVER(3)
      WRITE (10,160) DO,DI,TLEN,DN,WT
110   CONTINUE
      RETURN
C
```

```
120   FORMAT (1H /14H *************/14H *           */4H *  ,A4,I3,3H  *
     1/14H *            */13H ************,I1)
130   FORMAT (15H ERROR IN SHAFT,I4)
140   FORMAT (6H SHAFT,I4,/,34H    DO      DI    LENG      DN      WT)
150   FORMAT (5F7.2,//)
160   FORMAT (3F7.1,2F7.1,//)
170   FORMAT (15HTHE DN VALUE OF,F4.2,15HMILLION IS HIGH)
      END
```

```
C*****************************************************************************
C
C SUBRCUTINE(TURB)
C ----------------
C
C PURPOSE
C -------
C THIS ROUTINE PERFORMS THE TURBINE PERFORMANCE
C CALCULATIONS AND THE BOOKKEEPING FOR THE
C MECHANICAL DESIGN.
C
C CALLING ROUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C EFFD
C TMECH
C DUCT
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE       ID     ANALYST      DISCRIPTION
C    -------- -------- ----------- ---------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLCSSARY
C --------
C
C
C   NAME      ORIGIN     USAGE      DISCRIPTION
C  ------     ------     -----    ----------------------------------------
C  ICOMP      ARG                 COMPONENT NUMBER
C  IP                             PRINT INDICATOR
C  NTT                            COMPONENT NUMBER
C  NODEIS                         BLEED MODE IN
C  NODEI                          NODE IN
C  NODEO                          NODE OUT
C  WI                             AIRFLOW IN
C  TI                             TEMPERATURE IN
C  PI                             PRESSURE IN
C  ITURB                          TURBINE INDICATOR
C  NT                             TURBINE INDICATOR
C  FAI                            FUEL AIR RATIO IN
C  EPI                            EFFICIENCY
C  IDES                           DATA INDICATOR
C  CFT                            COOLING FLOW
C  TC                             TEMPERATURE OF THE COOLING FLOW
C  CFF                            COOLING FLOW TO THE FRONT OF TURBINE
```

```
C   CFR                             COOLING FLOW TO THE BACK OF THE TURBINE
C   AT                              MACH NUMBER
C   TLD                             TURBINE LOADING PARAMETER
C   NRPM                            RPM LOCATOR
C   RPM                             RPM
C   RCC                             CONTROL RADIUS
C   IDI                             COMPRESSOR NUMBER FOR RCC
C   NODRCC                          NODE FOR CONTROL RADIUS
C   CW                              CORRECTED WEIGHT FLOW
C   HC                              ENTHALPY OF COOLING GAS
C   HI                              ENTHALPY OF INLET AIR
C   FAI                             FUEL AIR RATIO
C   WI                              AIRFLOW INTO THE COMPONENT
C   WHP                             HORSE POWER
C   DHA                             ACTUAL DELTA ENTHALPY
C   H3                              ENTHALPY OUT
C   RP1                             RELATIVE PRESSURE IN
C   DHI                             IDEAL ENTHALPY
C   H2                              IDEAL ENTHALPY OUT
C   T2                              IDEAL TEMPERATURE OUT
C   RP2                             RELATIVE PRESSURE OUT
C   PR                              PRESSURE RATIO
C   PR1                             PRESSURE RATIO
C   EF2T                            EFFICIENCY
C   TR                              TEMPERATURE RATIO
C   H4                              EXIT ENTHALPY
C   FAO                             FUEL AIR RATIO OUT
C   TO                              TEMPERATURE OUT
C   PO                              PRESSURE OUT
C   WO                              AIRFLOW OUT
C   GA                              GAMMA
C   GAC                             GAS CONSTANT - R
C   VI                              VELOCITY
C   VCR                             CRITICAL VELOCITY
C   HST                             STATIC ENTHALPY
C   TST                             STATIC TEMPERATURE
C   PRST                            STATIC RELATIVE PRESSURE
C   PST                             STATIC PRESSURE
C   AT1                             EXIT AREA
C   EFS                             POLYTROPIC EFFICIENCY
C   ATD                             MACH NUMBER IN OR EXIT AREA
C   XME                             MACH NUMBER OUT
C   XMS                             MACH NUMBER IN
C
C
C*****************************************************************************
C
      SUBROUTINE TURB (ICOMP)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C               ******************
C               * COMMON BLOCKS *
C               ******************
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
```

```
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     1O(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
C
C              ********************
C              * DATA STATEMENTS *
C              ********************
C
      DATA TSTD,PSTD,C1,FA,G,R/518.67,2116.22,778.,0.,32.174,53.34/
      DATA LLPT/4HLPT /
C
C CHECK FOR BAD INLET TEMPERATURE. CALCULATE CORRECTED INLET FLOW
C (CW), COOLING FLOW ENTHALPY (HC) AND INLET ENTHALPY (H1)
C
      IF (IOUTCD.GT.1) WRITE (10,70) IWMEC(1,ICOMP),ICOMP,IOUTCD
      IP=IOUTCD
      NTT=ICOMP
      NODEIS=JCONF(NTT,2)
      NODEI=JCONF(NTT,1)
      NODEO=JCONF(NTT,3)
      WI=WTF(NODEI)
      TI=TOTEMP(NODEI)
      PII=TOPRES(NODEI)
      PI=PII*144.
      ITURB=8
      NT=5
      IF (IWMEC(1,NTT).EQ.LLPT) ITURB=9
      IF (IWMEC(1,NTT).EQ.LLPT) NT=7
      FAI=FAR(NODEI)
      EFI=DATCUT(8,NTT)
      IDES=1
      IF (DESVAL(1,NTT).EQ.0.) IDES=2
      CFT=0.
      TC=0.
      IF (NODEIS.NE.0) TC=TOTEMP(NODEIS)
      IF (NODEIS.NE.0) CFT=WTF(NODEIS)
      CFF=CFT*DATINP(2,NTT)*DATINP(9,NTT)
      CFR=CFT*DATINP(2,NTT)*(1.-DATINP(9,NTT))
      GO TO (10,20),IDES
10    AT=DESVAL(1,NTT)
      TLP=DESVAL(2,NTT)
      GO TO 30
20    AT=DEFAUL(1,ITURB)
      TLP=DEFAUL(2,ITURB)
30    NRPM=IWMEC(3,NTT)
      RPM=RPMT(NRPM)
      RPMT(NTT)=RPM
```

```
      IDI=IWMEC(4,NTT)
      IPOS=3
      IF (IDI.LT.0) IPOS=1
      NODRCC=NODEI
      IDI=IABS(IDI)
      IF (IDI.NE.0) NODRCC=JCONF(IDI,IPOS)
      IF (IPOS.EQ.3) RCC=RO(2,NODRCC)/12.
      IF (IPOS.EQ.1) RCC=RO(1,NODRCC)/12.
      IF (DESVAL(10,NTT).NE.0.) RCC=DESVAL(10,NTT)/12.
      IF (DESVAL(10,NTT).NE.0..AND.ISII) RCC=RCC/CONVER(1)
      IF (TI.LT.200.) TI=200.
      IF (TI.GT.6000.) TI=6000.
      CW=WI*SQRT(TI/TSTD)/PI*PSTD
      HC=0.
      IF (NODEIS.NE.0) HC=STHERM(4,TC,FA)
      H1=STHERM(4,TI,FAI)
      H1=(H1*WI+HC*CFF)/(WI+CFF)
      FAI=FAI*WI/(WI+CFF)
      WI=WI+CFF
      TI=STHERM(1,H1,FAI)
C
C INITIALIZE EFFICIENCY (EF) AND CALCULATE ACTUAL WORK (WHP), ENTHALPY
C CHANGE ACROSS TURBINE (DHA), EXIT ENTHALPY (H3) AND EXIT PRESSURE
C RATIO (RP1)
C
      EF=ABS(EF1)
      WHP=DATCUT(1,NTT)
      DHA=WHP*.7068/WI
      IF (DHA.LE..0001) DHA=.0001
      H3=H1-DHA
      RP1=STHERM(2,TI,FAI)
C
C BEGIN EFFICIENCY ITERATION. CALCULATE IDEAL ENTHALPY (DHI) CHANGE
C ACROSS COMPONENT, IDEAL EXIT ENTHALPY (H2) AND TOTAL PRESSURE
C RATIO (RP2)
C
      K=0
40    K=K+1
      DHI=DHA/EF
      H2=H1-DHI
      T2=STHERM(1,H2,FAI)
      RP2=STHERM(2,T2,FAI)
C
C CALCULATE PRESSURE RATIO (PR) ACROSS COMPONENT AND EFFICIENCY (EF)
C
      PR=RP1/RP2
      PR1=-PR
      EF2T=EF
      CALL EFFD (TI,PR1,EF1,EF,FAI)
C
C CHECK FOR CONVERGENCE OF ITERATION
C
      IF (ABS((EF2T-EF)/EF).LE..0001) GO TO 50
      IF (K.GT.10) GO TO 50
      GO TO 40
50    IF (K.GT.10) WRITE (10,80) NT
```

```
C
C CALCULATE EXIT TOTAL TEMPERATURE (T3) AND TEMPERATURE RATIO (TR)
C
      T3=STHERM(1,H3,FAI)
      TR=TI/T3
C
C CALCULATE EXIT ENTHALPY (H4), FUEL-TO-AIR RATIO (FAO) AND TOTAL
C TEMPERATURE (T4) AFTER ADDITION OF COOLING FLOW
C
      H4=(H3*WI+HC*CFR)/(WI+CFR)
      FAC=FAR(NODEO)
      TO=STHERM(1,H4,FAO)
C
C CALCULATE INLET AREA (AT - DESIGN) OR MACH NUMBER (XM - OFF-DESIGN),
C AND ACTUAL PRESSURE LOSS (DP2) AND INLET DUCT EXIT TOTAL PRESSURE
C (PO1)
      CALL DUCT (TI,PI,WI,AT,FAI,XM,PS,DQ,ISIO,IP)
C
C CALCULATE EXIT TOTAL PRESSURE (PO), FLOW (WO), VELOCITY (V1) AND
C INLET CRITICAL SONIC VELOCITY (VCR)
C
      PO=PI/PR
      WO=WI+CFR
      GA=STHERM(5,TI,FAI)
      GAC=STHERM(6,FAI,FAI)
      V1=SQRT(2.*G*C1*DHA)
      VCR=SQRT((G*GA*GAC*TI)/((1.+GA)/2.))
      IF (V1.LT.VCR) VCR=V1
C
C CALCULATE STATIC ENTHALPY (HST), TEMPERATURE (TST), PRESSURE (PST)
C AND EXIT NOZZLE AREA (AT1)
C
      HST=H1-VCR/2.*VCR/G/C1
      TST=STHERM(1,HST,FAI)
      RPST=STHERM(2,TST,FAI)
      PST=PI/RP1*RPST
      AT1=WI/PST*R/VCR*TST
C
C CALCULATE COMPONENT MECHANICAL DESIGN AND DIMENSIONS
C
      EFS=EF1
      XMS=XM
      CALL TMECH (IP,IDES,NT,H1,DHA,DHI,RPM,WI,TI,PI,FAI,RCC,WHP,TLP,ITU
     1RB,EFS,XMS,XME,AT,FACL,WT,TL,NTT)
      ATD=XME
C
C CALCULATE TURBINE EXIT AREA (ATD - DESIGN) OR MACH NUMBER (XME -
C OFF-DESIGN), DYNAMIC PRESSURE (QTEX), REYNOLDS NUMBER (RENTEX)
C AND PRESSURE LOSS (DP2)
C
      CALL DUCT (TO,PO,WO,ATD,FAO,XME,PS,QTEX,ISIO,IP)
C
C WRITE TURBINE PERFORMANCE DATA
C
      IF (IP.NE.2) RETURN
      IF (ISIO) GO TO 60
```

```
      WRITE (10,90)
      WRITE (10,100) PR,TR,EF,PO,T3,TO
      WRITE (10,110)
      WRITE (10,120) H1,H3,AT1,WI,WHP
      WRITE (10,130) WATE(ICOMP)
      RETURN
60    WRITE (10,90)
      SPO=PO*CONVER(11)
      ST3=T3*CONVER(8)
      STO=TO*CONVER(8)
      SH1=H1*CONVER(9)
      SH3=H3*CONVER(9)
      SAT1=AT1*CONVER(4)
      SWI=WI*CONVER(3)
      SWHP=WHP*CONVER(10)
      WT1=WATE(ICOMP)*CONVER(3)
      WRITE (10,100) PR,TR,EF,SPO,ST3,STO
      WRITE (10,110)
      WRITE (10,120) SH1,SH3,SAT1,SWI,SWHP
      WRITE (10,130) WT1
      RETURN
C
70    FORMAT (1H /14H **************/14H *           */4H *  ,A4,I3,3H  *
     1/14H *            */13H ************,I1)
80    FORMAT (8H TURBINE,I3,37H EFFICIENCY ITERATIONS EXCEED MAXIMUM)
90    FORMAT (46H   PR      TR      AD EF    PO       TO      TO.1)
100   FORMAT (3F8.4,3F8.1)
110   FORMAT (37H  H IN    H OUT    AREA   FLOW     HP)
120   FORMAT (4F8.2,F8.0,F8.4,//)
130   FORMAT (/,41H ******************* TOTAL TURB WEIGHT IS,F10.3,/)
      END
```

```
C*****************************************************************************
C
C SUBROUTINE(TMECH)
C ----------------
C
C PURPOSE
C -------
C THIS ROUTINE PERFORMS THE TURBINE MECHANICAL
C DESIGN.
C
C
C CALLING RCUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C STRESS
C DUCT1
C EFFD
C TURWT
C MODIFICATION HISTORY
C --------------------
C
C       DATE       ID     ANALYST      DISCRIPTION
C     -------- -------- ----------- ---------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLCSSARY
C --------
C
C
C   NAME      ORIGIN     USAGE      DISCRIPTION
C  ------     ------     -----    ----------------------------------------
C  IP         ARG                 PRINT INDICATOR
C  IDES       ARG                 DATA LOCATION INDICATOR
C  NT         ARG                 TURBINE TYPE INDICATOR
C  H1         ARG                 ENTHALPY
C  DHA        ARG                 DELTA ENTHALPY
C  DHI        ARG                 IDEAL DELAT ENTHALPY
C  RPM        ARG                 RPM
C  WI         ARG                 AIRFLOW IN
C  TI         ARG                 TEMPERATURE IN
C  PI         ARG                 PRESSURE IN
C  FA         ARG                 F/A RATIO IN
C  RC         ARG                 CONTROL RADIUS FOR TURBINE
C  NS                             NUMBER OF STAGES
C  HT                             HUB-TIP RATIO
C  ST                             STRESS
C  WHP        ARG                 HORSEPOWER
C  RT                             TIP RADIUS
```

```
C   TLP         ARG                 TURBINE LOADING PARAMETER
C   ITURB       ARG                 TURBINE INDICATOR
C   PEF         ARG                 POLYTROPIC EFFICIENY
C   XM                              MACH IN
C   XME                             MACH OUT
C   AIN         ARG                 AREA IN
C   NTT         ARG                 COMPONENT NUMBER
C   GR                              GEAR RATIO
C   GBWT                            GEAR BOX WEIGHT
C   OM                              OMEGA
C   UTM                             MAX. TIP SPEED
C   UT                              TIP SPEED
C   RH                              HUB RADIUS
C   A                               AREA IN
C   DIAM                            TIP DIAMETER
C   TR                              BLADE TAPER RATIO
C   TORQ                            TORQUE
C   NODEI                           NODE IN
C   NODEO                           NODE OUT
C   RTIN                            TIP RADIUS - IN
C   RHIN                            HUB RADIUS - IN
C   SOLC                            SOLIDITY
C   ARIC                            TURBINE ASPECT RATIO IN
C   ARCC                            TURBINE ASPECT RATIO OUT
C   CIMN                            MACH INTO TURBINE
C   CCMN                            MACH OUT OF TURBINE
C   STR                             REF. STRESS FOR DISK
C   COCK                            COOLING FLOW
C   MODE                            DESIGN MODE FOR TURBINE
C   RPMR                            RPM RATIO - NMAX/NDES
C   DELMS                           MACH IN - MACH OUT
C   DELAR                           ASPECT RATIO IN - ASPECT RATIO OUT
C   WT                              STAGE WEIGHT
C   TL                              STAGE LENGTH
C   PCS                             PRESSURE IN OR OUT
C   EF                              EFFECIENCY
C   TTOS                            TEMPERATURE IN OR OUT
C   HCS                             ENTHALPY IN OR OUT
C   XMCS                            MACH INTO STAGE
C   AR                              ASPECT RATIO OF STAGE
C   RTB                             TIP RADIUS OF BLADE
C   RM                              MEAN RADIUS OF BLADE
C   RHB                             HUB RADIUS OF BLADE
C   RHBA                            HUB RADIUS - IN.
C   GAG                             GAMMA
C   HIS                             ENTHALPY INTO STAGE
C   TTIS                            TEMPERATURE INTO STAGE
C   PIS                             PRESSURE INTO STAGE
C   CW                              CORRECTED AIRFLOW
C   RTBA                            TIP RADIUS - IN.
C   UTP1                            TIP SPEED OF BLADE
C   BH                              BLADE HEIGHT
C   WTFRA                           FRAME WEIGHT
C
C
C*************************************************************************
```

```
C
      SUBROUTINE TMECH (IP,IDES,NT,H1,DHA,DHI,RPM,WI,TI,PI,FA,RC,WHP,TLP
     1,ITURB,PEF,XM,XME,AIN,FACL,WT,TL,NTT)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C               ******************
C               * COMMON BLOCKS *
C               ******************
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
C
C               ********************
C               * DATA STATEMENTS *
C               ********************
C
      DATA TSTD,PSTD,PIE,CC1,G/518.67,2116.22,3.14159,778.,32.174/
      DIMENSION PRR(10), GR(3), GBWT(3)
C
C CHECK FOR BAD INPUTS AND CASE TYPE.  SET FLAG FOR STAGE-BY-STAGE
C TURBINE DESIGN
C
      IF (RPM.EQ.0.) RETURN
C
C INITIALIZE TURBINE DESIGN VALUES
C
      SN=0.
      NNT=NT-4
      RPM2=RPM
C
C FOR DESIGN CASE: INITIALIZE STAGE DESIGN VALUES
C
      OM=RPM*2.*PIE/60.
      KK=0
      UTM=RC*OM
C
C BEGIN ITERATION FOR NUMBER OF STAGES (SN) BASED ON BLADE
C TIP SPEED (UT)
C
      IF (IWMEC(5,NTT).NE.0) SN=IWMEC(5,NTT)
      IF (IWMEC(5,NTT).NE.0) GO TO 20
10    SN=SN+1.
      KK=KK+1
      IF (SN.GT.40.) GO TO 40
```

```
20     DH1=DHA/SN
       UT=SQRT(TLP*DH1*G*2.*CC1)
C
C CHECK FOR CONVERGENCE AND CALCULATE BLADE TIP RADIUS (RT)
C
       IF (IWMEC(5,NTT).NE.0) GO TO 30
       IF (UT.GT.UTM) GO TO 10
30     RT=UT/OM
       GO TO 50
C
C    ERROR IN NUMBER OF STAGES
C
40     IF (ISIO) SRC=RC*CONVER(1)
       IF (ISIC) WRITE (10,200) NT,SRC
       IF (.NOT.ISIO) WRITE (10,200) NT,RC
       RETURN
C
C FOR DESIGN CASE: CALCULATE HUB RADIUS (RH), BLADE TIP RADIUS (RT)
C AND CHECK FOR CONVERGENCE ON NUMBER OF STAGES
C
50     A=AIN
       C1=RT*RT-A/PIE
       IF (C1.LE.0.) C1=.0001
       RH=SQRT(C1)
       RT=SQRT(A/PIE+RH*RH)
C
C CALCULATE BLADE TIP DIAMETER (DIAM) IN INCHES, HUB-TO-TIP RATIO (HT),
C TIP SPEED (UT) AND NUMBER OF STAGES (NS)
C
       DIAM=RT*24.
       HT=RH/RT
       UT=RT*2.*PIE/60.*RPM2
       NS=IFIX(SN+.01)
       SND=SN
C
C INITIALIZE BLADE TAPER RATIO (TR).  CALCULATE SHAFT TORQUE (TORQ)
C AND 1ST BLADE STRESS (ST)
C
       TR=1.
       TORQ=WHP/RPM2*63025.
       RHO=0.
       IF (DESVAL(11,NTT).NE.0.) RHO=DESVAL(11,NTT)
       IF (ISII.AND.DESVAL(11,NTT).NE.0.) RHO=RHO/CONVER(5)
       RHO1=RHO
       TM=0.
       CALL STRESS (RT,TI,UT,HT,RPM2,ST,TR,NT,IP,RHO1,TM)
       RTIN=RT*12.
       RHIN=RH*12.
       IF (IP.NE.2) GO TO 70
C
C WRITE TURBINE DESIGN VALUES
C
       WRITE (10,210) NTT
       WRITE (10,220)
       IF (ISIO) GO TO 60
       WRITE (10,230) HT,SN,TLP,A
```

```
      WRITE (10,240)
      WRITE (10,250) UT,RTIN,RHIN,DHA,RPM2,TORQ
      GO TO 70
60    SA=A*CONVER(4)
      WRITE (10,230) HT,SN,TLP,SA
      SRT=RTIN*CONVER(1)
      SRH=RHIN*CONVER(1)
      SUT=UT*CONVER(2)
      SDHA=DHA*CONVER(9)
      STORQ=TORQ*CONVER(2)*CONVER(3)
      WRITE (10,240)
      WRITE (10,250) SUT,SRT,SDHA,RPM2,STORQ
C
C THIS IS THE STAGE-BY-STAGE TURBINE DESIGN SECTION ENCOUNTERED ONLY
C FOR A DESIGN CASE OR A COPY OF A DESIGN CASE
C
C INITIALIZE THE APPROPRIATE DESIGN VALUES
C
70    NODEI=JCONF(NTT,1)
      NODEO=JCONF(NTT,3)
      RI(1,NODEI)=RHIN
      RO(1,NODEI)=RTIN
      GO TO (80,90),IDES
80    SOLC=DESVAL(3,NTT)
      ARIC=DESVAL(4,NTT)
      AROC=DESVAL(5,NTT)
      CIMN=XM
      COMN=DESVAL(6,NTT)
      STR=DESVAL(7,NTT)
      COOK=DATINP(2,NTT)
      MODE=IFIX(DESVAL(8,NTT)+.01)
      RPMR=DESVAL(9,NTT)
      GO TO 100
90    SOLC=DEFAUL(3,ITURB)
      ARIC=DEFAUL(4,ITURB)
      AROC=DEFAUL(5,ITURB)
      CIMN=XM
      COMN=DEFAUL(6,ITURB)
      STR=DEFAUL(7,ITURB)
      COOK=DATINP(2,NTT)
      MODE=IFIX(DEFAUL(8,ITURB)+.01)
      RPMR=DEFAUL(9,ITURB)
100   IF (.NOT.ISII) GO TO 110
      STR=STR/CONVER(6)
C
C CALCULATE DELTA MACH NUMBER (DELMNS), ASPECT RATIO (DELAR) AND
C ENTHALPY (DHAS) PER STAGE AND INITIALIZE VALUES FOR STAGE-BY-STAGE
C CONSTANT HUB TURBINE DESIGN
C
110   DELMNS=(CIMN-COMN)
      IF (DELMNS.NE.0.) DELMNS=DELMNS/SN
      IF (COMN.EQ.0.) DELMNS=0.05
      DELAR=ARIC-AROC
      IF (SN.GT.1.) DELAR=DELAR/(SN-1.)
      IF (AROC.EQ.0..AND.NT.EQ.5) DELAR=0.05
      IF (AROC.EQ.0..AND.NT.GT.5) DELAR=0.2
```

```
      DHAS=DHA/SN
      WT=0.
      TL=0.
      POS=PI
      EF=-PEF
      TTOS=TI
      HOS=HI
      XMCS=CIMN+DELMNS
      AR=ARIC+DELAR
      XME=CCMN
      IF (XME.EQ.0.) XME=CIMN-(DELMNS*SN)
C
C CALCULATE CONSTANT HUB RADIUS (RHB) - IN INCHES (RHBA) AND 1ST
C STAGE INLET GAMMA (GAO)
C
      RTB=RT
      RM=RT*RT-AIN/(2.*PIE)
      IF (RM.LT.0.) GO TO 190
      RM=SQRT(RM)
      CHECKA=RT*PT-AIN/PIE
      IF (CHECKA.LE.0.) GO TO 190
      RHB=SQRT(CHECKA)
      RHBA=RHB*12.
      GAO=STHERM(5,TI,FA)
      NSTAG(NTT)=NS
      NST=NS+1
C
C BEGIN STAGE-BY-STAGE TURBINE DESIGN
C
      DO 160 I=1,NST
C
C INITIALIZE STAGE INLET VALUES
C
      XMCS=XMCS-DELMNS
      IF (XMCS.LE.0.) GO TO 190
      HIS=HOS
      TTIS=TTOS
      PIS=POS
      AR=AR-DELAR
C
C CALCULATE STAGE EXIT ENTHALPY (HOS), TOTAL TEMPERATURE (TTOS), INLET
C GAMMA (GAI), EXIT GAMMA (GAO), AVERAGE GAMMA (GAV) AND TOTAL PRESSURE
C RATIC (PRR) ACROSS THE STAGE
C
      HOS=HIS-DHAS
      TTCS=STHERM(1,HOS,FA)
      GAI=GAO
      GAO=STHERM(5,TTOS,FA)
      GAV=(GAI+GAO)/2.
      TOS1=ALOG(TTIS/TTOS)/EF
      TOS2=EXP(TOS1)
      PRR(I)=TOS2**(GAV/(GAV-1.))
C
C CALCULATE STAGE EXIT TOTAL PRESSURE (POS), INLET CORRECTED FLOW (CW)
C AND INLET AREA (A1)
C
```

```
      POS=PIS/PRR(I)
      A1=0.
      CALL DUCT1 (TTIS,PIS,WI,GAI,XMCS,A1)
      GO TO (120,130,140),MODE
C
C   CALULATES RHB FOR CONSTANT TIP RAD
C
120   RHB=RTB*RTB-A1/PIE
      IF (RHB.LE.0.) GO TO 190
      RHB=SQRT(RHB)
      GO TO 140
C
C    CALCULATES RHB FOR CONSTANT MEAN
C
130   RHB=RM*RM-A1/(2.*PIE)
      IF (RHB.LE.0.) GO TO 190
      RHB=SQRT(RHB)
      GO TO 140
C
C CALCULATE BLADE TIP RADIUS (RTB), BLADE HEIGHT (BH), NUMBER OF
C BLADES (NB) AND HUB-TO-TIP RATIO (HTB)
C
140   RTB=SQRT(A1/PIE+RHB*RHB)
      BH=RTB-RHB
      NB=IFIX(PIE*2.*RTB*SOLC*AR/BH)
      HTB=RHB/RTB
C
C CALCULATE BLADE TIP RADIUS (RTBA) IN INCHES, TIP SPEED (UTP1)
C AND STRESS LEVEL (ST1)
C
      RTBA=RTB*12.
      RHBA=RHB*12.
      UTP1=RPM2*2.*PIE/60.*RTB
      IF (I.GE.NST) GO TO 160
      UTP1=UTP1*RPMR
      IPP=0
      CALL STRESS (RTB,TTIS,UTP1,HTB,RPM2,ST1,TR,NT,IPP,RHO1,TM)
C
C CALCULATE STAGE WEIGHT (WTT) AND LENGTH (TLT) AND TOTAL COMPONENT
C WEIGHT (WT) AND LENGTH (TL)
C
      BH=BH*12.
      IF (IP.EQ.2) WRITE (10,310) I
      CALL TURWT (RHBA,BH,ST1,NB,AR,STR,COOK,RHO1,WTT,TLT)
      WT=WT+WTT
      TL=TL+TLT
      IF (IP.NE.2) GO TO 160
      WRITE (10,280)
      IF (ISIC) GO TO 150
      WRITE (10,290) PRR(I),DHAS,XMCS,A1,RHBA,RTBA,NB,UTP1,ST1,WTT,TLT
      GO TO 160
150   SDHAS=DHAS*CONVER(9)
      SA1=A1*CONVER(4)
      SRHBA=RHBA*CONVER(1)
      SRTBA=RTBA*CONVER(1)
      SUTP1=UTP1*CONVER(2)
```

```
      SST1=ST1*CONVER(6)
      SWTT=WTT*CONVER(3)
      STLT=TLT*CONVER(1)
      WRITE (10,300) PRR(I),SDHAS,XMCS,SA1,SRHBA,SRTBA,NB,SUTP1,SST1,SWT
     1T,STLT
160   CONTINUE
      WTFRA=0.
      IF (IWMEC(2,NTT).NE.0.) CALL FRAME (RTBA,3,WTFRA,IP)
      IF (IWMEC(2,NTT).NE.0) TL=TL+TL/NS
      WT=WT+WTFRA
      RI(2,NODEO)=RHBA
      RO(2,NODEO)=RTBA
      ALENG(NTT)=TL
      WATE(NTT)=WT
      IF (IO.NE.2) RETURN
C
C WRITE COMPONENT DIMENSICNS
C
      WRITE (10,260)
      IF (ISIG) GO TO 170
      WRITE (10,270) NS,TL,WT
      GO TO 180
170   TL=TL*CONVER(1)
      WT=WT*CONVER(3)
      WRITE (10,270) NS,TL,WT
180   RETURN
190   WRITE (10,320) NTT
      RETURN
C
200   FORMAT (8H TURBINE,I3,31H  WORK OR RADIUS TOO HIGH, RC =,F6.2)
210   FORMAT (9H  TURBINE,I3,20H  MECHANICAL DESIGN )
220   FORMAT (36H      H/T   N STG LOADING    AREA    )
230   FORMAT (4F8.3)
240   FORMAT (49H       UT    RTIP    RHUB   DEL H     RPM    TORQ )
250   FORMAT (5F8.1,F8.0)
260   FORMAT (/,26H  N STG  LENGTH  WEIGHT   )
270   FORMAT (I6,F9.2,F8.2,/)
280   FORMAT (42H   PR  DEL H  MACH  AREA  R HUB  R TIP  NB, 30H  U TIP
     1  STR   WEIGHT  LENGTH)
290   FORMAT (F7.4,F6.1,F6.3,F7.3,F6.2,F7.2,I4,F7.1,F7.0,2F8.2)
300   FORMAT (F7.4,F6.1,F6.3,F7.3,F6.2,F7.2,I4,F7.1,F7.0,2F8.2)
310   FORMAT (/,7H STAGE ,I4)
320   FORMAT (8H TURBINE,I3,40H  STAGE AND BLADE PARAMETERS MEANINGLESS)
      END
```

```
C*************************************************************************
C
C SUBRCUTINE(TURWT)
C ----------------
C
C PURPOSE
C -------
C THIS ROUTINE CALCULATES THE WEIGHT AND LENGHT
C OF TURBINE STAGES.
C
C
C CALLING ROUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE      ID    ANALYST     DISCRIPTION
C    -------- -------- ---------- --------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C --------
C
C
C   NAME     ORIGIN    USAGE     DISCRIPTION
C  ------    ------    -----   ----------------------------------------
C  RHBA      ARG               HUB RADIUS - IN
C  BH        ARG               BLADE HEIGHT - IN
C  ST1       ARG               STRESS
C  NB        ARG               NUMBER OF BLADES
C  AR        ARG               ASPECT RATIO
C  STR       ARG               REFERENCE STRESS
C  RHCB      ARG               BLADE DENSITY
C  COOK                        COOLING FLOW
C  WT                          WEIGHT - LBF
C  TL                          LENGHT - IN
C  STF                         STRESS FACTOR
C  DISKV                       DISK VOLUME -LBF/CU IN
C  BLADEW                      BLADE WEIGHT - LBF
C  BLADEL                      BLADE LENGTH - IN
C  WNOZZ                       VANE WEIGHT - LBF
C  TLNOZ                       VANE LENGHT - IN
C  WTNB                        NUTS AND BOLTS WEIGHT - LBF
C  CASEW                       CASE WEIGHT - LBF
C
```

```
C
C*****************************************************************
C
C
      SUBROUTINE TURWT (RHBA,BH,ST1,NB,AR,STR,COOK,RHOB,WT,TL)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C               *****************
C               * COMMON BLOCKS *
C               *****************
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCCMP,NGSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     1O(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
      TR=1.
C
C READ IN VALUES OF REFERENCE STRESS AND COOLING
C
      COOL=.8
      IF (COOK.LE.0.) COOL=1.
C
C CALCULATE DISK VOLUMES
C
      STF=ST1*RHBA/STR/12.
      DISKV=.95238*STF
      IF (STF.GT..168) DISKV=1273.20662*STF**4-1188.71514*STF**3+432.626
     1981*STF**2-67.4673543*STF+3.90623508
      IF (STF.GT..3) DISKV=7.18751*STF-1.33625
C
C CALCULATE DISK WEIGHT
C
      DISKW=DISKV*.296*(2.*RHBA)**2
C
C CALCULATE BLADE WEIGHT AND LENGTH
C
      BLADEW=.195*BH**3/AR**2*RHOB*NB*COOL
      BLADEL=BH/AR
C
C CALCULATE NOZZLE WEIGHT AND LENGTH
C
      WNOZZ=.144*BH**3/(AR/2.)**2*RHOB*(NB)
      TLNOZ=BH/AR*2.
      TL=(TLNOZ+BLADEL)*1.17
C
C CALCULATE NUTS AND BOLTS WEIGHT
```

```
C
      WTNB=RHBA*.75*2.*3.1416*.075*TL*.296*RHBA
C
C CALCULATE CASEWEIGHT
C
      CASEW=(RHBA+BH)*2.*3.1416*.1*.286*TL
C
C CALCULATE TOTAL STAGE WEIGHT AND LENGTH
C
      WT=DISKW+BLADEW+WNOZZ+WTNB+CASEW
      IF (IOUTCD.NE.2) RETURN
      WRITE (10,30)
      IF (ISIC) GO TO 10
      WRITE (10,20) DISKW,BLADEW,WNOZZ,WTNB,CASEW,AR
      RETURN
10    DISKW=DISKW*CONVER(3)
      BLADEW=BLADEW*CONVER(3)
      WNOZZ=WNOZZ*CONVER(3)
      WTNB=WTNB*CONVER(3)
      CASEW=CASEW*CONVER(3)
      WRITE (10,40) DISKW,BLADEW,WNOZZ,WTNB,CASEW,AR
      RETURN
C
20    FORMAT (5F7.1,F6.2)
30    FORMAT (39H  DISK   BLADE  VANE   HWD    CASE   AR)
40    FORMAT (5F7.2,F6.2)
      END
```

```
C*****************************************************
C
C  SUBROUTINE(WMIXR)
C  -----------------
C
C  PURPOSE
C  -------
C  THIS ROUTINE CALCULATES THE WEIGHT AND DIMENSION
C  OF FORCED MIXERS
C
C
C  CALLING ROUTINES
C  ----------------
C
C
C  REQUIRED SUBROUTINES
C  --------------------
C
C
C  MODIFICATION HISTORY
C  --------------------
C
C        DATE       ID     ANALYST      DISCRIPTION
C     -------- -------- ----------- ---------------
C
C
C  AUTHOR/LANGUAGE/DATE
C  --------------------
C    E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C  GLOSSARY
C  --------
C
C
C    NAME      ORIGIN     USAGE      DISCRIPTION
C   ------     ------     -----    ----------------------------------------
C   ICOMP      ARG                 COMPPONENT NUMBER
C   NCDEII                         NODE IN OF INNER
C   NODEOO                         NODE IN OR OUTER
C   AII                            AREA OF INNER
C   AIO                            AREA OF OUTER
C   RII                            REF. RADIUS OF INNER
C   RIO                            REF. RADIUS OF OUTER
C   RMI2                           MEAN RADIUS OF INNER SQUARED
C   RI2                            INNER RADIUS OF MIXER SQUARED
C   RMI                            INNER RADIUS OF MIXER
C   RMC                            MID RADIUS OF MIXER
C   ROO                            OUTER RADIUS OF MIXER
C   SPL                            SPECIFIC LENGTH SQRT(L/4A/PIE)
C   PN                             NUMBER OF PASSAGES
C   ALE                            MIXER LENGTH
C   WTM                            MIXER WEIGHT
C
C
C*****************************************************************
```

```
C
      SUBROUTINE WMIXR (ICOMP)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C               ******************
C               * COMMON BLOCKS *
C               ******************
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCCMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     1O(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
C
C               ********************
C               * DATA STATEMENTS *
C               ********************
C
      DATA LFMIX/4HFMIX/
C
C    INPUT DESIGN VALUES
C
      INOD=1
      IF (IWMEC(2,ICOMP).NE.0) INOD=2
      NODEO=JCONF(ICOMP,3)
      GO TO (10,20),INOD
10    NODEII=JCONF(ICOMP,1)
      NODEIC=JCONF(ICOMP,2)
      AII=DATOUT(1,ICOMP)
      AIO=DATOUT(2,ICOMP)
      GO TO 30
20    NODEII=IWMEC(2,ICOMP)
      NODE=JCONF(ICOMP,1)
      NODEIC=JCONF(ICOMP,2)
      AII=DATOUT(1,ICOMP)
      AIO=DATOUT(2,ICOMP)
      IF (NODEII.EQ.NODE) GO TO 30
      AII=DATOUT(2,ICOMP)
      AIO=DATOUT(1,ICOMP)
      NODEIO=NODE
30    IDES=1
      IF (IWMEC(1,ICOMP).EQ.LFMIX) IDES=2
C
C    CALCULATE DIMENSIONS OF MIXER
C
      RII=RI(2,NODEII)
      ROI=RO(2,NODEII)
```

```
      RMI2=(ROI**2+RII**2)/2.
      RI2=RMI2-AII/6.2832
      IF (RI2.LE.0.) RI2=0.
      RMI=SQRT(RI2)
      RMO=SQRT(AII/3.1416+RI2)
      ROO=SQRT(AIO/3.1416+RMO**2)
      RI(1,NODEII)=RMI
      RO(1,NODEII)=RMO
      RI(1,NODEIO)=RMO
      RO(1,NODEIO)=ROO
      RI(2,NODEO)=RMI
      RO(2,NODEO)=ROO
      IF (IDES.EQ.2) GO TO 40
      ALENG(ICOMP)=0.
      WATE(ICCMP)=0.
      RETURN
C
C   DESIGN FOR FORCED MIXER
C
40    AA=(AII+AIO)/2.
      ITP=1
      IF (DESVAL(1,ICOMP).EQ.0.) ITP=2
      GO TO (50,60),ITP
50    SPL=DESVAL(1,ICOMP)
      PN=DESVAL(2,ICOMP)
      GO TO 70
60    SPL=DEFAUL(1,16)
      PN=DEFAUL(2,16)
C
C  CALCULATE WEIGHT AND LENGTH
C
70    ALE=SPL*SQRT(4.*AA/3.1416)
      WTM=(3.927*RMO+1.25*PN*(ROO-RMI))*ALE*.028
      WATE(ICOMP)=WTM
      ALENG(ICOMP)=ALE
      IF (IOUTCD.NE.2) RETURN
      WRITE (10,90) IWMEC(1,ICOMP),ICOMP,IOUTCD
      IF (ISIC) GO TO 80
      WRITE (10,100) ALE,WTM
      RETURN
80    WTM=WTM*CONVER(3)
      ALE=ALE*CONVER(1)
      WRITE (10,100) ALE,WTM
      RETURN
C
90    FORMAT (1H /14H *************/14H *           */4H *  ,A4,I3,3H  *
     1/14H *            */13H *************,I1)
100   FORMAT (8H LENGTH=,F7.2,9H WEIGHT =,F8.2,/)
      END
```

```
C*******************************************************************
C
C SUBROUTINE(WSPLT)
C ----------------
C
C PURPOSE
C -------
C THIS ROUTINE CALCULATES DIMENSIONS FOR NON
C ROTATING SPLITTERS.
C
C
C CALLING ROUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE      ID     ANALYST      DISCRIPTION
C     -------- -------- ---------- ---------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C --------
C
C
C   NAME      ORIGIN    USAGE     DISCRIPTION
C  ------     ------    -----    ---------------------------------------
C  ICOM       ARG               COMPONENT NUMBER
C  NODEOP                       NODE OUT PRIMARY
C  NODEOS                       NODE OUT SECONDARY
C  NODEI                        NODE IN
C  BYP                          BYPASS RATIO
C  RSO                          OUTER RADIUS
C  RSI                          INNER RADIUS
C  RM                           SPLITTER RADIUS
C
C
C*******************************************************************
C
      SUBROUTINE WSPLT (ICOMP)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C               ******************
C               * COMMON BLOCKS *
C               ******************
```

```
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     1O(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
C
C   ESTABLISH INPUT VALUES AND DETERMINE DINENSIONS
C
      NODEOP=JCONF(ICOMP,3)
      NODEOS=JCONF(ICOMP,4)
      NODEI=JCONF(ICOMP,1)
      BYP=DATOUT(1,ICOMP)
      RSO=RO(2,NODEI)
      RSI=RI(2,NODEI)
      IF (DESVAL(1,ICOMP).EQ.0.) GO TO 10
      WI=WTF(NODEI)
      TI=TOTEMP(NODEI)
      PI=TOPRES(NODEI)
      AI=DESVAL(1,ICOMP)
      HTR=DESVAL(2,ICOMP)
      IP=0
      CALL DUCT (TI,PI,WI,AI,XM,PS,Q,ISIO,IP)
      RSO=SQRT(AI*144./3.14159/(1.-HTR**2))
      RSI=RSO*HTR
      RO(2,NODEI)=RSO
      RI(2,NODEI)=RSI
10    RM=SQRT((RSO**2+BYP*RSI**2)/(1.+BYP))
      RI(2,NODEOP)=RSI
      RO(2,NODEOP)=RM
      RI(2,NODEOS)=RM
      RO(2,NODEOS)=RSO
      WATE(ICOMP)=0.
      ALENG(ICOMP)=0.
      RETURN
      END
```

```
C*****************************************************************
C
C SUBROUTINE(WTNOZ)
C ----------------
C
C PURPOSE
C -------
C THIS ROUTINE CALCULATES DIMENSIONS AND WEIGHT
C OF CONVERGENT AND DIVERGENT NOZZLES.
C
C
C REQUIRED SUBROUTINES
C --------------------
C
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE      ID     ANALYST      DISCRIPTION
C    -------- -------- ------------ ----------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 09 30 76
C
C
C GLOSSARY
C --------
C
C   NAME      ORIGIN     USAGE      DISCRIPTION
C  ------     ------     -----    ---------------------------------------
C  ICOM       ARG                 COMPONENT NUMBER
C  NCDEI                          NODE IN
C  NCDEO                          NODE OUT
C  TI                             TEMPERATURE IN - DEG R
C  RHC                            MATERIAL WEIGHT PER SQIN
C  ITYP                           NOZZLE TYPE
C  NCR                            REFERENCE NODE FOR OUTER RADIUS
C  RNO                            OUTER RADIUS - IN
C  IDES                           DESIGN VALUE INDICATOR
C  TLD                            LENGHT/DIAMETER
C  WTN                            WEIGHT - LBF
C  ALN                            LENGHT - IN
C  TYP                            TYPE NOZZLE SCALER
C
C
C*****************************************************************
C
      SUBROUTINE WTNOZ (ICCMP)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TCLT,TOLTT,DEPV,DTOL,PERPF
C
C               ******************
C               * COMMON BLOCKS *
C               ******************
```

```
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     1O(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
      IF (IOUTCD.GT.1) WRITE (10,110) IWMEC(1,ICOMP),ICOMP,IOUTCD
C
C    ESTABLISH INPUT VALUES
C
      NODEI=JCONF(ICOMP,1)
      NODEO=JCONF(ICOMP,3)
      TI=TOTEMP(NODEI)
      RHO=.0168
      IF (TI.GT.1160.) RHO=.0283
      ITYP=IWMEC(2,ICOMP)
      NCR=NODEI
      RNO=RO(2,NCR)
      JTYP=1
      IF (IWMEC(3,ICOMP).GT.0) JTYP=2
      IF (IWMEC(3,ICOMP).LT.0) JTYP=3
      GO TO (30,20,10),JTYP
10    NC=-IWMEC(3,ICOMP)
      NCR=JCONF(NC,1)
      RNO=RC(1,NCR)
      GO TO 30
20    NC=IWMEC(3,ICOMP)
      NCR=JCONF(NC,3)
      RNO=RO(2,NCR)
30    IDES=1
      IF (DESVAL(1,ICOMP).EQ.0.) IDES=2
      GO TO (40,50),IDES
40    TLD=DESVAL(1,ICOMP)
      GO TO 60
50    TLD=DEFAUL(1,18)
60    RO(1,NODEI)=RNO
      RO(2,NODEO)=RNO-2.
C
C  CALCULATE WEIGHT AND LENGTH FOR CONVERGENT NOZZ
C
      WTN=4.*3.1416*RHO*TLD*RNO**2
      ALN=2.*RNO*TLD
      TYP=1.
      IF (ITYP.NE.1) TYP=2.75
C
C  CALCULATE WEIGHT FOR VARIABLE NOZZLE
C
      WTN=WTN*TYP
```

```
      WTNT=WTN
C     CALCULATE THRUST REVERSER WT
      WTTR=0.
      IF (IWMEC(4,ICOMP).EQ.0) GO TO 90
      PO=TOPRES(NODEI)
      WC=CORFLO(NODEI)/1.54972555
      PRN=PO/14.696
      CMIX=1.
      IF (IWMEC(4,ICOMP).EQ.1) GO TO 70
      B1=.23014*PRN+.56091
      WTTR=(2.2222*WC+11.1)*B1*CMIX
      GO TO 80
70    A1=1.0036*PRN-.5054
      IF (A1.LE.1.) A1=1.
      WTTR=(.52631*WC+423.)*A1
80    WTNT=WTN+WTTR
90    WATE(ICOMP)=WTNT
      ALENG(ICOMP)=ALN
      IF (IOUTCD.NE.2) RETURN
      WRITE (10,120) ICOMP
      IF (ISIC) GO TO 100
      WRITE (10,130) WTN,ALN,WTTR
      RETURN
100   WTN=WTN*CONVER(3)
      ALN=ALN*CONVER(1)
      WTTR=WTTR*CONVER(3)
      WRITE (10,130) WTN,ALN,WTTR
      RETURN
C
110   FORMAT (1H /14H **************/14H *            */4H *  ,A4,I3,3H  *
     1/14H *             */13H *************,I1)
120   FORMAT (8H NOZZLE ,I4)
130   FORMAT (9H WEIGHT= ,F8.2,9H LENGTH= ,F8.3,7H TR WT=,F8.2,/)
      END
```

```
 BLOCK DATA
 COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
2UTCD,NSTAG(60)
 COMMON /CONVER/ CONVER(15)
 DATA DESVAL/900*0./
 COMMON /DEFAUL/ DEFAUL(15,20)
 DATA IWMEC/420*0/
 DATA CONVER/2.540,.3048,.4536,.0929,.027681,.68948,4.882,.55556,1.
105435,.07457,47.88,4*0./
 DATA DEFAUL/.55,1.7,.45,1.5,4.,3.,.45,0.,0.,1.,0.,2.,1.,0.,0.,.55,
11.7,.45,1.5,4.,3.,.45,0.,0.,1.,0.,2.,1.,0.,0.,.55,1.7,.45,1.5,4.,3
2.,.45,0.,0.,1.,0.,2.,1.,0.,0.,.55,1.7,.45,1.5,4.,3.,.45,0.,0.,1.,0
3.,2.,1.,0.,0.,.55,1.7,.45,1.5,4.,3.,.45,0.,0.,1.,0.,2.,1.,0.,0.,.5
4,1.5,.4,1.5,4.,3.,.45,0.,0.,1.,0.,2.,1.,0.,0.,.4,1.4,.7,1.5,3.,1.5
5,.3,0.,0.,1.,0.,2.,1.,0.,0.,.3,.25,1.5,1.5,1.5,.45,125000.,2.,1.,6
6*0.,.45,.25,1.5,2.,4.,.55,125000.,2.,1.,6*0.,100.,.015,13*0.,150.,
7.015,13*0.,.4,1.,0.,-1.,11*0.,300.,.015,13*0.,50000.,.286,13*0.,50
800.,.5,.5,7.,.05,.8,9*0.,1.,8.,13*0.,1.,8.,.5,.5,11*0.,1.,14*0.,30
9*0./
 END
```

```
C*************************************************************
C
C FUNCTION STHERM
C ---------------
C
C PURPOSE
C ------
C     TO COMMUNICATE SINGLE PRECISION CALLS OF WEIGHT ESTIMATING
C     ROUTINES FOR FLUID PROPERTIES WITH THE NNEP ROUTINE -THERM
C      WHICH REQUIRES DOUBLE PRECISION ARGUMENTS
C
C USAGE
C ----
C
C FUNCTION STHERM(I,ARG,FA)
C
C REQUIRED SUBROUTINES
C      THERM
C
C GLOSSARY
C     I      FLAG FOR USAGE
C     ARG   ARGUMENT TO THERM (SINGLE PRECISION)
C     FA     FUEL AIR RATIO (SINGLE PRECISION)
C     DARG   ARGUMENT TO THERM (DOUBLE PRECISION)
C     DFA    FUEL AIR RATIO (DOUBLE PRECISION)
C
      FUNCTION STHERM (I,ARG,FA)
      REAL *8DARG,DFA
      DARG=ARG
      DFA=FA
      STHERM=THERM(I,DARG,DFA)
      RETURN
      END
```

```
C*****************************************************************
C
C SUBROUTINE WTEST
C ----------------
C
C PURPOSE
C -------
C     TO CONTROL THE CALLING OF SUBROUTINES WHICH WILL ESTIMATE THE
C     WEIGHT AND LENGTH OF INDIVIDUAL COMPONENTS
C
C DESCRIPTION
C -----------
C     THE OVERALL LENGTH OF THE ENGINE IS CALCULATED BY PROCESSING THE
C     ILENG ARRAY.ALL COMPONENTS EXCEPT DUCTS AND SHAFTS, THEN DUCTS.
C     THE REMAINING COMPONENTS EXCEPT DUCTS AND SHAFTS ARE PROCESSED.
C     THE DUCTS ARE PROCESSED AND FINIALY THE SHAFTS.
C     A BUILT-IN ASSUMPTICN IN THE DUCT ROUTINE IS THAT NO DUCT IS
C     CONNECTED TO ANOTHER DUCT I.E. THE DUCT SIZE IS DETERMINED BY THE
C     ADJOINING COMPONENTS.
C     THEN THE MAXIMUM RADIUS IS FOUND. THEN DEPENDING ON THE PRINT
C     FLAG -IOUTCD- THE REQUIRED PRINTING IS DONE
C     IF THE PLOT CODE FLAG -IPLT- IS TRUE ROUTINE EPLT IS CALLED
C USAGE
C -----
C     CALL WTEST
C
C CALLING ROUTINES
C ----------------
C     FLOCAL-
C     ZTOPZ -
C
C REQUIRED SUBROUTINES
C --------------------
C     COMP   -COMPRESSOR WEIGHT/LENGTH
C     TURB   -TURBINE
C     SHAFT  -SHAFT
C     DUCTW  -DUCT
C     COMBWT -PRIMARY BURNER WEIGHT/LENGTH
C     WTNOZ  -NOZZLE     WEIGHT/LENGTH
C     WMIXR  -MIXER
C     WSPLT  -SPLITTER
C     EPLT   -PRINTER/PLOTTER
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE     ID      ANALYST              DESCRIPTION
C     -------- ------ -----------   ------------------------------------
C     MO/DA/YR IDENT  NAME          DESCRIPTION OF CHANGES
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C     NORMAN PREWITT-BOEING COMPUTER SERV.  /FORTRAN IV    / OCT 10,1976
C
C GLCSSARY
C --------
```

```
C      NAME     ORIGIN USAGE              DESCRIPTION
C      ----     ------ -----  ----------------------------------------
C      IWMEC    /WMECH/ I     CONTROL INFORMATION
C      WATE     /WMECH/ O     WEIGHT OF EACH COMPONENT
C      ALENG    /WMECH/ O     ACTUAL LENGTH OF EACH COMPONENT
C      TLENG    /WMECH/ O     ACCUMULATED LENGTH TO END OF COMPONENT
C      RI       /WMECH/ O     RADIUS INNER INLET,OUTLET EACH STATION
C      RO       /WMECH/ O     RADIUS OUTER INLET,OUTLET EACH STATION
C      DESVAL   /WMECH/ I     MECHANICAL DESIGN DATA OVERRIDES DEFAUL
C      DSHAF    /WMECH/ O     SHAFT DIAMETER INNER TO OUTER
C      RPMT     /WMECH/ I     ACTUAL COMPONENT RPM
C      IWT      /WMECH/ I     WEIGHT ESTIMATION FLAG TRU=: DO IT
C      IPLT     /WMECH/ I     PLOTTER FLAG TRUE= DO IT
C      IERR     /WMECH/ O     ERROR FLAG
C      ISIO     /WMECH/ I     OUTPUT UNITS 0=ENGLISH, 0 SI
C      ISII     /WMECH/ I     INPUT UNITS 0=ENGLISH, 0 SI
C      IOUTCD   /WMECH/ I     PRINT FLAG 0=SUMMARY, 1=GENERAL,2=DIAGNOSTIC
C      ILENG    /WMECH/ I     COMPONENTS CONTRIBUTING TO OVERALL LENGTH
C      IDID             O     FLAG = 0 COMPONENT NOT YET WEIGHED  =1 YES
       SUBROUTINE WTEST
C              ******************
C              * COMMON BLOCKS *
C              ******************
       COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
      140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
      2T,DEPV(20),DTOL(20),PERPF(20)
       COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
      1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
      2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
      3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
       COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
      1O(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
      2UTCD,NSTAG(60)
       COMMON /CONVER/ CONVER(15)
       COMMON /NEPOPT/ DEBUG,DEPQ,SELAST,DD,NDSET,NPARTS,ESCALE,NPASSO,NV
      1OPT,NJOPT,BOTM,TOPZ
C
C              ****************************
C              * DATA STORAGE DEFINITION *
C              ****************************
       REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
      1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
       LOGICAL PINP,IWT,IPLT,ISIO,ISII
       INTEGER IDID(60),ILENG(40)
       NAMELIST / W/IWMEC,DESVAL,ACCS,IWT,IPLT,ISII,ISIO,IOUTCD,ILENG
C
C              ********************
C              * DATA STATEMENTS *
C              ********************
       DATA IDUC,LSHAF,ENGU,SIU,IVALV/4HDUCT,4HSHAF,4HENGL,4HSIU ,4HVALV/
       DATA PINP/.TRUE./
C
C---- TEST WTEST FLAG
C
       IF (.NOT.IWT) GO TO 420
C
```

```
C---- ZERO OUT OUTPUT ARRAYS
C
      DO 10 I=1,5
10    DSHAF(I)=0.
      DO 20 I=1,60
      WATE(I)=0
      NSTAG(I)=0
      IDID(I)=0
      RPMT(I)=0.
20    ALENG(I)=0
      DO 30 I=1,40
      TLENG(I)=0
      RI(1,I)=0
      ILENG(I)=0
      RI(2,I)=0
      RO(1,I)=0
30    RO(2,I)=0
C
C---- NAMELIST READ OF WTEST DATA
C
      CALL NAMEPR (9,10,8,PINP)
      READ (8,W)
C
C---- PROCESS LENGTH CONTRIBUTING VECTOR EXCEPT DUCTS AND SHAFTS
C
      DO 150 I=1,40
      NC=ILENG(I)
      IF (NC.EQ.0) GO TO 160
      JT=JTYPE(NC)
      GO TO (150,70,110,40,50,120,100,60,90,150,150,150,150,150),JT
C---- COMPRESSOR
40    CALL CCMP (NC)
      GO TO 140
C---- TURBINE
50    CALL TURB (NC)
      GO TO 140
C---- MIXER
60    CALL WMIXR (NC)
      GO TO 140
C---- PRIMARY BURNER
70    IF (IWMEC(1,NC).EQ.IDUC) GO TO 80
      IF (IWMEC(1,NC).EQ.IVALV) GO TO 130
      CALL COMBWT (NC)
      GO TO 140
C---  DUCTS
80    CALL DUCTW (NC)
      GO TO 140
C----  NOZZLES
90    CALL WTNOZ (NC)
      GO TO 140
C---- SPLITTER
100   CALL WSPLT (NC)
      GO TO 140
C     TRANSFER DIMENSIONS FOR WATER INJECTION
110   CALL DUMMY (NC)
      GO TO 140
```

```
C     HEAT EXCHANGER WEIGHT
120    CALL HMEC (NC)
       GO TO 140
C    VALVES
130    CALL VALVWT (NC)
C----  ACCUME LENGTH
140    IUP=JCONF(NC,1)
       IDN=JCONF(NC,3)
       TLENG(IDN)=TLENG(IUP)+ALENG(NC)
       IF (JT.EQ.6) TLENG(IDN)=TLENG(IUP)
       ID2=JCONF(NC,4)
       IF (ID2.GT.0) TLENG(ID2)=TLENG(IUP)+ALENG(NC)
       IF (JT.EQ.6) TLENG(ID2)=TLENG(IUP)
       IU2=JCONF(NC,2)
       IF (IU2.GT.0) TLENG(IU2)=TLENG(IUP)
       IDID(NC)=1
150    CONTINUE
C---- LAST COMPONENT WAS A NOZZLE SET ENGINE MAXIMUM LENGTH
160    ENGLEN=TLENG(IDN)
C
C      PROCESS REMAINING COMPONENTS
C
       DO 250 I=1,NCOMP
       IF (IDID(I).EQ.1) GO TO 250
C
C--    PROCESS COMPRESSORS,TURBINES,MIXERS,BURNERS,SPLITTERS
       NC=JTYPE(I)
       IF (NC.LE.0) GO TO 250
       GO TO (250,200,240,170,180,230,220,190,250,250,250,250,250,250),NC
C--    COMPRESSOR
170    CALL COMP (I)
       GO TO 250
C--    TURBINES
180    CALL TURB (I)
       GO TO 250
C--    MIXER
190    CALL WMIXR (I)
       GO TO 250
C--    BURNERS
200    IF (IWMEC(1,I).EQ.IDUC) GO TO 250
       IF (IWMEC(1,I).EQ.IVALV) GO TO 210
       CALL COMBWT (I)
       GO TO 250
C     VALVES
210    CALL VALVWT (I)
       GO TO 250
C---   SPLITTER
220    CALL WSPLT (I)
       GO TO 250
C     HEAT EXCHANGERS
230    CALL HMEC (I)
       GO TO 250
C     TRANSFER DIMENSIONS FOR WATER INJECTION
240    CALL DUMMY (I)
250    CONTINUE
C
```

```
C---- PROCESS DUCTS
      DO 260 I=1,NCOMP
      IF (IDID(I).EQ.1) GO TO 260
      NC=JTYPE(I)
      IF (NC.NE.2) GO TO 260
      IF (IWMEC(1,I).NE.IDUC) GO TO 260
      CALL DUCTW (I)
260   CONTINUE
C---- PROCESS NOZZLES
      DO 270 I=1,NCOMP
      IF (IDID(I).EQ.1) GO TO 270
      NC=JTYPE(I)
      IF (NC.NE.9) GO TO 270
      CALL WTNOZ (I)
270   CONTINUE
C---- ACCUME LENGTH
      DO 290 I=1,NCOMP
      IF (IDID(I).EQ.1) GO TO 290
      NC=JTYPE(I)
      GO TO (290,280,280,280,280,280,280,280,280,290,290,290,290,290),NC
280   IUP=JCONF(I,1)
      IU2=JCONF(I,2)
      IDN=JCONF(I,3)
      ID2=JCONF(I,4)
      TLENG(IDN)=TLENG(IUP)+ALENG(I)
      IF (NC.EQ.6) TLENG(IDN)=TLENG(IUP)
      IF (IU2.GT.0) TLENG(IU2)=TLENG(IUP)
      IF (ID2.GT.0) TLENG(ID2)=TLENG(IDN)
      IDID(I)=1
290   CONTINUE
C---- PROCESS SHAFTS
      DO 310 J=1,5
      DO 300 I=1,25
      NC=KKINDS(11,I)
      IF (NC.LE.0) GO TO 310
      IF (IWMEC(1,NC).NE.LSHAF) GO TO 300
      IF (IWMEC(2,NC).EQ.J) CALL SHAFT (NC)
300   CONTINUE
310   CONTINUE
C
C---- FIND ENGINE MAXIMUM RADIUS
      XR=0
      DO 330 I=1,NOSTAT
      IF (XR.GE.RO(1,I)) GO TO 320
      XR=RO(1,I)
320   IF (XR.GE.RO(2,I)) GO TO 330
      XR=RO(2,I)
330   CONTINUE
C
C---- GET ENGINE TOTAL WEIGHT AND  ALENG CONVERSION
      WATENG=0
      IF (ACCS.EQ.0) ACCS=.1
      WAT=0.
      DO 340 I=1,NCOMP
      IF (JTYPE(I).EQ.9) GO TO 340
      WAT=WATE(I)+WAT
```

```
340   CONTINUE
      WATACC=ACCS*WAT
      IF (IOUTCD.GT.1) WRITE (10,430) IOUTCD
      IF (ISIO) WATACC=WATACC*CONVER(3)
      IF (IOUTCD.GT.1) WRITE (10,460) WATACC
      DO 350 I=1,NCOMP
      WFACTR=1.
      IF (DESVAL(15,I).NE.0.) WFACTR=DESVAL(15,I)
      WATE(I)=WATE(I)*WFACTR
      IF (.NOT.ISIO) GO TO 350
      WATE(I)=WATE(I)*CONVER(3)
      ALENG(I)=ALENG(I)*CONVER(1)
350   WATENG=WATENG+WATE(I)
C
C---- CONVERT RADIAL DIMENSIONS AND TLENG
      IF (.NOT.ISIO) GO TO 370
      DO 360 I=1,NOSTAT
      RI(1,I)=RI(1,I)*CONVER(1)
      RI(2,I)=RI(2,I)*CONVER(1)
      RO(1,I)=RO(1,I)*CONVER(1)
      RO(2,I)=RO(2,I)*CONVER(1)
      TLENG(I)=TLENG(I)*CONVER(1)
360   CONTINUE
C
C---- WRITE COMPONENT WEIGHT INFO
370   UNITSI=ENGU
      IF (ISII) UNITSI=SIU
      UNITSO=ENGU
      IF (ISIO) UNITSO=SIU
      WRITE (10,440) UNITSI,UNITSO
      IF (IOUTCD.LT.1) GO TO 400
      WRITE (10,450)
      DO 390 I=1,NCOMP
      NC=JTYPE(I)
      IF (NC.LE.0) GO TO 390
      GO TO (380,380,380,380,380,380,380,380,380,390,380,390,390,390),NC
380   IUP1=JCONF(I,1)
      IUP2=JCONF(I,2)
      IDN1=JCONF(I,3)
      IDN2=JCONF(I,4)
      WRITE (10,470) I,WATE(I),ALENG(I),TLENG(IDN1),RI(1,IUP1),RO(1,IUP1
     1),RI(1,IUP2),RO(1,IUP2),RI(2,IDN1),RO(2,IDN1),RI(2,IDN2),RO(2,IDN2
     2),NSTAG(I)
390   CONTINUE
C
C---- MAKE SUMMARY PRINT
400   IF (.NOT.ISIO) GO TO 410
      XR=XR*CONVER(1)
      ENGLEN=ENGLEN*CONVER(1)
410   WRITE (10,480) WATENG,WATACC,ENGLEN,XR
      IF (IPLT) CALL ENGPLT (ENGLEN,XR)
420   IWT=.FALSE.
      RETURN
C
430   FORMAT (1H /14H *************/14H *           */,14H *  ACCS WT  *
     1/14H *            */13H ************,I1)
```

```
440   FORMAT (1H1,26H     WEIGHT INPUT DATA IN ,A4,6H UNITS/27H     WEIG
     1HT OUTPUT DATA IN ,A4,6H UNITS//)
450   FORMAT (69H    COMP   WT   COMP  ACCU    UPSTREAM RADIUS      DOWNS
     1TREAM RADIUS  /77H     NO   EST    LEN   LEN   RI   RO   RI   RO
     2  RI   RO   RI   RO    NSTAGE/)
460   FORMAT (/,11H   ACCS WT=,F8.3)
470   FORMAT (I7,F6.0,F7.0,F6.0,4F5.0,F6.0,3F5.0,I8)
480   FORMAT (/,27H  TOTAL BARE ENGINE WEIGHT=,F6.0,2X,12HACCESSORIES=,F
     17.2,2X,23HESTIMATED TOTAL LENGTH=,F6.0,2X,25HESTIMATED MAXIMUM RAD
     2IUS=,F5.0)
      END
```

```
C*********************************************
C
C SUBRCUTINE NPPNT
C ---------------
C
C PURPOSE
C -------
C GIVEN X AND Y SCALES, TWO POINTS AND A CHARACTER
C PLOT THAT CHARACTER IN AN ARRAY
C
C USAGE
C -----
C CALL NPPNT(XS,YS,ARRY,CH,P1,P2)
C DIMENSION ARRY(130,54),P1(2),P2(2)
C
C CALLING ROUTINES
C ----------------
C        DTRAP    - PLOTS A TRAPAZOID
C        ENGPLT   - PLOT CONTROLLER
C
C REQUIRED SUBROUTINES
C --------------------
C      NONE
C
C MODIFICATION HISTORY
C --------------------
C        DATE     ID      ANALYST          DESCRIPTION
C      ------- ------  -----------  ---------------------------------
C      MO/DA/YR IDENT   NAME           REASON FOR CHANGE
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C BOEING COMPUTER SERVICES/FORTRAN IV/15OCT76
C
C GLCSSARY
C ---------
C      NAME    ORIGIN USAGE            DESCRIPTION
C      ----    ------ ------    ------------------
C      ARRY     ARG    O          PLOT SPACE
C      CH       ARG    I          CHARACTER TO PLOT
C      P1       ARG    I          THE X,Y OF THE FIRST POINT
C      P2       ARG    I          THE X,Y OF THE SECOND POINT
       SUBROUTINE NPPNT (XS,YS,ARRY,CH,P1,P2)
       DIMENSION ARRY(130,54), P1(2), P2(2)
C
C     FIND MAX AXIS SUBTENDED
       DX=P2(1)-P1(1)
       DY=P2(2)-P1(2)
       IF (ABS(DX).GE..01) DIRX=DX/ABS(DX)
       IF (ABS(DY).GE..01) DIRY=DY/ABS(DY)
       XS10=XS*10.
       YS6=YS*6.
       INC=0
       IF (ABS(DY).GT.ABS(DX)) INC=1
       XI=P1(1)
       YI=P1(2)
```

```
      IF (ABS(DX).GE..01) SLOPE=DY/DX
C    CALCULATE RASTER LOCATION
10    IXR=XI*XS10
      IYR=54.-YI*YS6
      IXR=MAXO(1,MINO(130,IXR))
      IYR=MAXO(1,MINO(54,IYR))
      ARRY(IXR,IYR)=CH
C   INCREMENT ALONG THE LINE
C   CHOOSE X OR Y BASED ON INC
      IF (INC.NE.0) GO TO 20
C   INCREMENT X
      XI=XI+DIRX/XS10
      IF (ABS(DY).LT.0.01) GO TO 30
      YI=(SLOPE*(XI-P1(1))+P1(2))
      GO TO 30
C    INCREMENT Y
20    YI=YI+DIRY/YS6
      IF (ABS(DX).LT.0.01) GO TO 30
      XI=(((YI-P1(2))/SLOPE)+P1(1))
C   TEST FOR END POINT
30    IF (INC.NE.0) GO TO 40
      IF (ABS(DX).GT.ABS(XI-P1(1))) GO TO 10
      GO TO 50
40    IF (ABS(DY).GT.ABS(YI-P1(2))) GO TO 10
C PLOT END POINT
50    IXR=P2(1)*XS10
      IYR=54.-P2(2)*YS6
      IXR=MAXO(1,MINO(130,IXR))
      IYR=MAXO(1,MINO(54,IYR))
      ARRY(IXR,IYR)=CH
      RETURN
      END
```

```
C SUBROUTINE DTRAP
C ------------------
C
C PURPOSE
C ---------
C DRAW TRAPAZOID GIVEN START,END,SCALES,RADII,
C AND PLOT CHARACTER
C
C USAGE
C -----
C CALL DTRAP(XS,YS,SI,SE,SII,SIO,SEI,SEO,CH,ARRY)
C DIMENSION(ARRY(130,54)
C
C CALLING ROUTINES
C ------------------
C     ENGPLT   PLOTTING CONTROLLER
C
C REQUIRED SUBROUTINES
C ---------------------
C     NPPNT     - PLOT A LINE
C
C MODIFICATION HISTORY
C --------------------
C
C       DATA      ID      ANALYST          DESCRIPTION
C     -------- -------  ----------    --------------------------
C    MO/DA/YR  IDENT   NAME          REASON FOR CHANGE
C
C AUTHOR/LANGUAGE/DATA
C --------------------
C BOEING COMPUTER SERVICES/FORTRAN IV/15OCT76
C
C GLOSSARY
C --------
C     NAME      ORIGIN USAGE      DESCRIPTION
C   ------      ------ -----    -------------------
C   XS          ARG      I       X SCALE FACTOR
C   YS          ARG      I       Y SCALE FACTOR
C   SI          ARG      I       X OF FIRST STATION
C   SE          ARG      I       X OF LAST  STATION
C   SII         ARG      I       Y OF INSIDE AT FIRST STATION
C   SIO         ARG      I       Y OF OUTER  AT FIRST STATION
C   SEI         ARG      I       Y OF INSIDE AT LAST  STATION
C   SEO         ARG      I       Y OF OUTER  AT LAST  STATION
C   CH          ARG      I       CHARACTER TO BE PLOTTED
C   ARRY        ARG      O       PLOT ARRAY
      SUBROUTINE DTRAP (XS,YS,SI,SE,SII,SIO,SEI,SEO,CH,ARRY)
C
      DIMENSION ARRY(130,54), P1(2), P2(2), P3(2), P4(2)
C---   SET UP CORNER POINTS
      P1(1)=SI
      P1(2)=SII
      P2(1)=SI
      P2(2)=SIO
      P3(1)=SE
      P3(2)=SEO
```

```
P4(1)=SE
P4(2)=SEI
CALL NPPNT (XS,YS,ARRY,CH,P1,P2)
CALL NPPNT (XS,YS,ARRY,CH,P2,P3)
CALL NPPNT (XS,YS,ARRY,CH,P3,P4)
CALL NPPNT (XS,YS,ARRY,CH,P4,P1)
RETURN
END
```

```
C SUBROUTINE ENGPLT
C ------------------
C
C PURPOSE
C --------
C TO MAKE A PRINTER/PLOT OF THE ENGINE COMPONENTS
C
C DESCRIPTION
C -----------
C A ARRAY THAT IS 130 (NUMBER OF PRINT COLS) BY
C 54 (NUMBER OF LINES OF PRINT ON ONE PAGE IS SET
C TO BLANK. A SCALE FACTOR IS ESTABLISHED AND THE
C COMPONENTS ARE PLOTTED BY CHANGING THE APPROPRIA
C CHARACTER TO A CHARACTER REPRESENATIVE OF THE
C COMPONENT IE C FOR COMPRESSOR, B FOR BURNER,
C T FOR TURBINE, D FOR DUCT, N FOR NOZZLE, M FOR
C MIXER,
C
C USAGE
C -----
C     CALL ENGPLT(XL,XR)
C
C CALLING ROUTINES
C ----------------
C     WTEST  -- THE WEIGHT ESTIMATION ROUTINE
C
C REQUIRED SUBROUTINES
C --------------------
C     NPPNT  -- PLOT A LINE
C     DTRAP  -- PLOT A TRAPAZOID
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE      ID      ANALYST          DESCRIPTIO
C     -------   -----   ------------    ------------
C    MO/DA/YR   IDENT   NAME             REASON FOR
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C BOEING COMPUTER SERVICES/FORTRAN IV/15OCT76
C
C GLOSSARY
C --------
C     NAME    ORIGIN USAGE           DESCRIPTION
C     ----    ------ -----    --------------------
C     XS               L        X SCALE FACTOR
C     YS               L        Y SCALE FACTOR
C     XL      ARG      I        ENGINE MAX LENGTH
C     XR      ARG      I        ENGINE MAX DIAMETER
C
      SUBROUTINE ENGPLT (XL,XR)
C
C               ******************
C               * COMMON BLOCKS *
C               ******************
```

```
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     1O(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
C
C               ********************
C               * DATA STATEMENTS *
C               ********************
C
      DIMENSION P1(10), P2(2), ARRY(130,54), CL(4), IDC(5)
      DATA IDC/4HDUCT,4HPBUR,4HDBUR,4HAUG ,4HFMIX/
      DATA CHA,CHB,CHC,CHD,CHM,CHN,CHP,CH1,CHT/1HA,1HB,1HC,1HD,1HM,1HN,1
     1HP,1H),1HT/
      DATA CL/1H-,1HC,1H/,1HL/
      DATA BL/1H /
      DO 10 I=1,130
      DO 10 J=1,54
10    ARRY(I,J)=BL
      XS=13./XL
      YS=9./XR
      XS=AMIN1(XS,YS)
      YS=XS
C---- DRAW A CENTER LINE OF THE ENGINE
C----  THE LINE IS OF THE FORM  -----C/L-----C/L-----C/L-----
      I=2
      DO 30 J=1,15
      DO 20 K=1,5
      ARRY(I,54)=CL(1)
20    I=I+1
      ARRY(I,54)=CL(2)
      ARRY(I+1,54)=CL(3)
      ARRY(I+2,54)=CL(4)
30    I=I+3
      DO 40 L=1,8
40    ARRY(I+L,54)=CL(1)
C---- PROCESS EACH COMPONENT
      DO 130 I=1,NCOMP
      IJ1=JCONF(I,1)
      IJ2=JCONF(I,2)
      IJ3=JCONF(I,3)
      JT=JTYPE(I)
      IF (JT.LE.0) GO TO 130
      GO TO (130,50,130,90,100,130,130,110,120,130,130,130,130,130),JT
C---- PROCESS DUCTS,PRIMARY BURNERS,DUCT BURNERS, AND AUGMENTERS
```

```
50     IF (IWMEC(1,I).NE.IDC(1)) GO TO 60
C---- DUCTS
       P1(1)=TLENG(IJ1)
       P2(1)=TLENG(IJ3)
       P1(2)=RC(1,IJ1)
       P2(2)=RC(2,IJ3)
       CALL NPPNT (XS,YS,ARRY,CHD,P1,P2)
       P1(2)=RI(1,IJ1)
       P2(2)=RI(2,IJ3)
       CALL NPPNT (XS,YS,ARRY,CHD,P1,P2)
       GO TO 130
60     IF (IWMEC(1,I).NE.IDC(2)) GO TO 70
C--- PROCESS PRIMARY BURNERS
       P1(1)=TLENG(IJ1)
       P2(1)=TLENG(IJ3)
       P1(2)=RC(2,IJ1)
       P2(2)=RO(1,IJ1)
       CALL NPPNT (XS,YS,ARRY,CHP,P1,P2)
       P1(2)=RI(2,IJ1)
       P2(2)=RI(1,IJ1)
       CALL NPPNT (XS,YS,ARRY,CHP,P1,P2)
       P1(1)=TLENG(IJ3)
       P1(2)=RI(1,IJ3)
       CALL NPPNT (XS,YS,ARRY,CHP,P1,P2)
       P1(2)=RO(1,IJ3)
       P2(2)=RO(1,IJ1)
       CALL NPPNT (XS,YS,ARRY,CHP,P1,P2)
       GO TO 130
70     IF (IWMEC(1,I).NE.IDC(3)) GO TO 80
C--- DRAW DUCT BURNER
       P1(1)=TLENG(IJ1)
       P2(1)=TLENG(IJ3)
       P1(2)=RO(1,IJ1)
       P2(2)=RO(2,IJ3)
       CALL NPPNT (XS,YS,ARRY,CHB,P1,P2)
       P1(2)=RI(1,IJ1)
       P2(2)=RI(2,IJ3)
       CALL NPPNT (XS,YS,ARRY,CHB,P1,P2)
       P1(1)=P1(1)+.25*(P2(1)-P1(1))
       P2(1)=P1(1)
       P1(2)=RI(1,IJ1)
       P2(2)=RO(1,IJ1)
       CALL NPPNT (XS,YS,ARRY,CH1,P1,P2)
       GO TO 130
80     IF (IWMEC(1,I).NE.IDC(4)) GO TO 130
C--- DRAW AN AUGMENTER
       P1(1)=TLENG(IJ1)
       P2(1)=TLENG(IJ3)
       P1(2)=RO(1,IJ1)
       P2(2)=RO(2,IJ3)
       CALL NPPNT (XS,YS,ARRY,CHA,P1,P2)
       P1(1)=P1(1)+.25*(P2(1)-P1(1))
       P2(1)=P1(1)
       P2(2)=0.
       CALL NPPNT (XS,YS,ARRY,CH1,P1,P2)
       GO TO 130
```

```
C--- DRAW A TRAPZOID FOR A COMPRESSOR
90    CALL DTRAP (XS,YS,TLENG(IJ1),TLENG(IJ3),RI(1,IJ1),RO(1,IJ1),RI(2,I
     1J3),RO(2,IJ3),CHC,ARRY)
      GO TO 130
C--- DRAW A TRAPAZOID FOR A TURBINE
100   CALL DTRAP (XS,YS,TLENG(IJ1),TLENG(IJ3),RI(1,IJ1),RO(1,IJ1),RI(2,I
     1J3),RO(2,IJ3),CHT,ARRY)
      GO TO 130
C--- DRAW A MIXER
110   IF (IWMEC(1,I).NE.IDC(5)) GO TO 130
      P1(1)=TLENG(IJ1)
      P2(1)=TLENG(IJ3)
      P1(2)=RI(1,IJ1)
      P2(2)=RI(2,IJ3)
      CALL NPPNT (XS,YS,ARRY,CHM,P1,P2)
      P1(2)=RO(1,IJ1)
      CALL NPPNT (XS,YS,ARRY,CHM,P1,P2)
      P1(2)=RI(1,IJ2)
      P2(2)=RO(2,IJ3)
      CALL NPPNT (XS,YS,ARRY,CHM,P1,P2)
      P1(2)=RO(1,IJ2)
      CALL NPPNT (XS,YS,ARRY,CHM,P1,P2)
      GO TO 130
C--- DRAW A NOZZLE
120   P1(1)=TLENG(IJ1)
      P2(1)=TLENG(IJ3)
      P1(2)=RO(1,IJ1)
      P2(2)=RO(2,IJ3)
      CALL NPPNT (XS,YS,ARRY,CHN,P1,P2)
130   CONTINUE
      WRITE (10,140)
      WRITE (10,150) ARRY
      WRITE (10,140)
      RETURN
C
140   FORMAT (1H1)
150   FORMAT (2X,130A1)
      END
```

```
C SUBROUTINE(DUMMY)
C ----------------
C
C PURPOSE
C -------
C THIS ROUTINE TRANSFERS DIMENSIONS
C
C
C CALLING ROUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE       ID     ANALYST      DISCRIPTION
C     -------- -------- ----------- --------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 01 04 77
C
C
C GLOSSARY
C --------
C
C
C   NAME      ORIGIN     USAGE      DISCRIPTION
C  ------     ------     -----    ---------------------------------------
C
C  ICOMP      ARG        I/O      COMPONENT NUMBER
C
C*************************************************************************
C
      SUBROUTINE DUMMY (ICOMP)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C               ******************
C               * COMMON BLOCKS *
C               ******************
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
```

```
2UTCD,NSTAG(60)
 COMMON /CONVER/ CONVER(15)
 COMMON /DEFAUL/ DEFAUL(15,20)
 LOGICAL IWT,IPLT,IERR,ISII,ISIO
 NODEI=JCONF(ICOMP,1)
 NODEO=JCONF(ICOMP,3)
 WATE(ICOMP)=0.
 ALENG(ICOMP)=0.
 RO(1,NODEI)=RO(2,NODEI)
 RI(1,NODEI)=RI(2,NODEI)
 RO(2,NODEO)=RO(2,NODEI)
 RI(2,NODEO)=RI(2,NODEI)
 RETURN
 END
```

```
C*****************************************************************
C
C SUBROUTINE(HMEC)
C ----------------
C
C PURPOSE
C -------
C THIS ROUTINE CALCULATES THE WEIGHT AND LENGTH
C OF FIXED OR ROTARY HEAT EXCHANGERS.
C
C
C CALLING ROUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C
C   DUCT
C
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE       ID     ANALYST      DISCRIPTICN
C    -------- -------- ----------- ---------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. GNAT , R. J. PERA/FORTRAN IV/ 01 04 77
C
C
C GLCSSARY
C --------
C
C
C   NAME      ORIGIN     USAGE      DISCRIPTION
C  ------     ------     -----    ---------------------------------------
C
C  ICOMP      ARG        I/O      COMPONENT NUMBER
C  TSCA                           MATERIAL SCALER
C  IDES                           DESVAL/DEFAUL INDICATOR
C  NODEIP                         INLET OF PRIMARY
C  NODEIS                         INLET OF SECONDARY
C  NODEOP                         OUTLET OF PRIMARY
C  NODEOS                         OUTLET OF SECONDARY
C  TAI                            SECONDARY INLET TEMP
C  TAO                            SECONDARY EXIT TEMP
C  TEI                            PRIMARY INLET TEMP
C  TEO                            SECONDARY EXIT TEMP
C  PAI                            PRIMARY INLET PRESS
C  PEI                            SECONDARY INLET PRESS
C  WAA                            SECONDARY AIR FLOW
C  WAE                            PRIMARY AIR FLOW
C  FAA                            SECONDARY F/A
```

```
C   FAE                             PRIMARY F/A
C   CNT                             NUMBER OF TUBES
C   AMA                             SECONDARY MACH NUMBER
C   AME                             PRIMARY MACH NUMBER
C   TAAV                            SECONDARY AVERAGE TEMP
C   TEAV                            PRIMARY AVERAGE TEMP
C   AA1                             SECONDARY AREA
C   AE1                             PRIMARY AREA
C   VISA                            SECONDARY FLOW VISCOSITY
C   VISE                            PRIMARY FLOW VISCOSITY
C   REA                             SECONDARY REYNOLDS NUMBER
C   REE                             PRIMARY REYNOLDS NUMBER
C   CKA                             CP*K FOR THE SECONDARY
C   CKE                             CP*K FOR THE PRIMARY
C   DT1                             DELTA TEMP INLET
C   DT2                             DELTA TEMP FOR EXIT
C   AREQ                            REQUIRED AREA
C   HL                              LENGTH
C   RHO                             MATERIAL DENSITY
C   STR                             REFERENCE STRESS
C   WT                              TOTAL WT
C
C*******************************************************************************
C
      SUBROUTINE HMEC (ICOMP)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C               ******************
C               * COMMON BLOCKS *
C               ******************
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCCMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     10(2,40),DESVAL(15,60),DSHAF(5),RPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
C
C     INITIALIZE INPUTS
C
      IDES=1
      IF (IOUTCD.GT.1) WRITE (10,160) IWMEC(1,ICOMP),ICOMP,IOUTCD
      NODEIP=JCONF(ICOMP,1)
      NODEIS=JCONF(ICOMP,2)
      NODEOP=JCONF(ICOMP,3)
      NODEOS=JCONF(ICOMP,4)
      TAI=TOTEMP(NODEIS)
      TAO=TOTEMP(NODEOS)
```

```
      TEI=TCTEMP(NODEIP)
      TEO=TOTEMP(NODEOP)
      PAI=TOPRES(NODEIS)
      PEI=TOPRES(NODEIP)
      WAA=WTF(NODEIS)
      WAE=WTF(NODEIP)
      FAA=FAR(NODEIS)
      FAE=FAR(NODEIP)
C
C     LOAD DESVAL INPUTS
C
      IF (IWMEC(2,ICOMP).EQ.2) GO TO 40
      IF (DESVAL(1,ICOMP).EQ.0.) IDES=2
      GO TO (10,20),IDES
10    CNT=DESVAL(1,ICOMP)
      AMA=DESVAL(2,ICOMP)
      AME=DESVAL(3,ICOMP)
      GO TO 30
20    CNT=DEFAUL(1,15)
      AMA=DESVAL(2,15)
      AME=DESVAL(3,15)
30    CONTINUE
C
C     AVERAGE TEMP AND REQUIRED AREA CALCULATIONS
C
      TAAV=(TAI+TAO)*.5
      TEAV=(TEI+TEO)*.5
      AA1=AMA
      AE1=AME
      CALL DUCT (TAAV,PAI,WAA,AA1,FAA,AMA,PSA,VA,ISIO,IP)
      CALL DUCT (TEAV,PEI,WAE,AE1,FAE,AME,PSE,VE,ISIO,IP)
C
C     TUBE AREA AND DIAMETER CALCULATIONS
C
      DIAM=12.*SQRT(4./3.1416*(AA1+AE1))
      AAT=AA1/CNT
      AET=AE1/CNT
      DAT=SQRT(AAT/3.1416*4.)
      DET=SQRT(AET/3.1416*4.)
C
C     FLUID VISCOSITY AND REYNOLDS NUMBER CALCULATIONS
C
      VISA=.02+.0000455*TAAV
      VISE=.02+.0000455*TEAV
      REA=PAI/VISA*VA/53.54*DAT/TAAV*3600.
      REE=PEI/VISE*VE/53.34*DET/TEAV*3600.
      CKA=.000025*TAAV
      CKE=.000025*TEAV
      HA=CKA/DAT*.022*REA**.8
      HE=CKE/DET*.022*REE**.8
C
C     DELTA TEMPERATURE CALCULATIONS FOR PARALLEL AND COUNTER FLOW
C
      DT1=ABS(TEI-TAO)
      DT2=ABS(TEO-TAI)
      IF (IWMEC(3,ICOMP).EQ.1) DT1=ABS(TEI-TAI)
```

```
      IF (IWMEC(3,ICOMP).EQ.1) DT2=ABS(TEO-TAC)
      IF (ABS(DT1-DT2).LT..1) DT1=DT2+.1
      DTM=(DT1-DT2)/ALOG(DT1/DT2)
C
C     REQUIRED Q,TOTAL AREA,LENGTH AND WEIGHT CALCULATIONS
C
      QOA=DTM/(1./HA+1./HE)
      HAO=STHERM(4,TAO,FAA)
      HAI=STHERM(4,TAI,FAA)
      Q=ABS(WAA*(HAO-HAI))
      AREQ=Q/QOA*3600.
      HL=AREQ/3.1416/DAT/CNT
      HL1=HL*12.
      DET1=DET*12.
      DAT1=DAT*12.
      RHO=.168
      STR=50000.
      IF (TAI.GT.1160..OR.TEI.GT.1160.) RHO=.286
      IF (TAI.GT.1160..OR.TEI.GT.1160.) STR=70000.
      THICE=PEI*DET1/2./STR
      THICA=PAI*DIAM/2./STR
      IF (THICE.LT..01) THICE=.01
      IF (THICA.LT..01) THICA=.01
      WT=HL1*3.14159*(DET1*THICE*CNT+DIAM*THICA)*RHO
      WTT=2.*WT
      WATE(ICOMP)=WTT
      ALENG(ICOMP)=HL1
      IF (IOUTCD.NE.2) RETURN
      IF (.NOT.ISIO) GO TO 140
      HL1=HL1*CONVER(1)
      AREQ=AREQ*CONVER(4)
      DAT1=DAT1*CONVER(1)
      DET1=DET1*CONVER(1)
      WTT=WTT*CONVER(3)
      DIAM=DIAM*CONVER(1)
      VA=VA*CONVER(2)
      VE=VE*CONVER(2)
      GO TO 140
40    IF (DESVAL(4,ICOMP).EQ.0) IDES=2
      GO TO (50,60),IDES
50    BPR=DESVAL(4,ICOMP)
      GO TO 70
60    BPR=0.
70    CONTINUE
      DELTP=DATOUT(1,ICOMP)
      EFF=DATOUT(4,ICOMP)
      WCP=CORFLO(NODEIP)/1.54972555
      WCS=CORFLO(NODEIS)/1.54972555
      IF (TEI.GE.TAI) WSCA=WCP
      IF (TEI.LT.TAI) WSCA=WCS
      IF (DELTP.GE..1) GO TO 100
      IF (EFF.GE..90) GO TO 90
      IF (EFF.GE..85) GO TO 80
      WTT=(703.8-10.5*BPR)*WSCA/200.
      GO TO 130
80    WTT=(1040.-19.5*BPR)*WSCA/200.
```

```
      GO TO 130
 90   WTT=(1745.-44.1*BPR)*WSCA/200.
      GO TO 130
100   IF (EFF.GE..90) GO TO 120
      IF (EFF.GE..85) GO TO 110
      WTT=(577.8-16.0*BPR)*WSCA/200.
      GO TO 130
110   WTT=(794.9-19.6*BPR)*WSCA/200.
      GO TO 130
120   WTT=(1275.-27.8*BPR)*WSCA/200.
130   WATE(ICCMP)=WTT
      IF (IOUTCD.NE.2) RETURN
      IF (.NOT.ISIO) GO TO 150
      WTT=WTT*CONVER(3)
      GO TO 150
140   WRITE (10,170)
      WRITE (10,180) HL1,AREQ,DAT1,DET1
      WRITE (10,190)
      WRITE (10,200) XMA,XME,WTT,DIAM
      WRITE (10,210)
      WRITE (10,220) VA,VE,REA,REE,CNT
      RETURN
150   WRITE (10,230)
      WRITE (10,240) WTT
      RETURN
C
160   FORMAT (1H /14H *************/14H *           */4H *  ,A4,I3,3H  *
     1/14H *            */13H *************,I1)
170   FORMAT (32H  LENGTH   AREA    DIM A   DIM E)
180   FORMAT (2F8.1,2F8.4,/)
190   FORMAT (30H    M A     M E     WT     DIAM)
200   FORMAT (2F8.3,2F8.1,/)
210   FORMAT (39H   VA      VE    RE A    RE E     TUBES)
220   FORMAT (5F8.0)
230   FORMAT (13H R HEX WEIGHT)
240   FORMAT (F9.1)
      END
```

```
C*****************************************************************************
C
C SUBROUTINE(VALVWT)
C ----------------
C
C PURPOSE
C -------
C THIS ROUTINE CALCULATES THE WEIGHT AND LENGTH
C OF AIV.
C
C
C CALLING ROUTINES
C ----------------
C
C
C REQUIRED SUBROUTINES
C --------------------
C
C   STHERM
C   DUCT1
C
C MODIFICATION HISTORY
C --------------------
C
C       DATE      ID    ANALYST     DISCRIPTION
C    -------- -------- ---------- ---------------
C
C
C AUTHOR/LANGUAGE/DATE
C --------------------
C   E. ONAT , R. J. PERA/FORTRAN IV/ 01 04 77
C
C
C GLOSSARY
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C
C   NAME      ORIGIN    USAGE     DISCRIPTION
C  ------     ------    -----   ----------------------------------------
C
C  ICOMP      ARG       I/O     COMPONENT NUMBER
C  TSCA                         MATERIAL SCALER
C  IDES                         DESVAL/DEFAUL INDICATOR
C  NODEII                       INLET OF INNER
C  NODEIO                       INLET OF OUTER
C  NODEOI                       OUTLET OF INNER
C  NODEOO                       OUTLET OF OUTER
C  NCOM                         OPPOSITE DUCT
C  SPL                          SPECIFIC LENGTH
C  PN                           NUMBER OF PASSAGES
C  AMI                          MACH INNER
C  AMO                          MACH OUTER
C  RH                           HUB RADIUS INNER
C  RTIC                         TIP RADIUS INNER
C  RHOC                         HUB RADIUS OUTER
C  RTOC                         TIP RADIUS OUTER
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C   WTSI                            INNER CYC WT/FT**2
C   WTSO                            OUTER CYC WT/FT**2
C   WTSW                            WALL WT/FT**2
C   TTI                             TEMPERATURE INNER
C   TTO                             TEMPERATURE OUTER
C   PI                              PRESSURE INNER
C   PO                              PRESSURE OUTER
C   WAI                             AIRFLOW INNER
C   WAO                             AIRFLOW OUTER
C   FAI                             FUEL/AIR INNER
C   FAC                             FUEL/AIR OUTER
C   GI                              GAMMA INNER
C   GO                              GAMMA OUTER
C   AI                              AREA INNER
C   AC                              AREA OUTER
C   WTIC                            INNER CYC WT
C   WTOC                            OUTER CYC WT
C   WTWALL                          WALL WT
C   WATC                            ACTUATOR WT
C   WTOT                            TOTAL WT
C   TLENG                           LENGTH
C
C*******************************************************************************
C
      SUBROUTINE VALVWT (ICOMP)
      REAL *8DATINP,DATOUT,WTF,TOPRES,TOTEMP,FAR,CORFLO,VMACH,STATP,ERRO
     1R,TOL,TOLT,TOLTT,DEPV,DTOL,PERPF
C
C               ******************
C               * COMMON BLOCKS *
C               ******************
C
      COMMON /DBL/ DATINP(15,60),DATOUT(9,60),WTF(40),TOPRES(40),TOTEMP(
     140),FAR(40),CORFLO(40),VMACH(40),STATP(40),ERROR(40),TOL,TOLT,TOLT
     2T,DEPV(20),DTOL(20),PERPF(20)
      COMMON /SNGL/ JM1,JM2,JP1,JP2,JCX,LOCTBL(9,60),JCOMP(70),IWAY,NIT,
     1ITAB(70),JCONF(60,4),JTYPE(60),JFLOW(70),IDEDAP(15),KKINDS(14,25),
     2NCOMP,NOSTAT,NITER,NFINIS,NPASS,JCC,NTBL,NCTS,JCIND(20),JCDEP(20),
     3JCVIND(20),JCVDEP(20),KDTYP(20),IDONE(60)
      COMMON /WMECH/ IWMEC(7,60),WATE(60),ALENG(60),TLENG(40),RI(2,40),R
     1O(2,40),DESVAL(15,60),DSHAF(5),PPMT(60),IWT,IPLT,IERR,ISII,ISIO,IO
     2UTCD,NSTAG(60)
      COMMON /CONVER/ CONVER(15)
      COMMON /DEFAUL/ DEFAUL(15,20)
      LOGICAL IWT,IPLT,IERR,ISII,ISIO
C
C     INITIALIZE INPUTS
C
      IF (IWMEC(3,ICOMP).LT.0) RETURN
      TSCA=1.
      IDES=1
      IF (IOUTCD.GT.1) WRITE (10,100) IWMEC(1,ICOMP),ICOMP,IOUTCD
      IF (IWMEC(2,ICOMP).EQ.2) GO TO 10
      NODEII=JCONF(ICOMP,1)
      NODEOI=JCONF(ICOMP,3)
      NCOM=IWMEC(3,ICOMP)
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      NODEIC=JCONF(NCOM,1)
      NODEOC=JCONF(NCOM,3)
      GO TO 20
10    NODEIC=JCONF(ICOMP,1)
      NODEOC=JCONF(ICOMP,3)
      NCOM=IWMEC(3,ICOMP)
      NODEII=JCONF(NCOM,1)
      NODEIO=JCONF(NCOM,3)
20    IWMEC(3,NCOM)=-ICOMP
      IF (DESVAL(1,ICOMP).EQ.0.) IDES=2
      GO TO (30,50),IDES
C
C     LOAD DESVAL INPUTS
C
30    SPL=DESVAL(1,ICOMP)
      PN=DESVAL(2,ICOMP)
      AMI=DESVAL(3,ICOMP)
      AMO=DESVAL(4,ICOMP)
      IF (DESVAL(5,ICOMP).EQ.0.) RH=RI(2,NODEII)
      IF (DESVAL(5,ICOMP).GT.0.) RH=DESVAL(5,ICOMP)
      IF (ISII.AND.DESVAL(5,ICOMP).GT.0.) RH=RH/CONVER(1)
      IF (DESVAL(5,ICOMP).LT.0.) IRH=ABS(DESVAL(5,ICOMP))
      IF (DESVAL(5,ICOMP).LT.0.) RH=RI(2,IRH)
      IRHO=1
      IF (DESVAL(6,ICOMP).EQ.0.) IRHO=2
      TTI=TCTEMP(NODEII)
      TTO=TOTEMP(NODEIO)
      IF (IRHO.EQ.2) GO TO 40
      WTSI=DESVAL(6,ICOMP)
      WTSO=DESVAL(7,ICOMP)
      WTSW=DESVAL(8,ICOMP)
      IF (.NOT.ISII) GO TO 70
      WTSI=WTSI/CONVER(7)
      WTSO=WTSO/CONVER(7)
      WTSW=WTSW/CONVER(7)
      GO TO 70
40    WTSI=1.1
      WTSO=1.1
      WTSW=1.1
      IF (TTI.GT.1160..OR.TTO.GT.1160.) TSCA=1.7
      GO TO 70
C
C     LOAD DEFAUL INPUTS
C
50    SPL=DEFAUL(1,17)
      PN=DEFAUL(2,17)
      AMI=DEFAUL(3,17)
      AMO=DEFAUL(4,17)
      IF (DEFAUL(5,17).EQ.0.) RH=RI(2,NODEII)
      IF (DEFAUL(5,17).GT.0.) RH=DEFAUL(5,17)
      IF (ISII.AND.DEFAUL(5,17).GT.0.) RH=RH/CONVER(1)
      IF (DEFAUL(5,17).LT.0.) IRH=ABS(DEFAUL(5,17))
      IF (DEFAUL(5,17).LT.0.) RH=RI(2,IRH)
      IRHO=1
      IF (DEFAUL(6,17).EQ.0.) IRHO=2
      TTI=TCTEMP(NODEII)
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      TTC=TCTEMP(NODEIO)
      IF (IRHO.EQ.2) GO TO 60
      WTSI=DEFAUL(6,17)
      WTSO=DEFAUL(7,17)
      WTSW=DEFAUL(8,17)
      IF (.NOT.ISII) GO TO 70
      WTSI=WTSI/CONVER(7)
      WTSO=WTSO/CONVER(7)
      WTSW=WTSW/CONVER(7)
      GO TO 70
60    WTSI=1.1
      WTSO=1.1
      WTSW=1.1
      IF (TTI.GT.1160..OR.TTO.GT.1160.) TSCA=1.7
C
C     DETERMINE DUCT ARES
C
70    PIE=3.1415926
      WAI=WTF(NODEII)
      WAO=WTF(NODEIO)
      PI=TOPRES(NODEII)*144.
      PO=TOPRES(NODEIO)*144.
      FAI=FAR(NODEII)
      FAC=FAR(NCDEIO)
      GI=STHERM(5,TTI,FAI)
      GO=STHERM(5,TTO,FAO)
      AI=0.
      AO=0.
      CALL DUCT1 (TTI,PI,WAI,GI,AMI,AI)
      CALL DUCT1 (TTO,PO,WAO,GO,AMO,AO)
      AA=(AO+AI)/2.
C
C     DETERMINE VALVE DIMENSIONS AND WEIGHTS
C
      RTIC=SQRT(AI/PIE*144.+RH**2)
      RHOC=RTIC
      RTOC=SQRT(AO/PIE*144.+RHOC**2)
      VLENG=SPL*SQRT(4.*AA/PIE*144.)
      RMEAN=SQRT(AA/PIE*144.+RH**2)
      WTIC=2.*PIE*RH*VLENG*WTSI/144.*TSCA
      WTOC=2.*PIE*RTOC*VLENG*WTSO/144.*TSCA
      WTWALL=(3.927*RMEAN+1.25*PN*(RTOC-RH))*VLENG*WTSW/144.*TSCA
      WTOT=WTIC+WTOC+WTWALL
      WACT=0.
      IF (IWMEC(4,ICOMP).EQ.0) GO TO 80
      WACT=.1*WTOT
      IF (WACT.LT.10.) WACT=10.
      IF (WACT.GT.40.) WACT=40.
      WTOT=WTOT+WACT
C
C     STORE WEIGHTS AND DIMENSIONS
C
80    WATE(ICOMP)=WTOT/2.
      WATE(NCCM)=WTOT/2.
      ALENG(ICOMP)=VLENG
      ALENG(NCOM)=VLENG
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      RI(1,NODEII)=RH
      RO(1,NODEII)=RTIC
      RI(1,NODEIO)=RHIC
      RO(1,NODEIO)=RTOC
      RI(2,NODEOI)=RH
      RO(2,NODEOI)=RTIC
      RI(2,NODEOO)=RHOC
      RO(2,NODEOO)=RTOC
      IF (IOUTCD.LE.1) RETURN
C
C     WRITE OUTPUT
C
      IF (.NOT.ISIO) GO TO 90
      RH=RH*CONVER(1)
      RTIC=RTIC*CONVER(1)
      RHOC=RHOC*CONVER(1)
      RTOC=RTOC*CONVER(1)
      VLENG=VLENG*CONVER(1)
      AI=AI*CONVER(4)
      AO=AO*CONVER(4)
      RMEAN=RMEAN*CONVER(1)
      WTIC=WTIC*CONVER(3)
      WTOC=WTOC*CONVER(3)
      WTWALL=WTWALL*CONVER(3)
      WACT=WACT*CONVER(3)
      WTOT=WTOT*CONVER(3)
90    WRITE (10,110) RH,RTIC,RHOC,RTOC,VLENG,AI,AO,RMEAN
      WRITE (10,120) WTIC,WTOC,WTWALL,WACT,WTOT
      RETURN
C
100   FORMAT (1H /14H *************/14H *           */4H *  ,A4,I3,3H  *
     1/14H *            */13H ************,I1)
110   FORMAT (/,6H RHUB=,2X,F6.2,5X,6H RTIP=,2X,F6.2,5X,7H RHOUT=,1X,F6.
     12,/,7H RTOUT=,1X,F6.2,5X,6H LENG=,2X,F6.2,5X,7H AREAI=,1X,F6.1,/,7
     2H AREAO=,1X,F6.1,5X,7H RMEAN=,1X,F6.2)
120   FORMAT (/,13H WT INNER CYC,3X,F6.1,5X,12HWT OUTER CYL,3X,F6.1,/,12
     1H WT OF WALLS,3X,F6.1,5X,10H WT OF ACT,5X,F6.1,/,15H TOTAL VALVE W
     2T,3X,F6.1)
      END
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