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# GENENG II — A PROGRAM FOR CALCULATING DESIGN AND OFF-DESIGN PERFORMANCE OF TWO- AND THREE-SPOOL TURBOFANS WITH AS MANY AS THREE NOZZLES

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16. Abstract

A computer program titled GENENG II which calculates steady-state design and off-design jet engine performance for two- or three-spool turbofans with one, two, or three nozzles is described. Included in the report are complete FORTRAN IV listings of the program with sample results for nine basic turbofan engines that can be calculated: (1) three-spool, three-stream engine; (2) two-spool, three-stream, boosted-fan engine; (3) two-spool, three-stream, supercharged-compressor engine; (4) three-spool, two-stream engine; (5) two-spool, two-stream engine; (6) three-spool, three-stream, aft-fan engine; (7) two-spool, three-stream, aft-fan engine; (8) two-spool, two-stream, aft-fan engine; (9) three-spool, two-stream, aft-fan engine. The simulation of other engines by using logical variables built into the program is also described. The computer program is available from the authors.

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# CONTENTS

# GENENG II - A PROGRAM FOR CALCULATING DESIGN AND OFF-DESIGN PERFORMANCE OF TWO- AND THREE-SPOOL TURBOFANS WITH AS MANY AS THREE NOZZLES

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## SUMMARY

A digital computer program titled GENENG II is described. This program is a derivative of GENENG standing for GENeralized ENGine. GENENG which is capable of calculating steady-state design and off-design performance of turbofan and turbojet engines was evolved from SMOTE (SiMulation Of Turbofan Engine) which was developed by the Turbine Engine Division of the Air Force Aero Propulsion Laboratory, Wright-Patterson Air Force Base, Ohio.

GENENG II calculates design and off-design jet engine performance for existing or theoretical turbofan engines with two or three spools and with one, two, or three nozzles. In addition, aft-fan engines can be calculated. Changes to the original SMOTE and GENENG are discussed.

Included in the report are complete FORTRAN IV listings of the program with sample results for nine basic turbofan engines that can be calculated without any programming changes:

(1) Three-spool, three-stream engine
(2) Two-spool, three-stream boosted-fan engine
(3) Two-spool, three-stream, supercharged-compressor engine
(4) Three-spool, two-stream engine
(5) Two-spool, two-stream engine
(6) Three-spool, three-stream, aft-fan engine
(7) Two-spool, three-stream, aft-fan engine
(8) Two-spool, two-stream, aft-fan engine
(9) Three-spool, two-stream, aft-fan engine

The first three of these engines are likely candidates for a STOL aircraft with internally blown flaps. By examining the methods used to simulate these engines, the reader may simulate others. As examples, a boosted aft-fan engine with two streams would simulate a high-bypass-ratio engine where the core and tip portions of the fan have different component performance maps; a boosted-fan, two-stream engine could be simulated (JT9D type); or supercharged-compressor, two-stream engines could be studied. The number of possibilities are too many to enumerate, being determined by the imagination of the user.

# INTRODUCTION

For preliminary as well as in-depth studies it is often necessary to study a broad range of engines operating at both design and off-design conditions in order to find an efficient airframe/engine combination. The spectrum of flight conditions through which an engine must operate will strongly affect the optimum design parameters for that engine.

The SMOTE code (SiMulation Of Turbofan Engines), discussed in references 1 and 2, provided a computer program having off-design-point calculation capability for either existing engines or theoretical ones - a major advance. Theoretical engines are simulated by scaling component performance from existing engines to the design conditions of the theoretical engine.

GENENG (GENeralized ENGine), a computer code derived from SMOTE and reported in a companion report to this one (ref. 3), greatly increased the versatility of the original code while retaining the ability to simulate theoretical engines. The most significant change was providing the capability of studying one- and two-spool turbojets as well as turbofans.

Additional changes to SMOTE included generalization of afterburner performance maps, an automatic redesign of the fan and compressor pressure ratios for mixed-flow turbofans (one-stream engines) if the static pressures at the mix point do not match, duct combustor pressure losses, a new method of entering data into the program, and an automatic recall of previously loaded design-point data so that it is only necessary to change what is being varied when studying a series of design engines.

This report describes GENENG II, a derivative program from GENENG. A need has arisen for the capability of calculating the performance of two- or three-spool turbofan engines with as many as three nozzles (or airstreams). An example of this type of engine would be one in which a fan is used to compress all the air, of which some is expanded through a separate nozzle to produce thrust. The remaining air passes through a compressor, after which some air is put into a wing duct and expelled over the wing flaps (an internally blown flap). The remaining air passes through another compressor into a combustor; is heated and expanded through three turbines, each of which drives one of the compressors; and is then expelled out the third (main) nozzle, producing more thrust. This engine type is under consideration for STOL aircraft; and until the development of GENENG II, off-design performance calculations were difficult to attain.

GENENG II was developed to provide the capability to study this engine type. Once this capability had been achieved, it was realized that many other engine types could be simulated by building simple options into the code and modifying the input data to the program. As an example, the fan and first compressor in the engine just described could be physically attached and driven by one turbine (the so-called "boosted turbofan"),

or the fan could be put at the rear of the engine (an aft fan). Thus GENENG II became a very versatile program with many engine design options built in internally. These are described in the next section ENGINE TYPES.

The GENENG II computer code is available from the authors upon request. This FORTRAN IV program can be used by computer centers having an IBM 7094 Model 2 computer. With modifications, the program can be used on all computers that have a FORTRAN compiler.

## ENGINE TYPES

All thermodynamic properties of air and gas are calculated by considering variable specific heats and no dissociation. The air and gas property tables of reference 4 were curve fit and are used herein.

### Type a - Three-Spool, Three-Steam Turbofan

The basic engine, a three-spool, three-stream turbofan, of which all other engine types are treated as variations, is shown in figure 1. Free-stream conditions exist at station 1. The conditions at station 2 are determined by flight conditions and inlet recovery. GENENG compressor maps work with corrected values of airflow. At the entrance to the fan, the corrected airflow $WA_{F,c}$ is

$$WA_{F,c} = \frac{WA_F\sqrt{T_2/T_{518.668}}}{P_2/P_{SLS}} \tag{1}$$

where $P_2$ and $P_{SLS}$ are in atmospheres and $P_{SLS}$ equals 1.0. All symbols are defined in appendix C. Some symbols are formed as the combination of other symbols; thus WA is airflow, F is for fan, and c when following a component symbol means corrected. Station numbers are defined on the appropriate figure.

All the fan air $WA_F$ is compressed by the fan giving rise to conditions at station 22. The power required to do this is

$$\text{Fan power} = WA_F \times (H_{22} - H_2) \tag{2}$$

Some fan air may be lost to the cycle as fan bleed $Bl_F$, which is expressed as a fraction of the fan airflow

$$Bl_F = PC_{Bl,F} \times WA_F \tag{3}$$

The corrected airflow into the intermediate compressor is

$$WA_{I,c} = \frac{WA_I\sqrt{T_{22}/T_{518.668}}}{P_{22}/1.0} \tag{4}$$

The remaining air goes through the fan duct, where some leakage from the core air may also enter (see eq. (16)).

$$WA_D = WA_F - Bl_F - WA_I + Bl_{DU} \tag{5}$$

This air, which may be heated by a duct burner to a temperature $T_{24}$, undergoes a pressure drop

$$P_{25} = P_{24} \times \left[1 - \left(\frac{\Delta P}{P}\right)_{DUCT}\right] \tag{6}$$

The air would have been heated by the addition of fuel, which can be expressed as a fuel-air ratio so that

$$WG_{24} = WA_{23} \times \left[1 + (f/a)_{23}\right] \tag{7}$$

The gas is then expanded through a nozzle (station 29) to produce thrust. The bypass ratio is defined by

$$BYPASS = \frac{WA_D}{WA_I} \tag{8}$$

The air going into the intermediate compressor is compressed to the conditions at station 21. The power required is

$$\text{Intermediate-compressor power} = WA_I \times (H_{21} - H_{22}) \tag{9}$$

The conditions at station 21 are the same as those at station 32, which is the entrance to the wing duct as the third streampath is called herein. The airflow entering this duct is

called $Bl_I$, meaning intermediate bleed flow, and is expressed as a fraction $PC_{Bl,I}$ of the total airflow at station 21.

$$Bl_I = PC_{Bl,I} \times WA_I \tag{10}$$

The remainder of the air enters the core compressor

$$WA_C = WA_I - Bl_I \tag{11}$$

and

$$WA_{C,c} = \frac{WA_C \times \sqrt{T_{21}/T_{518.668}}}{P_{21}/1.0} \tag{12}$$

The air entering the wing duct experiences a pressure drop

$$P_{36} = P_{32} \times \left[1 - \left(\frac{\Delta P}{P}\right)_{WING}\right] \tag{13}$$

and then passes through a nozzle (station 39) to produce additional thrust. The air continuing on through the core is compressed to conditions at station 3. The power required is

$$\text{Core compressor power} = WA_C \times (H_3 - H_{21}) = WA_3 \times (H_3 - H_{21}) \tag{14}$$

Some core bleed air $Bl_C$ may be used for turbine cooling. Some of the air is put back into the cycle into each of the three turbines, and some is lost to the cycle as overboard bleed or leakage into the fan duct.

$$Bl_C = PC_{Bl,C} \times WA_3 \tag{15}$$

$$Bl_{DU} = PC_{Bl,DU} \times Bl_C \tag{16}$$

$$Bl_{OB} = PC_{Bl,OB} \times Bl_C \tag{17}$$

$$Bl_{HP} = PC_{Bl,HP} \times Bl_C \tag{18}$$

$$Bl_{IP} = PC_{Bl,IP} \times Bl_C \tag{19}$$

$$Bl_{LP} = PC_{Bl,LP} \times Bl_C \tag{20}$$

Since $Bl_{DU} + Bl_{OB} + Bl_{HP} + Bl_{IP} + Bl_{LP} = Bl_C$, the sum of $PC_{Bl,DU}$, $PC_{Bl,OB}$, $PC_{Bl,HP}$, $PC_{Bl,IP}$, and $PC_{Bl,LP}$ must be equal to 1.

The remaining air is

$$WA_4 = WA_3 - Bl_C \tag{21}$$

and is heated to a turbine inlet temperature $T_4$ and goes through a combustor pressure drop $(\Delta P/P)_{COMB}$. The fuel required to do this is expressed as a fuel-air ratio $(f/a)_4$ so that the gas entering the first turbine $WG_4$ can be expressed as

$$WG_4 = WA_4 \times \left[1 + (f/a)_4\right] \tag{22}$$

This gas is then expanded through this high-pressure turbine to conditions at station 50. The enthalpy at station 50 is first calculated by making a power balance since this turbine drives the core compressor and supplies any work extracted (HPEXT). By using equation (14)

$$WG_4 \times (H_4 - H_{50}) = WA_3 \times (H_3 - H_{21}) + HPEXT \tag{23}$$

In addition, the physical speeds must match

$$N_{HP,TURBINE} = N_{COMP} \tag{24}$$

If high-pressure-turbine bleed air $Bl_{HP}$ is added back into the cycle at this point, $H_{50}$ must be readjusted

$$H_{50} = \frac{(Bl_{HP} \times H_3) + WG_4 H_{50}}{WG_4 + Bl_{HP}} = \frac{(Bl_{HP} \times H_3) + WG_4 H_{50}}{WG_{50}} \tag{25}$$

Similarly,

$$WG_{50} \times (H_{50} - H_5) = WA_I \times (H_{21} - H_{22}) \tag{26}$$

$$N_{IP,TURBINE} = N_{INT\ COMP} \tag{27}$$

$$H_5 = \frac{(Bl_{IP} \times H_3) + WG_{50}H_5}{WG_{50} + Bl_{IP}} = \frac{(Bl_{IP} \times H_3) + WG_{50}H_5}{WG_5} \tag{28}$$

$$WG_5 \times (H_5 - H_{55}) = WA \times (H_{22} - H_2) \tag{29}$$

$$N_{LP,TURBINE} = N_{FAN} \tag{30}$$

$$H_{55} = \frac{(Bl_{LP} \times H_3) + WG_5H_{55}}{WG_5 + Bl_{LP}} = \frac{(Bl_{LP} \times H_3) + WG_5H_{55}}{WG_{55}} \tag{31}$$

The gas flow $WG_{55}$ then may be heated by an afterburner to a gas temperature $T_7$ and may undergo a pressure drop.

$$P_7 = P_6 \left[1 - \left(\frac{\Delta P}{P}\right)_{AFTERBURNER}\right] \tag{32}$$

The gas flow would be increased by any fuel burned.

$$WG_7 = WG_{55} + WFA \tag{33}$$

The gas is then expanded through the nozzle (station 9) to produce the remainder of the total engine thrust.

## Type b - Two-Spool, Three-Stream, Boosted-Fan Turbofan

From figure 2 it is immediately apparent why the three-spool, three-stream engine can be modified to represent the other types presented herein. The only difference between engine b and engine a is that the intermediate compressor is physically attached to the fan in terms of speed and the combination is driven by one turbine (the low-pressure turbine). The thermodynamic calculation changes are that the speeds are attached.

$$N_{INT\ COMP} = N_{FAN} \tag{34}$$

The power of the low-pressure turbine is now

$$WG_{50} \times (H_{50} - H_{55}) = WA_F \times (H_{22} - H_2) + WA_I \times (H_{21} - H_{22}) \tag{35}$$

$PC_{Bl,IP}$ must be zero and $H_{55}$ is readjusted by

$$H_{55} = \frac{(Bl_{LP} \times H_3) + WG_{50}H_{55}}{WG_{50} + Bl_{LP}} \tag{36}$$

This type of engine is of interest because it might be created by adding a new boosted-fan - turbine combination to an existing core. If the third airstream is deleted (see engine e) and ductburner and afterburner are removed, engine b becomes a two-spool, two-stream turbofan of the type represented by the General Electric CF6 and Pratt & Whitney JT9D turbofan, both of which have booster stages on the fan.

## Type c - Two-Spool, Three-Stream Supercharged-Compressor Turbofan

Engine c is shown in figure 3. Here, the intermediate and core compressors have been physically attached. For programing reasons, the combination is driven by the intermediate-pressure turbine. The calculation procedure bypasses the routine which calculates high-pressure-turbine performance but transfers the turbine performance data from this routine into that of the intermediate-pressure turbine to represent the turbine performance. Since the intermediate-pressure turbine speed is set by the speed of the intermediate compressor which also sets the speed of the combination of the compressors, this procedure was necessary.

$$N_{COMP} = N_{INT\ COMP} \tag{37}$$

$$WG_{50} \times (H_{50} - H_5) = WA_I \times (H_{21} - H_{22}) + WA_C \times (H_3 - H_{21}) + HPEXT \tag{38}$$

$PC_{Bl,HP}$ must be zero and $H_5$ is readjusted by

$$H_5 = \frac{(Bl_{IP} \times H_3) + WG_{50}H_5}{WG_{50} + Bl_{IP}} \tag{39}$$

## Type d - Three-Spool, Two-Stream Turbofan

Engine d, shown in figure 4, is presently in existence (Rolls Royce RB 211) and differs from the reference engine in that all the air entering the intermediate compressor also enters the inner compressor. For this reason, the only change necessary to run this engine is to set $PC_{Bl,I}$ equal to zero.

## Type e - Two-Spool, Two-Stream Turbofan

Engine e is the typical turbofan and is shown in figure 5. To simulate this engine, it is necessary to have the air go through the intermediate compressor at a pressure ratio of 1.0 and an efficiency of 1.0 and to bypass the intermediate-pressure-turbine calculations. A logical control (DUMMYSPOOL) has been built into the program to do this. At the same time, $PC_{Bl,I}$ must be set equal to zero. By using this option, GENENG II can be used to replace its original version GENENG (ref. 3) in calculating turbofan performance. It cannot, however do turbojet calculations (two-spool, one-stream or one-spool, one-stream engines). As mentioned earlier, boosted-fan, two-spool, two-stream engines can be calculated by setting $PC_{Bl,I}$ equal to zero in engine b.

## Type f - Three-Spool, Three-Stream Aft-Fan Turbofan

The three-spool, three-stream aft-fan engine is shown in figure 6. Thermodynamically, the only difference between this and the reference engine is that the intermediate compressor sees the same conditions at its entrance as does the fan (conditions at station 2; both inlets assumed to have the same performance). This is accomplished by setting a logical control variable AFTFAN to be true. The power of the intermediate-pressure turbine would be

$$WG_{50} \times (H_{50} - H_5) = WA_I \times (H_{21} - H_2) \tag{40}$$

Each of the aft-fan engines has a counterpart in the front-fan engines, the only difference being that the intermediate compressor (or in the case of engine h, a two-spool, two-stream aft-fan engine, the compressor) sees free-stream conditions. These engines and their counterparts are described in the following sections.

## Type g - Two-Spool, Three-Stream Aft-Fan Turbofan

Engine g, a counterpart of engine c (fig. 3), is shown in figure 7. The power balance would be

$$WG_{50} \times (H_{50} - H_5) = WA_I \times (H_{32} - H_2) + WA_C \times (H_3 - H_{32}) \tag{41}$$

## Type h - Two-Spool, Two-Stream Aft-Fan Turbofan

Engine h, a counterpart of engine e (fig. 5), is shown in figure 8. The power balance would be

$$WG_{50} \times (H_{50} - H_5) = WA_C \times (H_3 - H_2) \tag{42}$$

## Type i - Three-Spool, Two-Stream Aft-Fan Turbofan

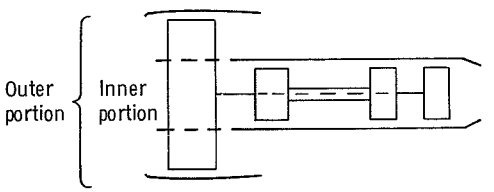
Engine i, a counterpart of engine d (fig. 4), is shown in figure 9. The power balance would be

$$WG_{50} \times (H_{50} - H_5) = WA_I \times (H_{21} - H_2) \tag{43}$$

## Other Engines

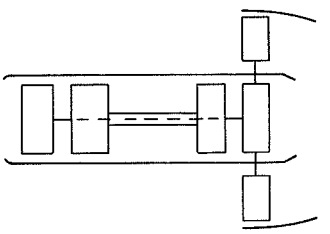
By using his imagination in conjunction with the engines illustrated, the reader can determine other engine types which can be simulated. An obvious one is a supercharged-compressor, two-stream turbofan which is a derivative of engine c, the only change necessary being setting $PC_{Bl,I} = 0$. In addition, all engines illustrated could be run as mixed-flow engines eliminating the fan duct nozzle (see ref. 3).

An interesting engine more difficult to be simulated is a high-bypass-ratio turbofan (two streams), where the outer and inner portions of the fan are represented by different performance maps. As can be seen by the following sketches, this engine can be simulated by a boosted aft-fan engine. When AFTFAN is true, the second spool sees free-stream conditions. When the fan and intermediate spool are attached, the physical rotational speeds of the aft fan (outer portion of fan) and the second spool (inner portion of fan) will be the same. Both are driven off the same turbine.




(a)

The high-bypass-ratio turbofan (sketch a) can be simulated by a boosted aft-fan engine (sketch b).



(b)

## BALANCING TECHNIQUE

An off-design engine cycle calculation requires satisfying various matching constraints (rotational speeds, airflows, compressor and turbine work functions, and nozzle flow functions) at each specified operating condition. GENENG II internally searches for compressor and turbine operating points that will satisfy the constraints. It does this by generating differential errors caused by small changes in the independent variables. The program then uses a matrix that is loaded with the differential errors to solve for the zero-error condition. This procedure is known as the Newton-Raphson iteration technique.

For a three-spool engine, a solution for a set of nine simultaneous linear equations is obtained; for other types, less equations are used. The nine independent variables selected are

ZF Ratio of pressure ratios of fan compressor along a speed line,

$$ZF = \frac{\text{(Pressure ratio along speed line) - (Low pressure ratio on speed line)}}{\text{(High pressure ratio on speed line) - (Low pressure ratio on speed line)}}$$

PCNF or T4 Percent fan speed or turbine inlet temperature

| | |
|---|---|
| ZI | Ratio of pressure ratios of intermediate compressor along a speed line (calculated the same as ZF) |
| PCNI | Percent intermediate compressor speed |
| ZC | Ratio of pressure ratios of inner compressor along a speed line (calculated same as ZF) |
| PCNC or T4 | Percent inner compressor speed or turbine inlet temperature |
| TFFHP | High-pressure-turbine flow function, $WG_4\sqrt{T_4}/P_4$ |
| TFFIP | Intermediate-pressure-turbine flow function, $WG_{50}\sqrt{T_{50}}/P_{50}$ |
| TFFLP | Low-pressure-turbine flow function, $WG_5\sqrt{T_5}/P_5$ |

The program initially selects new (perturbed) values for the variables, based on the design values. It is then possible to proceed through the entire engine cycle calculations, where up to nine errors are generated. The initial values of the nine (or less) variables and nine (or less) errors are base values.

As per reference 1, the partial differential equations for $E = f(V)$ are

$$dE_i = \sum_{j=1}^{j_{max}} \frac{\partial E_{ij}}{\partial V_j} dV_j \tag{44}$$

for $i$ going from 1 to $j_{max}$ where $j_{max}$ is 6, 7, or 9 depending on the engine type being run; and where $E$ is an error, $V$ is a variable, and $\partial E_{ij}$ is the change in $E_i$ caused by a change in $V_j$.

The assumption of a small change in the variables results in the following approximations (B refers to a base value):

$$dE = E - EB \tag{45}$$

$$dV = V - VB \tag{46}$$

$$\frac{\partial E}{\partial V} = \frac{\Delta E}{\Delta V} \tag{47}$$

With these approximations and the knowledge that $E$ should equal zero for the balanced engine, the set of partial differential equations (eq. (44)) reduces to

$$E_i - EB_i = \sum_{j=1}^{j_{max}} \frac{\Delta E_{ij}}{\Delta V_j} dV_j = -EB_i \tag{48}$$

for i going from 1 to $j_{max}$.

Thus the calculations made with the perturbed variables are used to compute $\Delta E/\Delta V$, and equation (48) is solved for $dV_j$. The variables V are then given new values from

$$V_j = V_jB + dV_j \tag{49}$$

If the engine cycle calculations were linear functions, the engine would balance (errors within some allowable limit) with the new values of the variables. However, this is not the case, and it is usually necessary to repeat the process of changing each variable by a small amount for each pass. A change in each error because of the small change in the variable is calculated for each pass, where the new values become the base values. This process occurs several times before a balance is obtained.

A subroutine (MATRIX) to determine the solution of a matrix is used to solve the set of differential equations. After each pass through the engine, a matrix array is loaded with the appropriate values; after a number of passes equal to 1 plus the number of independent variables (base value plus up to nine independent variables), the matrix subroutine is used to solve the matrix. The solution of the matrix (E within some allowable limit) yields the correct values of the independent variables and satisfies all the component matching constraints.

The most-often-used independent variables and the differential errors for each of the nine examples of engine types capable of being run on GENENG II are listed in table I.

## INPUTS FOR ENGINE PERFORMANCE CALCULATIONS

Two forms of data are supplied to GENENG II. Some data, such as all the constants and component map data, are in the form of BLOCK DATA subprograms. The varying data are supplied at execution time by the use of input data cards.

The FORTRAN listings of GENENG II are presented in appendix A. The function and description of the subroutines follow in the next section.

## GENENG II Subroutine Functions and Descriptions

A flow chart of the computer program with the subroutines is shown in figure 10. The functions of the subroutines are listed here and the purpose of each is described.

| | |
|---|---|
| GEN2 | Dummy main program to initiate the calculations and cause the input of the controlled output variables. Because of the looping between subroutines, control is never transferred back to this routine. |
| ENGBAL | Main subroutine. Controls all engine balancing loops; checks tolerances and number of loops and loads matrix; calls INPUT. |
| GUESS | Determines initial values of independent variables (see table I) at each point. |
| MATRIX | Solves error matrix. |
| PUTIN | Calls input subroutine package. Controls loop on static pressures for mixed-flow turbofan. |
| ZERO | Zeros nearly all of common and certain controls. |
| COINLT | Determines ram recovery and performs inlet calculations. |
| ATMOS | 1962 U. S. Standard Atmosphere table. |
| RAM | Calculates ram recovery defined by MIL-E-5008B specifications. |
| RAM2 | Calculates special cases of input ram recovery as a function of flight Mach number. |
| COFAN | Uses BLOCK DATA to perform fan calculations. |
| COINTC | Uses BLOCK DATA to perform intermediate-compressor calculations. |
| INTDUM | Makes intermediate compressor not change air conditions for engines e and h. |
| COCOMP | Uses BLOCK DATA to perform inner-compressor calculations. |
| WDUCT | Performs third-stream (wing) duct calculations (not used in two-stream engines). |
| COCOMB | Uses BLOCK DATA to perform combustor calculations. May use either $T_4$ or WFB as the main parameter. |
| COHPTB | Uses BLOCK DATA to perform inner-turbine calculations (not used in engines c and g). |
| COIPTB | Uses BLOCK DATA to perform intermediate-turbine calculations (not used in engines b, e, and h). |
| COLPTB | Uses BLOCK DATA to perform outer-turbine calculations. |

CODUCT Performs duct and duct-burning calculations for turbofans. May use either T24 or WFD as main parameters.

COMIX Performs gas-mixing calculations if in mixed-flow mode. At design points it calculates areas either from an input static pressure PS55 or from an input Mach number AM55 if PS55 = 0. At off-design points it calculates static pressures and Mach numbers from the design areas. Calculates ERR (5). Rescales pressure ratios for mixed-flow turbofans to match duct and core static pressures just prior to mixing. COMIX also calculates afterburner entrance area A6 as a function of afterburner entrance Mach number AM6.

COAFBN Performs afterburning calculations. May use either T7 or WFA as the main parameters.

FRTOSD Dummy routine to transfer values from common FRONT to common SIDE.

FASTBK Dummy routine to transfer values from common SIDE to common BACK.

COMNOZ Controls the main nozzle.

ERROR Controls all printouts if an error occurs. Prints names of subroutine where error occurred and also prints the values of all variables in the main commons.

SYG Controls printing from UNIT08. Throughout the program and particularly in ENGBAL, certain messages, variables, and matrix values are written on UNIT08 as an aid in determining why an error occurred or why a point did not balance. These values are printed out if subroutine ERROR is called and IDUMP is greater than zero, or after a good point if IDUMP = 2.

PERF Calculates performance after the engine is balanced.

OUTPUT Prints output except for controlled output. Prints the main commons after the design point.

CONOUT Controls and prints the controlled output variables.

THCOMP Performs isentropic calculations for compressors.

PROCOM Calculates thermodynamic gas properties for either air or a fuel-air mixture based on JP-4 using curve fits of the tables of reference 4.

SEARCH General table lookup and interpolation routine to obtain data from the BLOCK DATA subroutines.

MAPBAC Used when calculations result in values not on the turbine maps. Changes the map value and an independent variable (PCNF, PCNC, or T4) in an attempt to rectify the situation.

| | |
|---|---|
| CONVRG | Performs nozzle calculations for a convergent nozzle. |
| CONDIV | Performs nozzle calculations for a convergent-divergent (C-D) nozzle. |
| THTURB | Performs isentropic calculations for turbines. |
| THERMO | Provides thermodynamic conditions using PROCOM. |
| AFQUIR | General quadratic interpolation routine. |
| PARABO | Parabolic curve-fit routine. |
| OVELAY | DUMMY routine to restore working part of program to core when using overlay. |
| BLKFAN | Performance data for fan map (BLOCK DATA). |
| BLKINT | Performance data for intermediate-compressor map (BLOCK DATA). |
| BLKCMP | Performance data for inner-compressor map (BLOCK DATA). |
| CMBDAT | BLOCK DATA for combustor. |
| HPTDAT | Performance data for inner-turbine map (BLOCK DATA). |
| IPTDAT | Performance data for intermediate-turbine map (BLOCK DATA). |
| LPTDAT | Performance data for outer-turbine map (BLOCK DATA). |
| ETAAB | Generalized afterburner performance BLOCK DATA as a function of fuel-air ratio with correction factors for off-design afterburner entrance pressure and Mach number. |
| INPUT | Package of Huff input subroutines. (The Huff Input Routine is a very versatile input mechanism further detailed in appendix B.) |

## Entering the Data

The Huff Input Routine, used to enter input data into the program at execution time, is discussed in appendix B. Appendix C presents the individual symbols for component names, station numbers, etc., from which compound names such as WAFCDS (WA + F + C + DS) are formed. Table II and appendix A present the names of the variables, the values of which are supplied on data cards.

Choice of component maps - scaling laws. - Many engines that are studied using GENENG II are theoretical. Therefore, actual component maps for these engines will be nonexistent. The program, however, does require component maps in order to do off-design-point calculations. To alleviate this problem GENENG II uses scaling laws to change data from one component map into a new component map. Hopefully, a component map can be found which could be expected to perform in a similar manner to the

actual map for the engine being studied. In fact, most maps that the authors have obtained are identified as to the range of pressure ratio, airflow, etc., over which they are valid. Thus, a high-bypass-ratio fan map such as that from a CF6 could be used to simulate other high-bypass-ratio fan maps, etc.

The scaling equations used for the compressor maps are

$$PR = \frac{PR_{design} - 1}{PR_{map,design} - 1} (PR_{map} - 1) + 1$$

$$WA = \frac{WA_{design}}{WA_{map,design}} \times WA_{map}$$

$$ETA = \frac{ETA_{design}}{ETA_{map,design}} \times ETA_{map}$$

In the output are printed the correction factors used in scaling the maps. The closer these values are to 1.0, the more reasonable are the simulated maps of the engine. Conversely, however, not being close to 1.0 does not necessarily mean that the simulation is poor since many maps have been shown to be typical over quite large ranges in the variables.

BLOCK DATA input. - The three compressor performance maps are entered into the code as the BLOCK DATA subprograms BLKFAN, BLKINT, and BLKCMP. The subprograms supplied by the authors with the code and shown in appendix A are not to be taken as realistic maps. These maps are of an illustrative nature and are the ones used to run the sample calculations.

Using subprogram BLKFAN as an example (the first nine cards of which are printed here) and referring to a typical compressor map (fig. 11), the data are programmed as follows:

```
$IBFTC BLKFAN  DECK
C      THIS IS A GENERALIZED FAN MAP FOR UNREALISTIC SUPERSONIC ENGINE          1
       BLOCK DATA                                                               2
       COMMON /  FAN/CN(15),PR(15,15),WAC(15,15),ETA(15,15),N,NP(15)            3
       DATA N,NP/10,6,3*7,5*10,8,5*0/                                           4
       DATA CN/0.3,0.4,0.5,0.6,0.7,0.8,0.9,1.0,1.1,1.2,5*0./                    5
       DATA (PR( 1,J),WAC( 1,J),ETA( 1,J),J=1, 6)/                              6
     1  1.03000,  243.600,  0.75592,  1.01200,  229.800,  0.76120,              7
     2  1.02800,  199.800,  0.76648,  1.03840,  166.800,  0.75592,              8
     3  1.04480,  133.200,  0.72512,  1.04800,   86.400,  0.64152/              9
```

Card 1 reminds the reader that these maps are fictitious. Card 2 identifies program as BLOCK DATA. Card 3 identifies common block FAN into which data are to be stored and dimensions the program variable. Card 4 indicates that there are 10 speed lines

N and the number of points NP on each line (six on the lowest speed, seven on the next three lines, etc.). Card 5 assigns the value of speed to each of the 10 lines (low to high). Cards 6 to 9 along the speed line CN=0.3 sets the pressure ratio PR, corrected airflow WAC, and efficiency ETA in sets of three going from low pressure (PR = 1.0) to the surge line (PR = 1.048). Note there are six sets of three values (NP(1) = 6). The rest of the cards (appendix A) set the values for each speed line.

The combustor map is also a BLOCK DATA subprogram (CMBDT). It is a plot of temperature rise across the combustor against efficiency for constant input pressure. Entry to the map is through temperature rise and input pressure with efficiency being output. The cards in the subprogram CMBDT are reproduced here; a typical combustor map shown in figure 12.

```
$IBFTC CMBDT   DECK
       BLOCK DATA                                                          1
       COMMON / COMB/PSI(15),DELT(15,15),ETA(15,15),N,NP(15)               2
       DATA N,NP / 15,15*15 /                                              3
       DATA PSI/4.9116,9.8232,14.735,19.646,24.558,29.470,34.381,          4
      139.293,44.207,73.674,100.,200.,300.,400.,500./                     5
       DATA DELT/15*200.,15*300.,15*400.,15*500.,15*600.,15*700.,15*800.,  6
      115*900.,15*1000.,15*1100.,15*1200.,15*1300.,15*1400.,15*1500.,     7
      215*1600./                                                          8
       DATA ETA/                                                          9
      1.600,.726,.777,.806,.826,.843,.855,.865,7*.870,                    10
      2.758,.825,.858,.875,.888,.898,.906,.912,.914,6*.915,               11
      3.868,.893,.911,.925,.935,.942,.947,.951,7*.953,                    12
      4.925,.936,.946,.955,.963,.969,.974,.977,.978,6*.979,               13
      5.960,.966,.972,.977,.982,.985,.990,.992,.993,6*.995,               14
      6.988,.991,.992,.994,.995,.997,.998,8*.999,                         15
      78*1.00,7*.999,120*1.00/                                            16
       END                                                                17
```

Card 1 identifies the subprogram as BLOCK DATA. Card 2 identifies the common block COMB into which data are to be stored and dimensions each variable. Card 3 indicates that there are 15 lines of constant PSI (P3) by the value of N, and that there are 15 values of DELT (DT) and ETA (ETAB) along each line of constant PSI (P3). Cards 4 and 5 assign values to each of the P3 lines from low to high pressure. Cards 6 to 8 assign values of $\Delta T$ to each of the P3 lines, starting at low $\Delta T$. The lowest value of $\Delta T$ on each of the P3 lines is given starting with the lowest value of $\Delta T$ on the lowest value of P3. Next comes the second lowest value of $\Delta T$ on each P3, etc. Again, this map is unrealistic, being used for illustrative purposes only. Cards 9 to 16 assign the value of $\eta_B$ in a one-to-one correspondence with the $\Delta T$ values just assigned. The order is the same.

Also entered as BLOCK DATA subprograms are the turbine maps (HPTDAT, IPTDAT, and LPTDAT). To illustrate the entering of turbine data, LPTDAT will be used. A typical turbine map is shown in figure 13; the data are programmed as follows:

```
$IBFTC LPTDAT  DECK
      BLOCK DATA                                                          1
      COMMON / LTURB/TFF(15),CN(15,15),DH(15,15),ETA(15,15),N,NP(15)      2
      DATA N,NP/11,9*15,12,9,4*0/                                         3
      DATA TFF /   88.470,  102.795,  116.835,  129.330,  141.045,        4
     1  145.725,  150.000,  153.345,  156.405,  159.780,  163.170,4*0./    5
      DATA (CN( 1,J),DH( 1,J),ETA( 1,J),J=1,15)/                          6
     1    0.3582,   0.0018,   0.7120,   0.5336,   0.0026,   0.7300,      7
     2    0.7365,   0.0035,   0.7472,   0.9754,   0.0044,   0.7300,      8
     3    1.2146,   0.0051,   0.7140,   1.4173,   0.0056,   0.7000,      9
     4    1.5201,   0.0059,   0.6850,   1.7673,   0.0061,   0.6730,     10
     5    2.0247,   0.0062,   0.6452,   2.2827,   0.0061,   0.6200,     11
     6    2.4665,   0.0057,   0.6000,   2.6137,   0.0053,   0.5750,     12
     7    2.8166,   0.0044,   0.5310,   2.9456,   0.0035,   0.5000,     13
     8    3.3138,   0.0001,   0.3850/                                    14
```

Card 1 identifies subprogram as BLOCK DATA. Card 2 identifies common block into which data are to be loaded and dimensions the program variables. Card 3 indicates the number of constant turbine flow function lines TFF as 11 (N) and the number of points on each line from low to high TFF. Cards 4 and 5 set values of TFF from low to high. Cards 6 to 14 set values of corrected speed CN, work function DH, and efficiency ETA along TFF(1) starting from low CN (0.3682) and ending at high CN (3.3138). The rest of the cards set the values along higher TFF lines.

In many cases, turbine maps for high-performance engines operate at a choked condition (constant TFF). Thus, a turbine map to be represented could possibly have no lines representing constant TFF for a significant portion of the map. For complete map representation, lines of constant TFF may be estimated on the map up to the limit loading line by inputing slight changes for the values of TFF (e.g., one line for TFF is 62.105, the next may be input as equal to 62.108). This will eliminate computational difficulties which would arise if constant values for TFF lines were input.

Generalized afterburner performance has been programmed into subroutine COAFBN. The afterburner performance map included in the program is shown in a generalized form in figure 14(a). The performance map shows afterburner combustion efficiency as a function of fuel-air ratio. The values of the afterburner combustion efficiency correction factors $\Delta$ETAA during off-design operation are shown against afterburner entrance Mach number (fig. 14(b)) and afterburner entrance pressure (fig. 14(c)). Other correction factors or performance maps may be added as desired. The afterburner efficiency, fuel-air ratio, inlet total pressure, and Mach number are generalized.

A specific afterburner performance map is generalized by dividing the specific off-design value by the design value as shown below. The symbols shown are the symbols used in the ABETTA subroutine where the generalized and specific values are input. The generalized afterburner values are obtained as follows:

$$\text{Efficiency (ETABRT)} = \frac{\text{ETAA}}{\text{ETAADS}}$$

$$\text{Fuel-air ratio (FART)} = \frac{\text{FART}}{\text{FARTDS}}$$

$$\text{Entrance total pressure (P6T)} = \frac{\text{P6}}{\text{P6DS}}$$

$$\text{Entrance Mach number (EM6T)} = \frac{\text{AM6}}{\text{AM6DS}}$$

However, the correction factor for efficiency $\Delta$ETAA is not a generalized value. Also input in ABETTA are

(1) The change in efficiency as a function of EM6T is input as DELM6 (which is really $\Delta$ETAA = f(AM6)).

(2) The change in efficiency as a function of P6T is DELP6 (which is really $\Delta$ETTA= f(P6)).

At execution time for the design point, afterburner combustion efficiency ETAADS, exit total temperature T7DS, and entrance Mach number AM6DS design values are input. Then design fuel-air ratio and entrance pressure ratio are calculated from the input values and the other design engine characteristics.

To achieve a reasonable accuracy in cycle calculations when using a generalized component map, the usage of the map should be limited within a certain range of the original design values and configuration changes. Therefore if, for example, an afterburner has a design task that differs significantly from an example used, a new performance map should be used in order to simulate the component more accurately.

GENENG II normally uses a single-point input for the nozzle velocity coefficients (CVMNOZ, CVDWNG, and CVDNOZ) when calculating engine performance. When desired, however, a map of nozzle velocity or thrust coefficients can be readily incorporated.

Inputs required at execution time. - Basically what must be supplied are a list of the desired output variables, design values of any component existing in the engine (compressors, combustion, turbines, etc.), and engine operational controls. The variables that are to be output are selected by the first section of data cards. Any variable that is in one of the main commons (DESIGN, FRONT, SIDE, BACK, SPOOL2, or DUMMYS) may be selected for output by punching, in columns 1 to 6, the name of the variable as it appears in the common. Up to 150 variables (25 lines of six variables) may be chosen for a particular run. During the output phase, the name of the variable is printed out, with its value printed immediately below the name.

Another feature of the controlled output is the ability to change the name of a variable to be output; for example, it may be desired to change a station designation to one more common to a particular programer. In this case, the variable name would be

punched in columns 1 to 6 as described; but, in addition, the desired name would be punched in columns 13 to 18. Special symbols such as / may be used in the new name. The last card of the controlled output must be a card with "THEEND" punched in columns 1 to 6.

Table II summarizes the design inputs for the nine basic engines shown in this report.

The following control variables should always be supplied at the design point. The value used is independent on how the user wants the engine to operate. The symbols and their purpose are listed in the subroutine PUTIN but are shown here for the reader's convenience. The superscripts (1) to (4) on the symbols have the following meanings: (1) means "automatically returned to zero after each point is calculated, must be re-input if option is again desired"; (2) means "option can be used for design or off-design," whereas the other two MODE's can be used only at off-design; (3) means "these input values remain as input unless changed by a new input value"; (4) means "a setup case must be run where all the components are first matched before these $\neq 0$ options are used; then the identical case may be repeated exercising these options."

IDES = $1^{(1)}$ For calculating the design point.

$^{(2)}$MODE = $0^{(3)}$ Specify T4.

MODE = $1^{(3)}$ Specify PCNC.

$^{(2)}$MODE = $2^{(3)}$ Specify WFB.

MODE = $3^{(3)}$ Specify PCNF.

INIT = $0^{(3)}$ Initializes point.

INIT = $1^{(3)}$ Will not initialize point.

IDUMP = $0^{(3)}$ No looping write-outs.

IDUMP = $1^{(3)}$ Will dump looping write-outs if error occurs.

IDUMP = $2^{(3)}$ Will dump looping write-outs after every point.

IAMTP = $0^{(3)}$ Will use AM and military-specification ETAR.

IAMTP = $1^{(3)}$ Will use input AM and input ETAR.

IAMTP = $2^{(3)}$ Will use input T2 as T1 = T1 + T2 and standard P1. (T2 value needs to be input at every point or an error will occur whenever used.)

IAMTP = 3[3] Will use input P2 and standard T1.

IAMTP = 4[3] Will use input T2 and input P2.

IAMTP = 5[3] Will use specific schedule of ETAR located in subroutine RAMTWO.

IGASMX = -1[3] Separate flow, input A6.

IGASMX = 0[3] Separate flow, A6 = A55. (This control was used on all basic cycles in this report.)

IGASMX = 1[3] Will mix fan duct and main streams, A6 = A25 + A55.

IGASMX = 2[3] Will mix fan duct and main streams, input A6.

IDBURN = 1[1] For duct burning (fan stream only), input T24.[4]

IDBURN = 2[1] For duct burning (fan stream only), input WFD.[4]

IAFTBN = 1[1] For afterburning (main stream or mixed stream of fan and main stream), input T7.[4]

IAFTBN = 2[1] For afterburning (main stream or mixed stream of fan and main stream), input WFA.[4]

IDCD = 1[3] Fan duct nozzle will be convergent-divergent.

IMCD = 1[3] Main nozzle will be convergent-divergent.

NOZFLT = 1[3] For floating main nozzle exit area.[4]

NOZFLT = 2[3] For floating fan duct nozzle exit area.[4]

NOZFLT = 3[3] For floating fan duct and main nozzle exit area.[4]

ITRYS = N Number of passes through engine before quitting.

TOLALL = X Tolerance which the errors must satisfy before engine is matched.

The following are other input variables for which some value depending on the engine design should be input at the discretion of the user:

DELFG, DELFN, DELSFC Normally input as 1.0 unless a correction is desired.

| | |
|---|---|
| A6, AM55, AM23, AM6 HPEXT, AM, ALTP, CVMNOZ, CVDNOZ, CVDWNG | See appendix C, Input Symbols. |
| PCBLC, PCBLDU, PCBLOB, PCBLF | Values for bleed out of cycle; decimal equivalent of percent compressor flow. |
| PCBLHP, PCBLIP, PCBLLP | Value of total bleed returned to turbines; fractional equivalent of flow. The sum of these variables plus PCBLDU and PCBLOB should equal 1. |

Inputs required for additional options to basic cycles. - To run duct-burning (available only in fan stream duct) cases load ETAD, T24 or WFBDS, and DPDUDS. To run afterburning (mixed-flow fan or unmixed fan - available for core and fan stream if mixed, or for core stream if unmixed) cases load T7DS or WAFDS, ETAADS, and DPAFDS. Afterburner operation is the same as in reference 2 with the exception of a generalized afterburner performance map addition. For changing the generalized map to a specific map for a specific engine design, the preceding design values are needed at the design point.

Means of specifying mode of engine operation. - Shown in the section SAMPLE CALCULATIONS (pp. 26 to 53) are the methods of specifying off-design operation points. The most common one and the one used exclusively herein is to select a Mach number, an altitude, and a turbine inlet temperature other than design values. There are, however, several other possibilities which the user may employ. For example, changing the following controls:

MODE = 0 Specify a new turbine inlet temperature T4.

MODE = 1 Specify a compressor rotational speed PCNC.

MODE = 2 Specify a fuel flow rate WFB.

MODE = 3 Specify a fan rotational speed PCNF.

If the engine has all its nozzles fixed, then an input such as turbine inlet temperature, fuel flow, or speed will set the thrust level. But other means of changing engine operation can be accomplished by varying such nozzle throat areas as

A8 Main nozzle throat area

A38 Wing nozzle throat area

A28 Fan nozzle throat area

For example, an off-design condition may exist where, in an attempt to satisfy continuity of mass flow (one of the component matching requirements), the fan operating point may lie outside the limits of the data that were input for the component map. A

fan nozzle throat area change could be used to return the fan operating condition on the map such that a match would occur. This would indicate a possibility exists that a variable fan nozzle would be required on this engine for operation at the desired condition. The area is changed by inputing (example; A28 = 1.2*A28). Since the design areas are not known prior to running the design point, the Huff Input Routine provides the versatility in which A28 is increased by a factor of 1.2 as was shown. It should be noted that any area remains changed until it is recalculated by a new design case or altered by a new input. The preceding example and statements would apply if changes were made instead to A8 or A38.

If the engine uses thrust augmentation by either duct burning or afterburning, the affected throat area (A28 or A8) will adjust to account for the temperature increase during afterburning. The area adjustment will be such that sonic conditions will exist at the affected throat. The component cycle match point is not affected. The area will then revert to the original design of modified A28 or A8 when the next case is run without afterburning.

The nozzle exit area (A9 or A29) may be fully expanded (if A28 or A8 are sonic) by using the control variables NOZFLT = 1, 2, or 3 for the nonafterburning cases, or it is done automatically for the afterburning cases when the control variables of IAFTBN or IDBURN are used. The significance of these values was explained in the previous section.

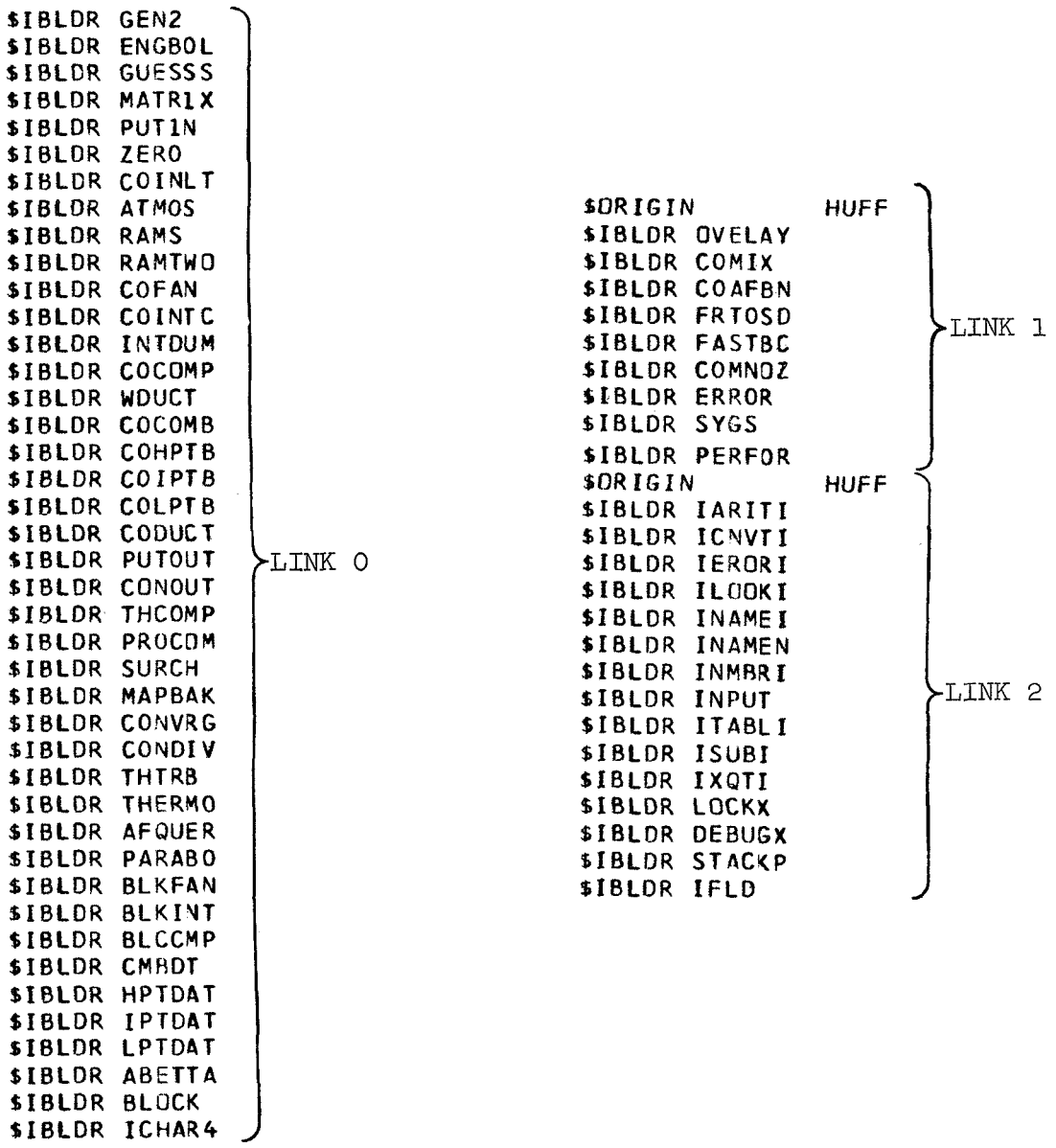
## Use of Overlay - The Huff Input Routine Subroutine Package

The use of the Huff Input Routine (appendix B) may, as in the case of The Lewis Research Center's 7094, require the use of overlay. Because of the flow of the program, the rules of overlay are violated in that the system will detect that it is possible to call a link which will override the link that called it. The link that is called is the Input Subroutine Package. The authors, however, have provided that as soon as the input is read, the original link is restored so that the program will execute correctly. The computer system might have to be told that the rules of overlay are being violated but to proceed anyway.

In addition, the use of overlay increases the execution time of the program. The sample cases being run herein take about 4 seconds per case without overlay and 8 seconds with overlay.

If the user feels that the aforementioned difficulties are not worth the flexibility of the Huff Input Routine, he may restore the program to the original form, in which NAMELIST was used. The authors will supply directions for this if so desired.

The suggested links when using overlay are as follows:


$IBLDR GEN2
$IBLDR ENGBOL
$IBLDR GUESSS
$IBLDR MATRIX
$IBLDR PUTIN
$IBLDR ZERO
$IBLDR COINLT
$IBLDR ATMOS
$IBLDR RAMS
$IBLDR RAMTWO
$IBLDR COFAN
$IBLDR COINTC
$IBLDR INTDUM
$IBLDR COCOMP
$IBLDR WDUCT
$IBLDR COCOMB
$IBLDR COHPTB
$IBLDR COIPTB
$IBLDR COLPTB
$IBLDR CODUCT
$IBLDR PUTOUT
$IBLDR CONOUT
$IBLDR THCOMP
$IBLDR PROCOM
$IBLDR SURCH
$IBLDR MAPBAK
$IBLDR CONVRG
$IBLDR CONDIV
$IBLDR THTRB
$IBLDR THERMO
$IBLDR AFQUER
$IBLDR PARABO
$IBLDR BLKFAN
$IBLDR BLKINT
$IBLDR BLCCMP
$IBLDR CMBDT
$IBLDR HPTDAT
$IBLDR IPTDAT
$IBLDR LPTDAT
$IBLDR ABETTA
$IBLDR BLOCK
$IBLDR ICHAR4
LINK 0
$ORIGIN HUFF
$IBLDR OVELAY
$IBLDR COMIX
$IBLDR COAFBN
$IBLDR FRTOSD
$IBLDR FASTBC
$IBLDR COMNOZ
$IBLDR ERROR
$IBLDR SYGS
$IBLDR PERFOR
LINK 1
$ORIGIN HUFF
$IBLDR IARITI
$IBLDR ICNVTI
$IBLDR IERORI
$IBLDR ILOOKI
$IBLDR INAMEI
$IBLDR INAMEN
$IBLDR INMBRI
$IBLDR INPUT
$IBLDR ITABLI
$IBLDR ISUBI
$IBLDR IXQTI
$IBLDR LOCKX
$IBLDR DEBUGX
$IBLDR STACKP
$IBLDR IFLD
LINK 2

# SAMPLE CALCULATIONS

Examples of nine basic engines capable of being run without changes to the computer code are shown in this section.

## Type a - Three-Spool, Three-Stream Turbofan

The first example engine is engine a, the three-spool, three-stream turbofan engine. The first page output from the program is reproduced at the end of this main section. What is shown are the card images of the input cards, which is one of the advantages of using the Huff Input Routine (HIR); they were printed under the control of that routine.

The card numbers have been added by the authors and appear to the right on the output sheets. Card 1 ($D(1)) is the identification card for the forthcoming block of data. The (1) agrees with the third argument of the CALL INPUT (5, 6, 1, WORD, ITABLE) statements in subroutine PUTIN. The ǂ1 (punched as :1) causes the carriage control to start a new page. Card 2 starts the TABLE relating the location of each of the named variables to the location of the variable "WORD" in common block ALL. These names have been mentioned in the section Inputs required at execution time and are listed alphabetically in appendix C. The first group of variables have been tagged with the label INTEGER, denoting their mode. Cards 3 to 14 complete the table with the REAL and LOGICAL variables. Cards 15 to 17 have been found to be useful in that they provide an easy method for designing an engine for other than a standard day. Since GENENG II uses corrected airflows as design-point inputs, the actual airflow into the fan must be multiplied by $\sqrt{\theta}$ (= 1 for standard day). The $\sqrt{\theta}$ for other than a standard day has been predetermined for the user (TROPICAL DAY = $\sqrt{(518.69 + 31)/518.69}$, etc.) and using the HIR, these factors can be used to multiply the desired airflows.

Cards 18 to 20 set the design point as a "normal" engine at sea-level-static conditions. Card 21, which has been made to stand out by the use of ǂ0, emphasizes the logical control variables which set the engine being run, in this case a three-spool, three-stream turbofan (engine a, fig. 1). Cards 22 to 24 describe the engine to be run and illustrate the use of the HIR to identify what is being done.

In table II are listed the required inputs to run each of the sample engines. Card 25 sets the fan design parameters and illustrates both tropical day and the HIR performing mathematical operations. In addition, the pressure coming out of the second spool was picked (2.2) and thus the pressure ratio of the intermediate compressor determined from this value and the pressure already achieved by the fan (1.4).

Cards 26 to 28 remind the user that the program requires corrected airflows and that the HIR is used to correct the airflow going into the intermediate compressor on card 29. Cards 30 to 36 complete the input data for the design case. The input values of turbine design data correspond to the design point on the turbine maps. The compressor data are the actual values for the components, and the design points on the compressor maps are specified by the percent corrected speeds (PCNFDS, PCNIDS, and PCNCDS) and the values of Z (ZFDS, ZIDS, and ZCDS). Card 34 sets the design day as being a tropical day (recall cards 25 and 29). Execution commences since the next card is a $D(1), indicating a new block of data. (This card is on page 34.)

The first group of output shows the scaling factors being used on the component maps. For the three compressors these are defined by

$$PR\_CF = 1 + \frac{PR\_DS - 1}{PR^* - 1} \tag{50}$$

$$ETA\_CF = \frac{ETA\_DS}{ETA^*} \tag{51}$$

$$WA\_CF = \frac{WA\_CDS}{WAC^*} \tag{52}$$

where the * values are those defined on the component maps by PCN_DS and Z_DS. Recall that the closer these and the turbine correction factors are to 1.0, the better the performance map data which were input to the program simulates the engine being studied. Even if these values are not close to 1.0, the simulation may still be quite accurate if the maps used were identified as being applicable over a range of design-point specification within which the user's design point falls.

The Mach number, the area of the throat, and the exit area of the wing duct are printed next, followed by the combustor design corrected airflow and combustor correction factors. For the combustor

$$ETABCF = \frac{ETABDS}{1.0} \tag{53}$$

and DTCOCF always equals 1 since the combustor value of DTCODS is calculated internally at the design point and the map is then scaled.

Following the combustor correction factors are the correction factors for each of the turbines, where

$$CN\_PCF = CN\_PDS \frac{\sqrt{T^*}}{PCN\_^{**}} \tag{54}$$

$$TF\_PCF = TF\_PDS \frac{14.696 \times P\_^*}{WG\_^* \times \sqrt{T^*}} \tag{55}$$

$$ET\_PCF = \frac{ET\_PDS}{ETAT\_P} \tag{56}$$

$$DH\_PCF = \frac{DHT\_C}{DHTC\_P} \tag{57}$$

where the * values are at the inlet to the turbine, PCN_** is the percent corrected speed of the compressor being driven by the turbine, DHT_C is the actual work function of the turbine, and ETAT_P and DHTC_P are the values of efficiency and work function, respectively, at the design point chosen on the turbine maps. These correction factors are followed by the areas for the duct nozzle, turbine exit, and core nozzle.

The aforementioned output occurs only at the design point. This is followed by output which was determined by a list of variable names submitted at execution time (see section Input required at execution time). The engine type is spelled out prior to the listing of the variable values. The list of variables printed here with their definitions are found in appendix C.

The type of nozzle is printed and then the number of loops required for convergence (always 1 for design points). Next is printed a line labeled COMMON and on this line reading from left to right are the values of ZF, PCNF, ZI, PCNI, ZC, PCNC, T4, and MODE. The variables in the labeled common BLOCKS are printed next according to the following code:

```
 COMMON /DESIGN/
1PCNFGU,PCNCGU,T4GU   ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,
2ZFDS   ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,
3ZCDS   ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,
4T4DS   ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,
5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS   ,
6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS  ,
7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,
8T7DS   ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,
9A55    ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,
$PS55   ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV
```

```
 COMMON / FRONT/
1T1     ,P1     ,H1     ,S1     ,T2     ,P2     ,H2     ,S2     ,
2T21    ,P21    ,H21    ,S21    ,T3     ,P3     ,H3     ,S3     ,
3T4     ,P4     ,H4     ,S4     ,T5     ,P5     ,H5     ,S5     ,
4T55    ,P55    ,H55    ,S55    ,BLF    ,BLC    ,BLDU   ,BLOB   ,
5CNF    ,PRF    ,ETAF   ,WAFC   ,WAF    ,WA3    ,WG4    ,FAR4   ,
6CNC    ,PRC    ,ETAC   ,WACC   ,WAC    ,ETAB   ,DPCOM  ,DUMF   ,
7CNHP   ,ETATHP ,DHTCHP ,DHTC   ,BLHP   ,WG5    ,FAR5   ,CS     ,
8CNLP   ,ETATLP ,DHTCLP ,DHTF   ,BLLP   ,WG55   ,FAR55  ,HPEXT  ,
9AM     ,ALTP   ,ETAR   ,ZF     ,PCNF   ,ZC     ,PCNC   ,WFB    ,
$TFFHP  ,TFFLP  ,PCBLF  ,PCBLC  ,PCBLDU ,PCBLOB ,PCBLHP ,PCBLLP
 COMMON /  SIDE/
1XP1    ,XWAF   ,XWAC   ,XBLF   ,XBLDU  ,XH3    ,DUMS1  ,DUMS2  ,
2XT21   ,XP21   ,XH21   ,XS21   ,T23    ,P23    ,H23    ,S23    ,
3T24    ,P24    ,H24    ,S24    ,T25    ,P25    ,H25    ,S25    ,
4T28    ,P28    ,H28    ,S28    ,T29    ,P29    ,H29    ,S29    ,
5WAD    ,WFD    ,WG24   ,FAR24  ,ETAD   ,DPDUC  ,BYPASS ,DUMS3  ,
6TS28   ,PS28   ,V28    ,AM28   ,TS29   ,PS29   ,V29    ,AM29
 COMMON /  BACK/
1XT55   ,XP55   ,XH55   ,XS55   ,XT25   ,XP25   ,XH25   ,XS25   ,
2XWFB   ,XWG55  ,XFAR55 ,XWFD   ,XWG24  ,XFAR24 ,XXP1   ,DUMB   ,
3T6     ,P6     ,H6     ,S6     ,T7     ,P7     ,H7     ,S7     ,
4T8     ,P8     ,H8     ,S8     ,T9     ,P9     ,H9     ,S9     ,
5WG6    ,WFA    ,WG7    ,FAR7   ,ETAA   ,DPAFT  ,V55    ,V25    ,
6PS6    ,V6     ,AM6    ,TS7    ,PS7    ,V7     ,AM7    ,AM25   ,
7TS8    ,PS8    ,V8     ,AM8    ,TS9    ,PS9    ,V9     ,AM9    ,
8VA     ,FRD    ,VJD    ,FGMD   ,VJM    ,FGMM   ,FGPD   ,FGPM   ,
9FGM    ,FGP    ,WFT    ,WGT    ,FART   ,FG     ,FN     ,SFC
 COMMON /SPOOL2/
1T22    ,P22    ,H22    ,S22    ,T50    ,P50    ,H50    ,S50    ,
2WA22   ,ZI     ,PCNI   ,CNI    ,PRI    ,ETAI   ,WACI   ,TFFIP  ,
3CNIP   ,ETATIP ,DHTCIP ,DHTI   ,BLIP   ,PCBLIP ,PCNIGU ,ZIDS   ,
4PCNIDS ,PRIDS  ,ETAIDS ,WAIDS  ,PRICF  ,ETAICF ,WAICF  ,TFIPDS ,
5CNIPDS ,ETIPDS ,TFIPCF ,CNIPCF ,ETAPCF ,DHIPCF ,WAICDS ,WAI    ,
6PCBLI  ,BLI    ,T22DS  ,WA21
 COMMON /DUMMYS/ XYZ(21) (not printed)
IWA32   ,DPWGDS ,DPWING ,WA32DS ,A38    ,AM38   ,V38    ,T38    ,
2H38    ,P38    ,TS38   ,PS38   ,T39    ,H39    ,P39    ,TS39   ,
3V39    ,AM39   ,A39    ,BPRINT ,WG37   ,CVDWNG ,FGMWNG ,FGPWNG ,
4FNWING ,FNMAIN ,FWOVFN ,PS39   ,FXFN2M ,FXM2CP ,TRUE   ,FALSE  ,
5FFOVEN ,FCOVFN ,FMNOFN ,FNOVFD ,AFTFAN ,DUMSPL ,FDES   ,PCBLID
6TFFHP  ,TFFIP  ,TFFLP  ,CNHP   ,CNIP   ,CNLP   ,DHTCHP ,DHTC
```

This completes the printout of the design-point engine. Next the engine is run at an altitude of 25 000 feet, a Mach number of 0.6, a turbine inlet temperature of 2260$^{o}$ R (recall MODE = 0), and standard-day conditions (IAMTP = 0).

What follows is the off-design performance for the three-spool engine. Note that the common blocks are not printed for the off-design-point case. The running of the other eight engines is described in the following subsections and appears at the end of this main section.

## Type b - Two-Spool, Three-Stream Boosted-Fan Turbofan

Two $D(1), IDES = 1 will cause the deck to run a new design-point engine. The first of these two cards recalls all the design data of the previous design case. Any variable name (except speed when attaching spools) with a DS on the end (e.g., PRFDS) remains unchanged unless overridden with a new value in input. These changed values must follow the second $D(1), IDES = 1 card. Therefore, referring to table II, to run engine b (the boosted fan; fig. 2) all that is necessary is to reset the design Mach number and altitude to zero, set up to run on a tropical day (T2 = 31, IAMTP = 2), and set FIXFANTOMIDDLE = .T. Note that in the output there are no correction factors for the intermediate-pressure turbine since the entire boosted fan is driven by the low-pressure turbine, and that PCNI and CNI are not 100 since the physical speed of the middle spool is set by that of the fan. Note also that TFFIP, CNIP, and DHTCIP are zero since that turbine is not used. The user was reminded of this by the line reading "FAN AND MIDDLE SPOOL ARE ATTACHED, USE INNER AND OUTER TURBINES."

To run the off-design case for all engines proceed as in engine a.

## Type c - Two-Spool, Three-Stream, Supercharged-Compressor Turbofan

To run engine c (fig. 3), it is necessary to detach the fan and middle spool (FIXFANTOMIDDLE = .F.); to set FIXMIDDLETOCOMP = .T.; to reset Mach number, altitude, and tropical day; and to reset PCNIDS to design value (100). Note that the high-pressure turbine has been deleted.

## Type d - Three-Spool, Two-Stream Turbofan

To run engine d (fig. 4), it is necessary to detach the middle and inner spools (FIXMIDDLETOCOMP = .F.); to reset Mach number, altitude, and tropical day; to reset PCNCDS to design value (100); and to set PCBLIDS, the fraction of air exiting the middle spool and going into the wing, equal to zero. Note that the intermediate duct is deleted and there is no wing thrust.

## Type e - Two-Spool, Two-Stream Turbofan

To run engine e (fig. 5), it is necessary to reset Mach number, altitude, and tropical day; to set DUMMYSPOOL = .T.; and to change inner-compressor pressure

ratio to 16/1.4 so that overall pressure ratio is the same. Note that CNI = 0; PRI = 1.0; WACI = WACC; and there is no wing thrust.

## Type f - Three-Spool, Three-Stream Aft-Fan Turbofan

To run engine f (fig. 6), it is necessary to set DUMMYSPOOL = .F.; to set AFTAN = .T.; to set WAICDS = 400* TROPICALDAY (middle spool at free-stream conditions; tropical day); to reset PCBLIDS = 0.5; to reset Mach number, altitude, and tropical day; to change airflows to fit new configuration; and to lower inner-compressor pressure ratio to 16/2.2 (since middle compressor is now operating). Note that WAI > WAF since WAF does not enter the middle spool.

## Type g - Two-Spool, Three-Stream Aft-Fan Turbofan

To run engine g (fig. 7), it is necessary to set FIXMIDDLETOCOMP = .T.; and to reset Mach number, altitude, and tropical day. Note that AFTFAN continued to be true.

## Type h - Two-Spool, Two-Stream Aft-Fan Turbofan

To run engine h (fig. 8), it is necessary to detach the middle and inner spools (FIXMIDDLETOCOMP = .F.); to set DUMMYSPOOL = .T.; to set PCBLIDS = 0 (no airflow into wing); to reset PCNIDS to 100 and change PRCDS to maintain overall pressure ratio of 16; and to reset Mach number, altitude, and tropical day.

## Type i - Two-Stream Aft-Fan Turbofan

To run engine i (fig. 9), it is necessary to set DUMMYSPOOL = .F.; to reset Mach number, altitude, and tropical day; to lower the inner-compressor pressure ratio; and to reset PRIDS. The last case is followed by a $END card to terminate the reading of data.

```
$D(1),$1 THIS CAUSES THIS CARD TO BE PRINTED AT TOP OF PAGE                    1
$TABLE (.INTEGER.,2=IDES,5=MODE,7=IDUMP,8=IAMTP,9=IGASMX,10=IDBURN,11=IAFTBN,  2
12=IDCD,13=IMCD,16=NOZFLT,17=ITRYS,.LOGICAL.,358=FIXFANTOMIDDLE,               3
359=FIXMIDDLETOCOMP,366=AFTFAN,367=DUMMYSPOOL,.REAL.22=TOLALL,34=DELFG,35=DELFN,  4
36=DELSFC,38=PCNFDS,39=PRFDS,40=ETAFDS,46=PCNCDS,47=PRCDS,48=ETACDS,53=T4DS,  5
54=WFBDS,56=ETABDS,58=DPCODS,63=ETHPDS,71=ETLPDS,82=DPDUDS,85=T7DS,88=ETAADS,  6
90=DPAFDS,95=A6,97=A8,99=A28,101=PS55,102=AM55,103=CVDNOZ,104=CVMNOZ,113=T2,   7
114=P2,125=T4,144=WAFCDS,152=WACCDS,172=HPEXT,173=AM,174=ALTP,175=ETAR,177=PCNF,  8
179=PCNC,180=WFB,183=PCBLF,184=PCBLC,185=PCBLDU,186=PCBLOB,187=PCBLHP,         9
188=PCBLLP,205=T24,225=ETAD,257=T7,270=WFA,273=ETAA,279=AM6,313=AM23,331=DPWGDS,  10
334=A38,400=HOTDAY,401=TROPICALDAY,402=COLDDAY,403=POLARDAY,433=PCNIDS,        11
430=PCBLIP,37=ZFDS,45=ZCDS,432=ZIDS,369=PCBLIDS,351=CVDWNG,                    12
61=TFHPDS,62=CNHPDS,440=TFIPDS,441=CNIPDS,69=TFLPDS,70=CNLPDS,                 13
434=PRIDS,435=ETAIDS,442=ETIPDS,447=WAICDS,449=PCBLI) # END OF TABLE            14
# THE FOLLOWING CONSTANTS ARE HELPFULL IN DESIGNING FOR OTHER THAN STANDARD DAY  15
# HOTDAY(T2=44),TROPICALDAY(T2=31),COLDDAY(T2=-19),POLARDAY(T2=-75)             16
HOTDAY=1.041553,TROPICALDAY=1.029451,COLDDAY=.9815130,POLARDAY=.9248777,       17
# CONTROL CARDS FOR NORMAL CASE - DESIGN FOR SEALEVEL                           18
AM=0,ALTP=0,IAFTBN=0,IDBURN=0,IAMTP=0,AM6=.24,AM23=.18,AM55=.238,              19
NOZFLT=0,IDUMP=1,IDCD=0,IMCD=0,IGASMX=0,MODE=0,TOLALL=.010,ITRYS=400,IDES=1,   20

FIXFANTOMIDDLE=.F.,FIXMIDDLETOCOMP=.F.,AFTFAN=.F.,DUMMYSPOOL=.F. $0            21

$0 RUN STANDARD 3 SPOOL-3 STREAM TURBOFAN ENGINE AND DESIGN IT FOR A TROP. DAY 22
# ACTUAL AIRFLOWS DESIRED ARE 600 LB/SEC INTO FAN, 400 LB/SEC INTO INTERMEDIATE 23
# COMPRESSOR, AND 200 LB/SEC INTO CORE. NOTE - PROGRAM USES CORRECTED AIRFLOWS  24
PRFDS=1.4,ETAFDS=.88,WAFCDS=600*TROPICALDAY,PCNFDS=100,PCBLF=0,PRIDS=2.2/1.4,  25

$0 AT SLS,SQRT(THETA)/DELTA=SQRT(1.+ (PRFDS**(.4/1.41-1.)/ETAFDS)/PRFDS        26
# SINCE THE PROGRAM REQUIRES CORRECTED AIRFLOWS, THE HIR CAN BE USED TO DO THIS 27
# THE HIR USES THE FUNCTION PWR(X,Y) TO CALCULATE X**Y                          28
WAICDS=400*TROPICALDAY*SQRT(1.+(PWR(PRFDS,(.4/1.4))-1.)/ETAFDS)/PRFDS          29
ETAIDS=.87,PCNIDS=100,PCBLIDS=.5,ETABDS=.983, #  50 PERCENT OF THE AIR THAT IS  30
# COMING OUT OF INTERMEDIATE COMPRESSOR GOES TO WING,REMAINDER TO CORE          31
DPCODS=.05,DPWGDS=.10,PRCDS=16/2.2,PCNCDS=100,ETACDS=.86,PCBLC=0,DPDUDS=.05,   32
ETHPDS=.9,ETIPDS=.9,ETLPDS=.9,DELSFC=1,DELFN=1,DELFG=1,PCBLOB=0,T4DS=2560,     33
IAMTP=2,T2=31, # DESIGN FOR TROP. DAY, INPUT T2 (T1=T1+T2 INPUT), STANDARD P1  34
TFHPDS=50,CNHPDS=2.0,TFIPDS=120,CNIPDS=2.2,TFLPDS=130,CNLPDS=2.3,              35
ZFDS=.83333333,ZIDS=.83333333,ZCDS=.81433225,CVDNOZ=.985,CVMNOZ=.985,CVDWNG=.985  36
```

```
FAN DESIGN              PRFCF= 0.10000000E+01 ETAFCF= 0.10000000E+01  WAFCF= 0.10294510E+01   T2DS= 0.54966819E+03

MIDDLE SPOOL DESIGN     PRICF= 0.95238095E+00 ETAICF= 0.98863635E+00  WAICF= 0.10351161E+01  T22DS= 0.61268656E+03

COMPRESSOR DESIGN       PRCCF= 0.89610390E+00 ETACCF= 0.10000000E+01  WACCF= 0.10632227E+01  T21DS= 0.70943958E+03

INTER DUCT DESIGN        A38= 0.23859579E+01   AM38= 0.10000000E+01    A39= 0.23859579E+01   AM39= 0.10000000E+01

COMBUSTOR DESIGN       WA3CDS= 0.30802648E+02 ETABCF= 0.98300000E+00 DTCOCF= 0.10000000E+01

H.P. TURBINE DESIGN    CNHPCF= 0.10119289E+01 TFHPCF= 0.10815634E+01 ETHPCF= 0.10000000E+01 DHHPCF= 0.95721405E+00

I.P. TURBINE DESIGN    CNIPCF= 0.99843589E+00 TFIPCF= 0.10150019E+01 ETIPCF= 0.10000000E+01 DHIPCF= 0.10077022E+01

L.P. TURBINE DESIGN    CNLPCF= 0.10026477E+01 TFLPCF= 0.78657749E+00 ETLPCF= 0.10201339E+01 DHLPCF= 0.13610839E+01

DUCT NOZZLE DESIGN       A28= 0.37508934E+01   AM28= 0.65160510E+00    A29= 0.37508934E+01   AM29= 0.65160510E+00

TURBINE AREA DESIGN      A55= 0.79371517E+01   AM55= 0.23826588E+00
```

```
NOZZLE DESIGN            A8= 0.31020577E+01   AM8= 0.10000000E+01    A9= 0.31020577E+01   AM9= 0.10000000E+01

OUTPUT                AM=  0.          ALTP=      0.          T4= 2560.00                        ETAR= 1.0000

THREE SPOOL ENGINE

      PCNF            CNF              ZF              PRF             WAFC            WAF
  0.100000E+03    0.100000E+01    0.833333E+00    0.140000E+01    0.617671E+03    0.600000E+03
      PCNI            CNI              ZI              PRI             WACI            WAI
  0.100000E+03    0.100000E+01    0.833333E+00    0.157143E+01    0.310535E+03    0.400004E+03
      PCNC            CNC              ZC              PRC             WACC            WAC
  0.100000E+03    0.100000E+01    0.814332E+00    0.727273E+01    0.106322E+03    0.200002E+03
      T2              P2              T22             P22             T21             P21
  0.549668E+03    0.100000E+01    0.612687E+03    0.140000E+01    0.709440E+03    0.220000E+01
      T3              P3              PCBLF           BLF             PCBLC           BLC
  0.131143E+04    0.160000E+02    0.              0.              0.              0.
      PCBLHP          BLHP            PCBLIP          BLIP            PCBLLP          BLLP
  0.              0.              0.              0.              0.              0.
      WA3             WFB             WG4             FAR4            T4              P4
  0.200002E+03    0.409714E+01    0.204099E+03    0.204855E-01    0.256000E+04    0.152000E+02
      TFFHP           CNHP            DHTCHP          DHTC            T50             P50
  0.462294E+02    0.197642E+01    0.600000E-01    0.147028E+03    0.205966E+04    0.533120E+01
      TFFIP           CNIP            DHTCIP          DHTI            T5              P5
  0.118226E+03    0.220345E+01    0.220000E-01    0.456615E+02    0.190038E+04    0.366320E+01
      TFFLP           CNLP            DHTCLP          DHTF            T55             P55
  0.165273E+03    0.229393E+01    0.171750E-01    0.444244E+02    0.174312E+04    0.246301E+01
      ETAB            PCBLDU          ETAD            DPDUC           T24             P24
  0.983000E+00    0.              0.              0.500000E-01    0.612687E+03    0.133000E+01
      WAD             WFD             WG24            FAR24           T25             P25
  0.199997E+03    0.              0.199997E+03    0.              0.612687E+03    0.133000E+01
      ETAF            ETAI            ETAC            ETATHP          ETATIP          ETATLP
```

| | | | | | |
|---|---|---|---|---|---|
| 0.880000E+00 | 0.870000E+00 | 0.860000E+00 | 0.900000E+00 | 0.900000E+00 | 0.900000E+00 |
| T6 | P6 | PS6 | AM6 | V6 | WG6 |
| 0.174312E+04 | 0.246301E+01 | 0.237252E+01 | 0.238266E+00 | 0.472365E+03 | 0.204099E+03 |
| T7 | WFA | WG7 | FAR7 | ETAA | DPAFT |
| 0.174312E+04 | 0. | 0.204099E+03 | 0.204855E-01 | 0. | 0. |
| PS8 | AM8 | V8 | PS9 | AM9 | V9 |
| 0.133990E+01 | 0.100000E+01 | 0.185277E+04 | 0.133990E+01 | 0.100000E+01 | 0.185277E+04 |
| PS28 | AM28 | V28 | PS29 | AM29 | V29 |
| 0.100000E+01 | 0.651605E+00 | 0.759245E+03 | 0.100000E+01 | 0.651605E+00 | 0.759245E+03 |
| BPRINT | DPCOM | DPWING | PS38 | AM38 | V38 |
| 0.100000E+01 | 0.500000E-01 | 0.100000E+00 | 0.104874E+01 | 0.100000E+01 | 0.119237E+04 |
| BYPASS | HPEXT | WFT | WGT | VA | FRD |
| 0.499987E+00 | 0. | 0.409714E+01 | 0.604097E+03 | 0. | 0. |
| PCBLI | WG37 | VJW | PS39 | AM39 | V39 |
| 0.500000E+00 | 0.200002E+03 | 0.117448E+04 | 0.104874E+01 | 0.100000E+01 | 0.119237E+04 |
| CVDWNG | FGMWNG | FGPWNG | FNWING | FNMAIN | P28 |
| 0.985000E+00 | 0.730087E+04 | 0.246082E+03 | 0.754695E+04 | 0.184570E+05 | 0.133000E+01 |
| FFOVFN | FWOVFN | FCOVFN | FMNOFN | FNOVFD | P38 |
| 0.178770E+00 | 0.290223E+00 | 0.531006E+00 | 0.709777E+00 | 0.100000E+01 | 0.198000E+01 |
| CVMNOZ | VJM | CVDNOZ | VJD | FGM | FGP |
| 0.985000E+00 | 0.182498E+04 | 0.985000E+00 | 0.747856E+03 | 0.235265E+05 | 0.247741E+04 |

MAIN SONIC CONVERGENT NOZZLE FG= 26003.95 FN= 26003.95 SFC= 0.56721
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER 1 LOOPS

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| COMMON | 0.833333E+00 | 0.100000E+03 | 0.833333E+00 | 0.100000E+03 | 0.814332E+00 | 0.100000E+03 | 0.256000E+04 | 0 |
| 0.100000E+03 | 0.100000E+03 | 0.256000E+04 | 0.100000E+03 | 0. | 0.100000E+01 | 0.100000E+01 | 0.100000E+01 | |
| 0.833333E+00 | 0.100000E+03 | 0.140000E+01 | 0.880000E+00 | 0.600000E+03 | 0.100000E+01 | 0.100000E+01 | 0.102945E+01 | |
| 0.814332E+00 | 0.100000E+03 | 0.727273E+01 | 0.860000E+00 | 0.200002E+03 | 0.896104E+00 | 0.100000E+01 | 0.106322E+01 | |
| 0.256000E+04 | 0. | 0.124857E+04 | 0.983000E+00 | 0.308026E+02 | 0.500000E-01 | 0.100000E+01 | 0.983000E+00 | |
| 0.500000E+02 | 0.200000E+01 | 0.900000E+00 | 0.108156E+01 | 0.101193E+01 | 0.100000E+01 | 0.957214E+00 | 0.549668E+03 | |
| 0.130000E+03 | 0.230000E+01 | 0.900000E+00 | 0.786577E+00 | 0.100265E+01 | 0.102013E+01 | 0.136108E+01 | 0.709440E+03 | |
| 0. | 0. | 0. | 0. | 0.353601E+04 | 0.500000E-01 | 0. | 0. | |
| 0. | 0. | 0. | 0. | 0.345970E+04 | 0. | 0. | 0. | |
| 0.793715E+01 | 0. | 0.793715E+01 | 0.793715E+01 | 0.310206E+01 | 0.310206E+01 | 0.375089E+01 | 0.375089E+01 | |
| 0.237252E+01 | 0.238266E+00 | 0.985000E+00 | 0.985000E+00 | 0. | 0. | 0. | 0. | |
| 0.549670E+03 | 0.100000E+01 | 0.131340E+03 | 0.160493E+01 | 0.549668E+03 | 0.100000E+01 | 0.131340E+03 | 0.160493E+01 | |
| 0.709440E+03 | 0.220000E+01 | 0.169750E+03 | 0.161219E+01 | 0.131143E+04 | 0.160000E+02 | 0.319790E+03 | 0.162873E+01 | |
| 0.256000E+04 | 0.152000E+02 | 0.681178E+03 | 0.182692E+01 | 0.190038E+04 | 0.366320E+01 | 0.488488E+03 | 0.183764E+01 | |
| 0.174312E+04 | 0.246301E+01 | 0.444064E+03 | 0.184049E+01 | 0. | 0. | 0. | 0. | |
| 0.100000E+01 | 0.140000E+01 | 0.880000E+00 | 0.617671E+03 | 0.600000E+03 | 0.200002E+03 | 0.204099E+03 | 0.204855E-01 | |
| 0.100000E+01 | 0.727273E+01 | 0.860000E+00 | 0.106322E+03 | 0.200002E+03 | 0.983000E+00 | 0.500000E-01 | 0. | |
| 0.200000E+01 | 0.900000E+00 | 0.574328E-01 | 0.147028E+03 | 0. | 0.204099E+03 | 0.204855E-01 | 0.114970E+04 | |
| 0.230000E+01 | 0.900000E+00 | 0.233766E-01 | 0.444244E+02 | 0. | 0.204099E+03 | 0.204855E-01 | 0. | |
| 0. | 0. | 0.100000E+01 | 0.833333E+00 | 0.100000E+03 | 0.814332E+00 | 0.100000E+03 | 0.409714E+01 | |
| 0.500000E+02 | 0.130000E+03 | 0. | 0. | 0. | 0. | 0. | 0. | |
| 0.100000E+01 | 0.600000E+03 | 0.200002E+03 | 0. | 0. | 0.319790E+03 | 0. | 0. | |
| 0.709440E+03 | 0.220000E+01 | 0.169750E+03 | 0.161219E+01 | 0.612687E+03 | 0.140000E+01 | 0.146452E+03 | 0.160788E+01 | |
| 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 | 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 | |
| 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 | 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 | |
| 0.199997E+03 | 0. | 0.199997E+03 | 0. | 0. | 0.500000E-01 | 0.499987E+00 | 0. | |
| 0.564699E+03 | 0.100000E+01 | 0.759245E+03 | 0.651605E+00 | 0.564699E+03 | 0.100000E+01 | 0.759245E+03 | 0.651605E+00 | |
| 0.174312E+04 | 0.246301E+01 | 0.444064E+03 | 0.184049E+01 | 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 | |
| 0.409714E+01 | 0.204099E+03 | 0.204855E-01 | 0. | 0.199997E+03 | 0. | 0.100000E+01 | 0. | |
| 0.174312E+04 | 0.246301E+01 | 0.444064E+03 | 0.184049E+01 | 0.174312E+04 | 0.246301E+01 | 0.444066E+03 | 0.184049E+01 | |
| 0.174312E+04 | 0.246301E+01 | 0.444066E+03 | 0.184049E+01 | 0.174312E+04 | 0.246301E+01 | 0.444066E+03 | 0.184049E+01 | |
| 0.204099E+03 | 0. | 0.204099E+03 | 0.204855E-01 | 0. | 0. | 0.472365E+03 | 0. | |
| 0.237252E+01 | 0.472365E+03 | 0.238266E+00 | 0.172717E+04 | 0.237232E+01 | 0.472360E+03 | 0.238266E+00 | 0. | |
| 0.149533E+04 | 0.133990E+01 | 0.185277E+04 | 0.100000E+01 | 0.149533E+04 | 0.133990E+01 | 0.185277E+04 | 0.100000E+01 | |
| 0. | 0. | 0.747856E+03 | 0.464873E+04 | 0.182498E+04 | 0.115769E+05 | 0. | 0.223133E+04 | |
| 0.235265E+05 | 0.247741E+04 | 0.409714E+01 | 0.604097E+03 | 0.682856E-02 | 0.260040E+05 | 0.260040E+05 | 0.567210E+00 | |
| 0.612687E+03 | 0.140000E+01 | 0.146452E+03 | 0.160788E+01 | 0.205966E+04 | 0.533120E+01 | 0.534150E+03 | 0.183496E+01 | |
| 0.4C0004E+03 | 0.833333E+00 | 0.100000E+03 | 0.100000E+01 | 0.157143E+01 | 0.870000E+00 | 0.310535E+03 | 0.120000E+03 | |
| 0.220000E+01 | 0.900000E+00 | 0.221694E-01 | 0.456615E+02 | 0. | 0. | 0.100000E+03 | 0.833333E+00 | |
| 0.100000E+03 | 0.157143E+01 | 0.870000E+00 | 0.400004E+03 | 0.952381E+00 | 0.988636E+00 | 0.103512E+01 | 0.120000E+03 | |
| 0.220000E+01 | 0.900000E+00 | 0.101500E+01 | 0.998436E+00 | 0. | 0.100770E+01 | 0.310535E+03 | 0.400004E+03 | |
| 0.500000E+00 | 0.200002E+03 | 0.612687E+03 | 0.200002E+03 | | | | | |
| 0.200002E+03 | 0.100000E+00 | 0.100000E+00 | 0.242141E+04 | 0.238596E+01 | 0.100000E+01 | 0.119237E+04 | 0.709440E+03 | |
| 0.169750E+03 | 0.198000E+01 | 0.591600E+03 | 0.104874E+01 | 0.709440E+03 | 0.169750E+03 | 0.198000E+01 | 0.591600E+03 | |
| 0.119237E+04 | 0.100000E+01 | 0.238596E+01 | 0.100000E+01 | 0.200002E+03 | 0.985000E+00 | 0.730087E+04 | 0.246082E+03 | |
| 0.754695E+04 | 0.184570E+05 | 0.290223E+00 | 0.104874E+01 | 0. | 0. | 0. | 0. | |
| 0.178770E+00 | 0.531006E+00 | 0.709777E+00 | 0.100000E+01 | 0. | 0. | 0.260040E+05 | 0.500000E+00 | |
| 0.462294E+02 | 0.118226E+03 | 0.165273E+03 | 0.197642E+01 | 0.220345E+01 | 0.229393E+01 | 0.600000E-01 | 0.147028E+03 | |

```
$D(1),AM=.6,ALTP=25000,IAMTP=0,T4=2260,# RUN AT ALTITUDE AT REDUCED T4-STD DAY

OUTPUT                  AM=  0.600        ALTP= 25000.          T4= 2260.00                    ETAR= 1.0000

THREE SPOOL ENGINE
                    PCNF            CNF             ZF              PRF             WAFC            WAF
                  0.942240E+02    0.102935E+01    0.786343E+00    0.140145E+01    0.651681E+03    0.327391E+03
                    PCNI            CNI             ZI              PRI             WACI            WAI
                  0.933258E+02    0.101769E+01    0.840261E+00    0.159827E+01    0.318517E+03    0.212025E+03
                    PCNC            CNC             ZC              PRC             WACC            WAC
                  0.933807E+02    0.101401E+01    0.830689E+00    0.758977E+01    0.109121E+03    0.107434E+03
                    T2              P2              T22             P22             T21             P21
                  0.460573E+03    0.473409E+00    0.515237E+03    0.663457E+00    0.601655E+03    0.106038E+01
                    T3              P3              PCBLF           BLF             PCBLC           BLC
                  0.113928E+04    0.804806E+01    0.              0.              0.              0.
                    PCBLHP          BLHP            PCBLIP          BLIP            PCBLLP          BLLP
                  0.              0.              0.              0.              0.              0.
                    WA3             WFB             WG4             FAR4            T4              P4
                  0.107434E+03    0.190718E+01    0.109341E+03    0.177521E-01    0.226000E+04    0.764753E+01
                    TFFHP           CNHP            DHTCHP          DHTC            T50             P50
                  0.462507E+02    0.196428E+01    0.600790E-01    0.129697E+03    0.180739E+04    0.267177E+01
                    TFFIP           CNIP            DHTCIP          DHTI            T5              P5
                  0.118389E+03    0.219521E+01    0.220459E-01    0.401518E+02    0.166336E+04    0.183258E+01
                    TFFLP           CNLP            DHTCLP          DHTF            T55             P55
                  0.165582E+03    0.231030E+01    0.172933E-01    0.391541E+02    0.152068E+04    0.122776E+01
                    ETAB            PCBLDU          ETAD            DPDUC           T24             P24
                  0.983000E+00    0.              0.              0.558117E-01    0.515237E+03    0.626428E+00
                    WAD             WFD             WG24            FAR24           T25             P25
                  0.115366E+03    0.              0.115366E+03    0.              0.515237E+03    0.626428E+00
                    ETAF            ETAI            ETAC            ETATHP          ETATIP          ETATLP
                  0.852878E+00    0.854577E+00    0.855369E+00    0.899049E+00    0.899082E+00    0.899963E+00
                    T6              P6              PS6             AM6             V6              WG6
                  0.152068E+04    0.122776E+01    0.118420E+01    0.237976E+00    0.442789E+03    0.109341E+03
                    T7              WFA             WG7             FAR7            ETAA            DPAFT
                  0.152068E+04    0.              0.109341E+03    0.177521E-01    0.              0.
                    PS8             AM8             V8              PS9             AM9             V9
                  0.665199E+00    0.100000E+01    0.173415E+04    0.665199E+00    0.100000E+01    0.173415E+04
                    PS28            AM28            V28             PS29            AM29            V29
                  0.371092E+00    0.897209E+00    0.926739E+03    0.371092E+00    0.897209E+00    0.926739E+03
                    BPRINT          DPCOM           DPWING          PS38            AM38            V38
                  0.973537E+00    0.497678E-01    0.999163E-01    0.504516E+00    0.100000E+01    0.109806E+04
                    BYPASS          HPEXT           WFT             WGT             VA              FRD
                  0.544115E+00    0.              0.190718E+01    0.329298E+03    0.609938E+03    0.620650E+04
                    PCBLI           WG37            VJW             PS39            AM39            V39
                  0.493296E+00    0.104591E+03    0.108159E+04    0.504516E+00    0.100000E+01    0.109806E+04
                    CVDWNG          FGMWNG          FGPWNG          FNWING          FNMAIN          P28
                  0.985000E+00    0.351602E+04    0.673685E+03    0.220693E+04    0.678512E+04    0.626428E+00
                    FFOVFN          FWOVFN          FCOVFN          FMNOFN          FNOVFD          P38
                  0.120785E+00    0.245431E+00    0.633784E+00    0.754569E+00    0.345795E+00    0.954433E+00
                    CVMNOZ          VJM             CVDNOZ          VJD             FGM             FGP
                  0.985000E+00    0.170814E+04    0.985000E+00    0.912838E+03    0.125942E+05    0.260439E+04

MAIN SCNIC CONVERGENT NOZZLE        FG= 15198.55                  FN=  8992.05                  SFC= 0.76355
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER  25 LOOPS
```

```
$D(1), IDES=1, # NOW GOING TO DESIGN SAME ENGINE WITH ONLY 2 SPOOLS USING
$D(1),IDES=1,# BOOSTED FAN (FIG 2) , NOTE NEED 2 IDES=1 CARDS TO RUN NEW DESIGN
AM=0,ALTP=0,FIXFANTOMIDDLE=.T.,IAMTP=2,T2=31, # NOTE PCBLIDS STILL = .5

FAN DESIGN              PRFCF= 0.10000000E+01 ETAFCF= 0.10000000E+01  WAFCF= 0.10294510E+01   T2DS= 0.54966819E+03

MIDDLE SPOOL DESIGN     PRICF= 0.10443214E+01 ETAICF= 0.97711820E+00  WAICF= 0.11059473E+01  T22DS= 0.61268656E+03

COMPRESSOR DESIGN       PRCCF= 0.89610390E+00 ETACCF= 0.10000000E+01  WACCF= 0.10632227E+01  T21DS= 0.70943958E+03

INTER DUCT DESIGN        A38= 0.23859580E+01   AM38= 0.10000000E+01    A39= 0.23859580E+01   AM39= 0.1000C0CCE+01

COMBUSTOR DESIGN       WA3CDS= 0.30802648E+02 ETABCF= 0.98300000E+00 DTCOCF= 0.10000000E+01

H.P. TURBINE DESIGN    CNHPCF= 0.10119289E+01 TFHPCF= 0.10815634E+01 ETHPCF= 0.10000000E+01 DHHPCF= 0.957214C5E+00

L.P. TURBINE DESIGN    CNLPCF= 0.10438194E+01 TFLPCF= 0.10995854E+01 ETLPCF= 0.10201339E+01 DHLPCF= 0.254663C5E+01

DUCT NOZZLE DESIGN       A28= 0.37508934E+01   AM28= 0.65160510E+00    A29= 0.37508934E+01   AM29= 0.65160510E+00

TURBINE AREA DESIGN      A55= 0.79688787E+01   AM55= 0.23826598E+00

NOZZLE DESIGN             A8= 0.31144586E+01    AM8= 0.10000000E+01     A9= 0.31144586E+01    AM9= 0.10CC0CC0E+01

OUTPUT                  AM=  0.           ALTP=     0.          T4= 2560.00                    ETAR= 1.0000
```

```
FAN AND MIDDLE SPOOL ARE ATTACHED , USE INNER AND OUTER TURBINES
          PCNF          CNF           ZF           PRF          WAFC          WAF
  0.100000E+03  0.100000E+01  0.833333E+00  0.140000E+01  0.617671E+03  0.600000E+03
          PCNI          CNI           ZI           PRI          WACI          WAI
  0.947177E+02  0.947177E+00  0.833333E+00  0.157143E+01  0.310535E+03  0.400004E+03
          PCNC          CNC           ZC           PRC          WACC          WAC
  0.100000E+03  0.100000E+01  0.814332E+00  0.727273E+01  0.106322E+03  0.200002E+03
           T2            P2           T22          P22           T21           P21
  0.549668E+03  0.100000E+01  0.612687E+03  0.140000E+01  0.709440E+03  0.220000E+01
           T3            P3          PCBLF          BLF         PCBLC          BLC
  0.131143E+04  0.160000E+02  0.            0.            0.            0.
        PCBLHP         BLHP         PCBLIP         BLIP         PCBLLP         BLLP
  0.            0.            0.            0.            0.            0.
          WA3           WFB           WG4          FAR4           T4            P4
  0.200002E+03  0.409714E+01  0.204099E+03  0.204855E-01  0.256000E+04  0.152000E+02
         TFFHP         CNHP         DHTCHP         DHTC          T50           P50
  0.462294E+02  0.197642E+01  0.600000E-01  0.147028E+03  0.205966E+04  0.533120E+01
         TFFIP         CNIP         DHTCIP         DHTI           T5            P5
  0.            0.            0.            0.            0.205966E+04  0.533120E+01
         TFFLP         CNLP         DHTCLP         DHTF          T55           P55
  0.118226E+03  0.220345E+01  0.171750E-01  0.900859E+02  0.174312E+04  0.245320E+01
          ETAB         PCBLDU          ETAD         DPDUC          T24           P24
  0.983000E+00  0.            0.            0.500000E-01  0.612687E+03  0.133000E+01
           WA0           WFD          WG24          FAR24          T25           P25
  0.199997E+03  0.            0.199997E+03  0.            0.612687E+03  0.133000E+01
          ETAF          ETAI          ETAC        ETATHP        ETATIP        ETATLP
  0.880000E+00  0.870000E+00  0.860000E+00  0.900000E+00  0.            0.900000E+00
           T6            P6           PS6           AM6           V6           WG6
  0.174312E+04  0.245320E+01  0.236307E+01  0.238266E+00  0.472365E+03  0.204099E+03
           T7           WFA           WG7          FAR7         ETAA         DPAFT
  0.174312E+04  0.            0.204099E+03  0.204855E-01  0.            0.
          PS8           AM8           V8           PS9          AM9           V9
  0.133457E+01  0.100000E+01  0.185277E+04  0.133457E+01  0.100000E+01  0.185277E+04
         PS28          AM28          V28          PS29         AM29          V29
  0.100000E+01  0.651605E+00  0.759245E+03  0.100000E+01  0.651605E+00  0.759245E+03
        BPRINT         DPCOM        DPWING         PS38         AM38          V38
  0.100000E+01  0.500000E-01  0.100000E+00  0.104874E+01  0.100000E+01  0.119237E+04
         BYPASS         HPEXT          WFT          WGT           VA           FRD
  0.499987E+00  0.            0.409714E+01  0.604097E+03  0.            0.
          PCBLI          WG37          VJW          PS39         AM39          V39
  0.500000E+00  0.200002E+03  0.117448E+04  0.104874E+01  0.100000E+01  0.119237E+04
         CVDWNG         FGMWNG        FGPWNG        FNWING        FNMAIN        P28
  0.985000E+00  0.730087E+04  0.246082E+03  0.754695E+04  0.184308E+05  0.133000E+01
         FFOVFN         FWOVFN        FCOVFN        FMNOFN        FNOVFD        P38
  0.178951E+00  0.290516E+00  0.530533E+00  0.709483E+00  0.100000E+01  0.198000E+01
         CVMNOZ          VJM         CVDNOZ          VJD           FGM           FGP
  0.985000E+00  0.182498E+04  0.985000E+00  0.747856E+03  0.235265E+05  0.245117E+04

MAIN SCNIC CONVERGENT NOZZLE          FG= 25977.71          FN= 25977.71          SFC= 0.5€778
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER   1 LOOPS
```

```
COMMON          0.833333E+00  0.100000E+03  0.833333E+00  0.947177E+02  0.814332E+00  0.100000E+03  0.256000E+04  0

  0.100000E+03  0.100000E+03  0.256000E+04  0.100000E+03  0.            0.100000E+01  0.100000E+01  0.100000E+01
  0.833333E+00  0.100000E+03  0.140000E+01  0.880000E+00  0.600000E+03  0.100000E+01  0.100000E+01  0.102945E+01
  0.814332E+00  0.100000E+03  0.727273E+01  0.860000E+00  0.200002E+03  0.896104E+00  0.100000E+01  0.106322E+01
  0.256000E+04  0.            0.124857E+04  0.983000E+00  0.308026E+02  0.500000E-01  0.100000E+01  0.983000E+00
  0.500000E+02  0.200000E+01  0.900000E+00  0.108156E+01  0.101193E+01  0.100000E+01  0.957214E+00  0.549668E+03
  0.130000E+03  0.230000E+01  0.900000E+00  0.109959E+01  0.104382E+01  0.102013E+01  0.254663E+01  0.709440E+03
  0.            0.            0.            0.            0.353601E+04  0.500000E-01  0.            0.
  0.            0.            0.            0.            0.347353E+04  0.            0.            0.
  0.796888E+01  0.            0.796888E+01  0.796888E+01  0.311446E+01  0.311446E+01  0.375089E+01  0.375089E+01
  0.236307E+01  0.238266E+00  0.985000E+00  0.985000E+00  0.            0.            0.            0.

  0.549670E+03  0.100000E+01  0.131340E+03  0.160493E+01  0.549668E+03  0.100000E+01  0.131340E+03  0.160493E+01
  0.709440E+03  0.220000E+01  0.169750E+03  0.161219E+01  0.131143E+04  0.160000E+02  0.319790E+03  0.162873E+01
  0.256000E+04  0.152000E+02  0.681178E+03  0.182692E+01  0.205966E+04  0.533120E+01  0.534150E+03  0.183496E+01
  0.174312E+04  0.245320E+01  0.444064E+03  0.184076E+01  0.            0.            0.            0.
  0.100000E+01  0.140000E+01  0.880000E+00  0.617671E+03  0.600000E+03  0.200002E+03  0.204099E+03  0.204855E-01
  0.100000E+01  0.727273E+01  0.860000E+00  0.106322E+03  0.200002E+03  0.983000E+00  0.500000E-01  0.
  0.200000E+01  0.900000E+00  0.574328E-01  0.147028E+03  0.            0.204099E+03  0.204855E-01  0.114970E+04
  0.230000E+01  0.900000E+00  0.437383E-01  0.900859E+02  0.            0.204099E+03  0.204855E-01  0.
  0.            0.            0.100000E+01  0.833333E+00  0.100000E+03  0.814332E+00  0.100000E+03  0.409714E+01
  0.500000E+02  0.130000E+03  0.            0.            0.            0.            0.            0.

  0.100000E+01  0.600000E+03  0.200002E+03  0.            0.            0.319790E+03  0.            0.
  0.709440E+03  0.220000E+01  0.169750E+03  0.161219E+01  0.612687E+03  0.140000E+01  0.146452E+03  0.160788E+01
  0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01  0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01
  0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01  0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01
  0.199997E+03  0.            0.199997E+03  0.            0.            0.500000E-01  0.499987E+00  0.
  0.564699E+03  0.100000E+01  0.759245E+03  0.651605E+00  0.564699E+03  0.100000E+01  0.759245E+03  0.651605E+00
```

```
0.174312E+04  0.245320E+01  0.444064E+03  0.184076E+01  0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01
0.409714E+01  0.204099E+03  0.204855E-01  0.            0.199997E+03  0.            0.100000E+01  0.
0.174312E+04  0.245320E+01  0.444064E+03  0.184076E+01  0.174312E+04  0.245320E+01  0.444066E+03  0.184076E+01
0.174312E+04  0.245320E+01  0.444066E+03  0.184076E+01  0.174312E+04  0.245320E+01  0.444066E+03  0.184076E+01
0.204099E+03  0.            0.204099E+03  0.204855E-01  0.            0.            0.472365E+03  0.
0.236307E+01  0.472365E+03  0.238266E+00  0.172717E+04  0.236288E+01  0.472361E+03  0.238266E+00  0.
0.149533E+04  0.133457E+01  0.185277E+04  0.100000E+01  0.149533E+04  0.133457E+01  0.185277E+04  0.100000E+01
0.            0.            0.747856E+03  0.464873E+04  0.182498E+04  0.115769E+05  0.            0.220509E+04
0.235265E+05  0.245117E+04  0.409714E+01  0.604097E+03  0.682856E-02  0.259777E+05  0.259777E+05  0.567783E+00

0.612687E+03  0.140000E+01  0.146452E+03  0.160788E+01  0.205966E+04  0.533120E+01  0.534150E+03  0.183496E+01
0.400004E+03  0.833333E+00  0.947177E+02  0.947177E+00  0.157143E+01  0.870000E+00  0.310535E+03  0.120000E+03
0.219177E+01  0.899082E+00  0.222157E-01  0.401518E+02  0.            0.            0.100000E+03  0.833333E+00
0.947177E+02  0.157143E+01  0.870000E+00  0.400004E+03  0.104432E+01  0.977118E+00  0.110595E+01  0.120000E+03
0.220000E+01  0.900000E+00  0.101500E+01  0.998436E+00  0.            0.100770E+01  0.310535E+03  0.400004E+03
0.5C0000E+00  0.200002E+03  0.612687E+03  0.200002E+03

0.2C0002E+03  0.100000E+00  0.100000E+00  0.242141E+04  0.238596E+01  0.100000E+01  0.119237E+04  0.709440E+03
0.169750E+03  0.198000E+01  0.591600E+03  0.104874E+01  0.709440E+03  0.169750E+03  0.198000E+01  0.591600E+03
0.119237E+04  0.100000E+01  0.238596E+01  0.100000E+01  0.200002E+03  0.985000E+00  0.730087E+04  0.246082E+03
0.754695E+04  0.184308E+05  0.290516E+00  0.104874E+01  0.000000E-38  0.            0.            0.
0.178951E+00  0.530533E+00  0.709483E+00  0.100000E+01  0.            0.            0.259777E+05  0.500000E+00
0.462294E+02  0.            0.118226E+03  0.197642E+01  0.            0.220345E+01  0.600000E-01  0.147028E+03
```

```
    $D(1),AM=.6,ALTP=25000,IAMTP=0,T4=2260,* RUN AT ALTITUDE AT REDUCED T4-STD DAY

OUTPUT                  AM=  0.600        ALTP= 25000.          T4= 2260.00                          ETAR= 1.0000

FAN AND MIDDLE SPOOL ARE ATTACHED , USE INNER AND OUTER TURBINES
                        PCNF              CNF               ZF                PRF               WAFC              WAF
                    0.943578E+02      0.103081E+01      0.782227E+00      0.140053E+01      0.653515E+03      0.328313E+03
                        PCNI              CNI               ZI                PRI               WACI              WAI
                    0.893735E+02      0.974618E+00      0.844122E+00      0.160785E+01      0.320184E+03      0.213001E+03
                        PCNC              CNC               ZC                PRC               WACC              WAC
                    0.933772E+02      0.101356E+01      0.830117E+00      0.757917E+01      0.109033E+03      0.107878E+03
                        T2                P2                T22               P22               T21               P21
                    0.460573E+03      0.473409E+00      0.515214E+03      0.663025E+00      0.602139E+03      0.106605E+01
                        T3                P3                PCBLF             BLF               PCBLC             BLC
                    0.113958E+04      0.807976E+01      0.                0.                0.                0.
                        PCBLHP            BLHP              PCBLIP            BLIP              PCBLLP            BLLP
                    0.                0.                0.                0.                0.                0.
                        WA3               WFR               WG4               FAR4              T4                P4
                    0.107878E+03      0.191458E+01      0.109792E+03      0.177476E-01      0.226000E+04      0.767752E+01
                        TFFHP             CNHP              DHTCHP            DHTC              T50               P50
                    0.462601E+02      0.196420E+01      0.604728E-01      0.129657E+03      0.180753E+04      0.268042E+01
                        TFFIP             CNIP              DHTCIP            DHTI              T5                P5
                    0.                0.                0.                0.                0.180753E+04      0.268042E+01
                        TFFLP             CNLP              DHTCLP            DHTF              T55               P55
                    0.118498E+03      0.221940E+01      0.172633E-01      0.794933E+02      0.152013E+04      0.122442E+01
                        ETAB              PCBLDU            ETAD              DPDUC             T24               P24
                    0.983000E+00      0.                0.                0.558207E-01      0.515214E+03      0.626015E+00
                        WAD               WFD               WG24              FAR24             T25               P25
                    0.115312E+03      0.                0.115312E+03      0.                0.515214E+03      0.626015E+00
                        ETAF              ETAI              ETAC              ETATHP            ETATIP            ETATLP
                    0.851517E+00      0.861143E+00      0.855535E+00      0.898265E+00      0.                0.899751E+00
                        T6                P6                PS6               AM6               V6                WG6
                    0.152013E+04      0.122442E+01      0.118073E+01      0.238655E+00      0.443966E+03      0.109792E+03
                        T7                WFA               WG7               FAR7              ETAA              DPAFT
                    0.152013E+04      0.                0.109792E+03      0.177476E-01      0.                0.
                        PS8               AM8               V8                PS9               AM9               V9
                    0.665151E+00      0.100000E+01      0.173385E+04      0.665151E+00      0.100000E+01      0.173385E+04
                        PS28              AM28              V28               PS29              AM29              V29
                    0.371092E+00      0.896824E+00      0.926377E+03      0.371092E+00      0.896824E+00      0.926377E+03
                        BPRINT            DPCOM             DPWING            PS38              AM38              V38
                    0.974461E+00      0.497839E-01      0.999307E-01      0.507285E+00      0.100000E+01      0.109850E+04
                        BYPASS            HPEXT             WFT               WGT               VA                FRD
                    0.541371E+00      0.                0.191458E+01      0.330227E+03      0.609938E+03      0.622397E+04
                        PCBLI             WG37              VJW               PS39              AM39              V39
                    0.493533E+00      0.105123E+03      0.108202E+04      0.507285E+00      0.100000E+01      0.109850E+04
                        CVDWNG            FGMWNG            FGPWNG            FNWING            FNMAIN            P28
                    0.985000E+00      0.353531E+04      0.687667E+03      0.223012E+04      0.680525E+04      0.626015E+00
                        FFOVFN            FWOVFN            FCOVFN            FMNOFN            FNOVFD            P38
                    0.120008E+00      0.246821E+00      0.633171E+00      0.753179E+00      0.347812E+00      0.959518E+00
                        CVMNOZ            VJM               CVDNOZ            VJD               FGM               FGP
                    0.985000E+00      0.170784E+04      0.985000E+00      0.912481E+03      0.126336E+05      0.262577E+04

MAIN SONIC CONVERGENT NOZZLE          FG= 15259.34                        FN=  9035.37                        SFC= 0.76283
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER  16 LOOPS
```

```
      $D(1),IDES=1, #  NOW GOING TO RUN SAME ENGINE WITH ONLY 2 SPOOLS USING
      $D(1),IDES=1,# SUPERCHARGED COMPRESSOR (FIGURE 3)
      FIXFANTOMIDDLE=.F.,FIXMIDDLETOCOMP=.T.,AM=0,ALTP=0,IAMTP=2,T2=31,
      PCNIDS=100, # MUST BE RESET BECAUSE IT PREVIOUSLY WAS DETERMINED BY PCNFDS
```

FAN DESIGN PRFCF= 0.10000000E+01 ETAFCF= 0.10000000E+01 WAFCF= 0.10294510E+01 T2DS= 0.54966819E+03

MIDDLE SPOOL DESIGN PRICF= 0.95238095E+00 ETAICF= 0.98863635E+00 WAICF= 0.10351161E+01 T22DS= 0.61268656E+03

COMPRESSOR DESIGN PRCCF= 0.10340043E+01 ETACCF= 0.10268452E+01 WACCF= 0.12048016E+01 T21DS= 0.70943958E+03

INTER DUCT DESIGN A38= 0.23859579E+01 AM38= 0.10000000E+01 A39= 0.23859579E+01 AM39= 0.10000000E+01

COMBUSTOR DESIGN WA3CDS= 0.30802649E+02 ETABCF= 0.98300000E+00 DTCOCF= 0.10000000E+01

I.P. TURBINE DESIGN CNIPCF= 0.10119288E+01 TFIPCF= 0.10815634E+01 ETIPCF= 0.10000000E+01 DHIPCF= 0.12544893E+01

L.P. TURBINE DESIGN CNLPCF= 0.10026477E+01 TFLPCF= 0.77781743E+00 ETLPCF= 0.10201339E+01 DHLPCF= 0.13610838E+01

DUCT NOZZLE DESIGN A28= 0.37508934E+01 AM28= 0.65160510E+00 A29= 0.37508934E+01 AM29= 0.65160510E+00

TURBINE AREA DESIGN A55= 0.80265361E+01 AM55= 0.23826609E+00

NOZZLE DESIGN A8= 0.31369934E+01 AM8= 0.10000000E+01 A9= 0.31369934E+01 AM9= 0.10000000E+01

OUTPUT AM= 0. ALTP= 0. T4= 2560.00 ETAR= 1.0000

MIDDLE AND COMPRESSOR SPOOLS ARE ATTACHED , USE MIDDLE AND OUTER TURBINES

| | | | | | |
|---|---|---|---|---|---|
| PCNF | CNF | ZF | PRF | WAFC | WAF |
| 0.100000E+03 | 0.100000E+01 | 0.833333E+00 | 0.140000E+01 | 0.617671E+03 | 0.600000E+03 |
| PCNI | CNI | ZI | PRI | WACI | WAI |
| 0.100000E+03 | 0.100000E+01 | 0.833333E+00 | 0.157143E+01 | 0.310535E+03 | 0.400004E+03 |
| PCNC | CNC | ZC | PRC | WACC | WAC |
| 0.929312E+02 | 0.929312E+00 | 0.814332E+00 | 0.727273E+01 | 0.106322E+03 | 0.200002E+03 |
| T2 | P2 | T22 | P22 | T21 | P21 |
| 0.549668E+03 | 0.100000E+01 | 0.612687E+03 | 0.140000E+01 | 0.709440E+03 | 0.220000E+01 |
| T3 | P3 | PCBLF | BLF | PCBLC | BLC |
| 0.131143E+04 | 0.160000E+02 | 0. | 0. | 0. | 0. |
| PCBLHP | BLHP | PCBLIP | BLIP | PCBLLP | BLLP |
| 0. | 0. | 0. | 0. | 0. | 0. |
| WA3 | WFB | WG4 | FAR4 | T4 | P4 |
| 0.200002E+03 | 0.409714E+01 | 0.204099E+03 | 0.204855E-01 | 0.256000E+04 | 0.152000E+02 |
| TFFHP | CNHP | DHTCHP | DHTC | T50 | P50 |
| 0. | 0. | 0. | 0. | 0.256000E+04 | 0.152000E+02 |
| TFFIP | CNIP | DHTCIP | DHTI | T5 | P5 |
| 0.462294E+02 | 0.197642E+01 | 0.600000E-01 | 0.192690E+03 | 0.190038E+04 | 0.362240E+01 |
| TFFLP | CNLP | DHTCLP | DHTF | T55 | P55 |
| 0.167134E+03 | 0.229393E+01 | 0.171750E-01 | 0.444244E+02 | 0.174312E+04 | 0.243558E+01 |
| ETAB | PCBLDU | ETAD | DPDUC | T24 | P24 |
| 0.983000E+00 | 0. | 0. | 0.500000E-01 | 0.612687E+03 | 0.133000E+01 |
| WAD | WFD | WG24 | FAR24 | T25 | P25 |
| 0.199997E+03 | 0. | 0.199997E+03 | 0. | 0.612687E+03 | 0.133000E+01 |
| ETAF | ETAI | ETAC | ETATHP | ETATIP | ETATLP |
| 0.880000E+00 | 0.870000E+00 | 0.860000E+00 | 0. | 0.900000E+00 | 0.900000E+00 |
| T6 | P6 | PS6 | AM6 | V6 | WG6 |
| 0.174312E+04 | 0.243558E+01 | 0.234610E+01 | 0.238266E+00 | 0.472365E+03 | 0.204099E+03 |
| T7 | WFA | WG7 | FAR7 | ETAA | DPAFT |
| 0.174312E+04 | 0. | 0.204099E+03 | 0.204855E-01 | 0. | 0. |
| PS8 | AM8 | V8 | PS9 | AM9 | V9 |
| 0.132498E+01 | 0.100000E+01 | 0.185277E+04 | 0.132498E+01 | 0.100000E+01 | 0.185277E+04 |
| PS28 | AM28 | V28 | PS29 | AM29 | V29 |
| 0.100000E+01 | 0.651605E+00 | 0.759245E+03 | 0.100000E+01 | 0.651605E+00 | 0.759245E+03 |
| BPRINT | DPCOM | DPWING | PS38 | AM38 | V38 |
| 0.100000E+01 | 0.500000E-01 | 0.100000E+00 | 0.104874E+01 | 0.100000E+01 | 0.119237E+04 |
| BYPASS | HPEXT | WFT | WGT | VA | FRD |
| 0.499987E+00 | 0. | 0.409714E+01 | 0.604097E+03 | 0. | 0. |
| PCBLI | WG37 | VJW | PS39 | AM39 | V39 |
| 0.500000E+00 | 0.200002E+03 | 0.117448E+04 | 0.104874E+01 | 0.100000E+01 | 0.119237E+04 |
| CVDWNG | FGMWNG | FGPWNG | FNWING | FNMAIN | P28 |
| 0.985000E+00 | 0.730087E+04 | 0.246082E+03 | 0.754695E+04 | 0.183831E+05 | 0.133000E+01 |
| FFOVFN | FWOVFN | FCOVFN | FMNOFN | FNOVFD | P38 |
| 0.179280E+00 | 0.291051E+00 | 0.529669E+00 | 0.708949E+00 | 0.100000E+01 | 0.198000E+01 |
| CVMNOZ | VJM | CVDNOZ | VJD | FGM | FGP |
| 0.985000E+00 | 0.182498E+04 | 0.985000E+00 | 0.747856E+03 | 0.235265E+05 | 0.240348E+04 |

MAIN SONIC CONVERGENT NOZZLE FG= 25930.02 FN= 25930.02 SFC= 0.56883
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER 1 LOOPS

```
COMMON          0.833333E+00  0.100000E+03  0.833333E+00  0.100000E+03  0.814332E+00  0.929312E+02  0.256000E+04   0

  0.100000E+03  0.100000E+03  0.256000E+04  0.100000E+03  0.           0.100000E+01  0.100000E+01  0.100000E+01
  0.833333E+00  0.100000E+03  0.140000E+01  0.880000E+00  0.600000E+03  0.100000E+01  0.100000E+01  0.102945E+01
  0.814332E+00  0.929312E+02  0.727273E+01  0.860000E+00  0.200002E+03  0.103400E+01  0.102685E+01  0.120480E+01
  0.256000E+04  0.           0.124857E+04  0.983000E+00  0.308026E+02  0.500000E-01  0.100000E+01  0.983000E+00
  0.500000E+02  0.200000E+01  0.900000E+00  0.           0.           0.           0.           0.549668E+03
  0.130000E+03  0.230000E+01  0.900000E+00  0.777817E+00  0.100265E+01  0.102013E+01  0.136108E+01  0.709440E+03
  0.           0.           0.           0.           0.353601E+04  0.500000E-01  0.           0.
  0.           0.           0.           0.           0.349866E+04  0.           0.           0.
  0.802654E+01  0.           0.802654E+01  0.802654E+01  0.313699E+01  0.313699E+01  0.375089E+01  0.375089E+01
  0.234610E+01  0.238266E+00  0.985000E+00  0.985000E+00  0.           0.           0.           0.

  0.549670E+03  0.100000E+01  0.131340E+03  0.160493E+01  0.549668E+03  0.100000E+01  0.131340E+03  0.160493E+01
  0.709440E+03  0.220000E+01  0.169750E+03  0.161219E+01  0.131143E+04  0.160000E+02  0.319790E+03  0.162873E+01
  0.256000E+04  0.152000E+02  0.681178E+03  0.182692E+01  0.190038E+04  0.362240E+01  0.488488E+03  0.183841E+01
  0.174312E+04  0.243558E+01  0.444064E+03  0.184125E+01  0.           0.           0.           0.
  0.100000E+01  0.140000E+01  0.880000E+00  0.617671E+03  0.600000E+03  0.200002E+03  0.204099E+03  0.204855E-01
  0.929312E+00  0.727273E+01  0.860000E+00  0.106322E+03  0.200002E+03  0.983000E+00  0.500000E-01  0.
  0.           0.           0.           0.           0.           0.204099E+03  0.204855E-01  0.114970E+04
  0.230000E+01  0.900000E+00  0.233766E-01  0.444244E+02  0.           0.204099E+03  0.204855E-01  0.
  0.           0.           0.100000E+01  0.833333E+00  0.100000E+03  0.814332E+00  0.929312E+02  0.409714E+01
  0.500000E+02  0.130000E+03  0.           0.           0.           0.           0.           0.

  0.100000E+01  0.600000E+03  0.200002E+03  0.           0.           0.319790E+03  0.           0.
  0.709440E+03  0.220000E+01  0.169750E+03  0.161219E+01  0.612687E+03  0.140000E+01  0.146452E+03  0.160788E+01
  0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01  0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01
  0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01  0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01
  0.199997E+03  0.           0.199997E+03  0.           0.           0.500000E-01  0.499987E+00  0.
  0.564699E+03  0.100000E+01  0.759245E+03  0.651605E+00  0.564699E+03  0.100000E+01  0.759245E+03  0.651605E+00

  0.174312E+04  0.243558E+01  0.444064E+03  0.184125E+01  0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01
  0.409714E+01  0.204099E+03  0.204855E-01  0.           0.199997E+03  0.           0.100000E+01  0.
  0.174312E+04  0.243558E+01  0.444064E+03  0.184125E+01  0.174312E+04  0.243558E+01  0.444066E+03  0.184125E+01
  0.174312E+04  0.243558E+01  0.444066E+03  0.184125E+01  0.174312E+04  0.243558E+01  0.444066E+03  0.184125E+01
  0.204099E+03  0.           0.204099E+03  0.204855E-01  0.           0.           0.472365E+03  0.
  0.234610E+01  0.472365E+03  0.238266E+00  0.172717E+04  0.234590E+01  0.472361E+03  0.238266E+00  0.
  0.149533E+04  0.132498E+01  0.185277E+04  0.100000E+01  0.149533E+04  0.132498E+01  0.185277E+04  0.100000E+01
  0.           0.           0.747856E+03  0.464873E+04  0.182498E+04  0.115769E+05  0.           0.215740E+04
  0.235265E+05  0.240348E+04  0.409714E+01  0.604097E+03  0.682856E-02  0.259300E+05  0.259300E+05  0.568827E+00

  0.612687E+03  0.140000E+01  0.146452E+03  0.160788E+01  0.256000E+04  0.152000E+02  0.681178E+03  0.182692E+01
  0.400004E+03  0.833333E+00  0.100000E+03  0.100000E+01  0.157143E+01  0.870000E+00  0.310535E+03  0.500000E+02
  0.200000E+01  0.900000E+00  0.752694E-01  0.192690E+03  0.           0.           0.100000E+03  0.833333E+00
  0.100000E+03  0.157143E+01  0.870000E+00  0.400004E+03  0.952381E+00  0.988636E+00  0.103512E+01  0.120000E+03
  0.220000E+01  0.900000E+00  0.108156E+01  0.101193E+01  0.           0.125449E+01  0.310535E+03  0.400004E+03
  0.500000E+00  0.200002E+03  0.612687E+03  0.200002E+03

  0.200002E+03  0.100000E+00  0.100000E+00  0.242141E+04  0.238596E+01  0.100000E+01  0.119237E+04  0.709440E+03
  0.169750E+03  0.198000E+01  0.591600E+03  0.104874E+01  0.709440E+03  0.169750E+03  0.198000E+01  0.591600E+03
  0.119237E+04  0.100000E+01  0.238596E+01  0.100000E+01  0.200002E+03  0.985000E+00  0.730087E+04  0.246082E+03
  0.754695E+04  0.183831E+05  0.291051E+00  0.104874E+01  0.           0.000000E-38  0.           0.
  0.179280E+00  0.529669E+00  0.708949E+00  0.100000E+01  0.           0.           0.259300E+05  0.500000E+00
  0.           0.462294E+02  0.167134E+03  0.           0.197642E+01  0.229393E+01  0.           0.
```

```
    $D(1),AM=.6,ALTP=25000,IAMTP=0,T4=2260,# RUN AT ALTITUDE AT REDUCED T4-STD DAY

OUTPUT                  AM=  0.600        ALTP= 25000.          T4= 2260.00                    ETAR= 1.0000

MIDDLE AND COMPRESSUR SPOOLS ARE ATTACHED , USE MIDDLE AND OUTER TURBINES
                    PCNF          CNF           ZF            PRF           WAFC          WAF
                  0.944038E+02  0.103131E+01  0.782864E+00  0.140127E+01  0.653913E+03  0.328512E+03
                    PCNI          CNI           ZI            PRI           WACI          WAI
                  0.936838E+02  0.102152E+01  0.845932E+00  0.160711E+01  0.319862E+03  0.212876E+03
                    PCNC          CNC           ZC            PRC           WACC          WAC
                  0.870615E+02  0.944101E+00  0.827728E+00  0.758119E+01  0.109122E+03  0.107869E+03
                    T2            P2            T22           P22           T21           P21
                  0.460573E+03  0.473409E+00  0.515320E+03  0.663373E+00  0.603297E+03  0.106611E+01
                    T3            P3            PCBLF         BLF           PCBLC         BLC
                  0.113799E+04  0.808241E+01  0.            0.            0.            0.
                    PCBLHP        BLHP          PCBLIP        BLIP          PCBLLP        BLLP
                  0.            0.            0.            0.            0.            0.
                    WA3           WFB           WG4           FAR4          T4            P4
                  0.107869E+03  0.191696E+01  0.109786E+03  0.177712E-01  0.226000E+04  0.768049E+01
                    TFFHP         CNHP          DHTCHP        DHTC          T50           P50
                  0.            0.            0.            0.            0.226000E+04  0.768049E+01
                    TFFIP         CNIP          DHTCIP        DHTI          T5            P5
                  0.462394E+02  0.197065E+01  0.600370E-01  0.169863E+03  0.166333E+04  0.182027E+01
                    TFFLP         CNLP          DHTCLP        DHTF          T55           P55
                  0.167379E+03  0.231473E+01  0.173050E-01  0.391884E+02  0.152052E+04  0.121897E+01
                    ETAB          PCBLDU        ETAD          DPDUC         T24           P24
                  0.983000E+00  0.            0.            0.559541E-01  0.515320E+03  0.626255E+00
                    WAD           WFD           WG24          FAR24         T25           P25
                  0.115637E+03  0.            0.115637E+03  0.            0.515320E+03  0.626255E+00
                    ETAF          ETAI          ETAC          ETATHP        ETATIP        ETATLP
                  0.851255E+00  0.850116E+00  0.861725E+00  0.            0.899548E+00  0.899818E+00
                    T6            P6            PS6           AM6           V6            WG6
```

```
 0.152052E+04   0.121897E+01   0.117572E+01   0.237976E+00   0.442765E+03   0.109786E+03
   T7             WFA            WG7            FAR7           ETAA           DPAFT
 0.152052E+04   0.             0.109786E+03   0.177712E-01   0.             0.
   PS8            AM8            V8             PS9            AM9            V9
 0.660433E+00   0.100000E+01   0.173406E+04   0.660433E+00   0.100000E+01   0.173406E+04
   PS28           AM28           V28            PS29           AM29           V29
 0.371092E+00   0.899116E+00   0.928506E+03   0.371092E+00   0.899116E+00   0.928506E+03
   BPRINT         DPCOM          DPWING         PS38           AM38           V38
 0.973473E+00   0.497287E-01   0.999108E-01   0.507217E+00   0.100000E+01   0.109955E+04
   BYPASS         HPEXT          WFT            WGT            VA             FRD
 0.543211E+00   0.             0.191696E+01   0.330429E+03   0.609938E+03   0.622776E+04
   PCBLI          WG37           VJW            PS39           AM39           V39
 0.493279E+00   0.105007E+03   0.108306E+04   0.507217E+00   0.100000E+01   0.109955E+04
   CVDWNG         FGMWNG         FGPWNG         FNWING         FNMAIN         P28
 0.985000E+00   0.353481E+04   0.687321E+03   0.223146E+04   0.679908E+04   0.626255E+00
   FFOVFN         FWOVFN         FCOVFN         FMVOFN         FNOVFD         P38
 0.121245E+00   0.247102E+00   0.631653E+00   0.752898E+00   0.348266E+00   0.959598E+00
   CVMNOZ         VJM            CVDNOZ         VJD            FGM            FGP
 0.985000E+00   0.170805E+04   0.985000E+00   0.914579E+03   0.126502E+05   0.260813E+04

MAIN SCNIC CONVERGENT NOZZLE          FG= 15258.30                  FN=  9030.54                  SFC= 0.76419
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER  21 LOOPS
```

```
     $D(1),IDES=1, * NOW GOING TO RUN 3 SPOOL,2 STREAM ENGINE (FIGURE 4)
     $D(1),FIXMIDDLETOCOMP=.F.,PCBLIDS=0,AM=0,ALTP=0,IAMTP=2,T2=31,IDES=1,PCNCDS=100,

FAN DESIGN              PRFCF= 0.10000000E+01 ETAFCF= 0.10000000E+01  WAFCF= 0.10294510E+01   T2DS= 0.54966819E+03

MIDDLE SPOOL DESIGN     PRICF= 0.95238095E+00 ETAICF= 0.98863635E+00  WAICF= 0.10351161E+01  T22DS= 0.61268656E+03

COMPRESSOR DESIGN       PRCCF= 0.89610390E+00 ETACCF= 0.10000000E+01  WACCF= 0.21264453E+01  T21DS= 0.70943958E+03

COMBUSTOR DESIGN       WA3CDS= 0.61605297E+02 ETABCF= 0.98300000E+00 DTCOCF= 0.10000000E+01

H.P. TURBINE DESIGN    CNHPCF= 0.10119289E+01 TFHPCF= 0.54078169E+00 ETHPCF= 0.10000000E+01 DHHPCF= 0.95721405E+00

I.P. TURBINE DESIGN    CNIPCF= 0.99843589E+00 TFIPCF= 0.50750092E+00 ETIPCF= 0.10000000E+01 DHIPCF= 0.50385109E+00

L.P. TURBINE DESIGN    CNLPCF= 0.10235123E+01 TFLPCF= 0.46674602E+00 ETLPCF= 0.10201339E+01 DHLPCF= 0.653C7859E+00

DUCT NOZZLE DESIGN        A28= 0.37508935E+01   AM28= 0.65160510E+00    A29= 0.37508935E+01   AM29= 0.65160510E+00

TURBINE AREA DESIGN       A55= 0.11109352E+02   AM55= 0.23826426E+00

NOZZLE DESIGN              A8= 0.43403495E+01    AM8= 0.10000000E+01     A9= 0.43403495E+01    AM9= 0.10CCC000E+01

OUTPUT                 AM=  0.          ALTP=     0.          T4= 2560.00                        ETAR= 1.0000

THREE SPOOL ENGINE

NO AIRFLOW INTO WING

   PCNF           CNF            ZF             PRF            WAFC           WAF
 0.100000E+03   0.100000E+01   0.833333E+00   0.140000E+01   0.617671E+03   0.600000E+03
   PCNI           CNI            ZI             PRI            WACI           WAI
 0.100000E+03   0.100000E+01   0.833333E+00   0.157143E+01   0.310535E+03   0.400004E+03
   PCNC           CNC            ZC             PRC            WACC           WAC
 0.100000E+03   0.100000E+01   0.814332E+00   0.727273E+01   0.212645E+03   0.400004E+03
   T2             P2             T22            P22            T21            P21
 0.549668E+03   0.100000E+01   0.612687E+03   0.140000E+01   0.709440E+03   0.22000CE+01
   T3             P3             PCBLF          BLF            PCBLC          BLC
 0.131143E+04   0.160000E+02   0.             0.             0.             0.
   PCBLHP         BLHP           PCBLIP         BLIP           PCBLLP         BLLP
 0.             0.             0.             0.             0.             0.
   WA3            WFB            WG4            FAR4           T4             P4
 0.400004E+03   0.819427E+01   0.408198E+03   0.204855E-01   0.256000E+04   0.152000E+02
   TFFHP          CNHP           DHTCHP         DHTC           T50            P50
 0.924587E+02   0.197642E+01   0.600000E-01   0.147028E+03   0.205966E+04   0.53312CE+01
   TFFIP          CNIP           DHTCIP         DHTI           T5             P5
 0.236453E+03   0.220345E+01   0.220000E-01   0.228307E+02   0.198030E+04   0.443787E+01
   TFFLP          CNLP           DHTCLP         DHTF           T55            P55
 0.278524E+03   0.224716E+01   0.171750E-01   0.222122E+02   0.190256E+04   0.368588E+01
   ETAB           PCBLDU         ETAD           DPDUC          T24            P24
 0.983000E+00   0.             0.             0.500000E-01   0.612687E+03   0.133000E+01
   WAD            WFD            WG24           FAR24          T25            P25
 0.199997E+03   0.             0.199997E+03   0.             0.612687E+03   0.13300CE+01
   ETAF           ETAI           ETAC           ETATHP         ETATIP         ETATLP
 0.880000E+00   0.870000E+00   0.860000E+00   0.900000E+00   0.900000E+00   0.900000E+00
   T6             P6             PS6            AM6            V6             WG6
 0.190256E+04   0.368588E+01   0.355121E+01   0.238264E+00   0.492279E+03   0.408198E+03
   T7             WFA            WG7            FAR7           ETAA           DPAFT
 0.190256E+04   0.             0.408198E+03   0.204855E-01   0.             0.
   PS8            AM8            V8             PS9            AM9            V9
```

| | | | | | |
|---|---|---|---|---|---|
| 0.200961E+01 | 0.100000E+01 | 0.193326E+04 | 0.200961E+01 | 0.100000E+01 | 0.193326E+04 |
| PS28 | AM28 | V28 | PS29 | AM29 | V29 |
| 0.100000E+01 | 0.651605E+00 | 0.759245E+03 | 0.100000E+01 | 0.651605E+00 | 0.759245E+03 |
| BPRINT | DPCOM | DPWING | PS38 | AM38 | V38 |
| 0. | 0.500000E-01 | 0. | 0. | 0. | 0. |
| BYPASS | HPEXT | WFT | WGT | VA | FRD |
| 0.499987E+00 | 0. | 0.819427E+01 | 0.608194E+03 | 0. | 0. |
| PCBLI | WG37 | VJW | PS39 | AM39 | V39 |
| 0.149012E-07 | 0. | 0. | 0. | 0. | 0. |
| CVDWNG | FGMWNG | FGPWNG | FNWING | FNMAIN | P28 |
| 0.985000E+00 | 0. | 0. | 0. | 0.380818E+05 | 0.13300CE+01 |
| FFOVFN | FWOVFN | FCOVFN | FMNOFN | FNOVFD | P38 |
| 0.122072E+00 | 0. | 0.877928E+00 | 0.100000E+01 | 0.100000E+01 | 0. |
| CVMNOZ | VJM | CVDNOZ | VJD | FGM | FGP |
| 0.985000E+00 | 0.190426E+04 | 0.985000E+00 | 0.747856E+03 | 0.288084E+05 | 0.927342E+04 |

MAIN SCNIC CONVERGENT NOZZLE FG= 38081.84 FN= 38081.84 SFC= 0.77463
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER 1 LOOPS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| COMMON | 0.833333E+00 | 0.100000E+03 | 0.833333E+00 | 0.100000E+03 | 0.814332E+00 | 0.100000E+03 | 0.256000E+04 0 |
| 0.100000E+03 | 0.100000E+03 | 0.256000E+04 | 0.100000E+03 | 0. | 0.100000E+01 | 0.100000E+01 | 0.100000E+01 |
| 0.833333E+00 | 0.100000E+03 | 0.140000E+01 | 0.880000E+00 | 0.600000E+03 | 0.100000E+01 | 0.100000E+01 | 0.102945E+01 |
| 0.814332E+00 | 0.100000E+03 | 0.727273E+01 | 0.860000E+00 | 0.400004E+03 | 0.896104E+00 | 0.100000E+01 | 0.212645E+01 |
| 0.256000E+04 | 0. | 0.124857E+04 | 0.983000E+00 | 0.616053E+02 | 0.500000E-01 | 0.100000E+01 | 0.983000E+00 |
| 0.500000E+02 | 0.200000E+01 | 0.900000E+00 | 0.540782E+00 | 0.101193E+01 | 0.100000E+01 | 0.957214E+00 | 0.549668E+03 |
| 0.130000E+03 | 0.230000E+01 | 0.900000E+00 | 0.466746E+00 | 0.102351E+01 | 0.102013E+01 | 0.653079E+00 | 0.709440E+03 |
| 0. | 0. | 0. | 0. | 0.353601E+04 | 0.500000E-01 | 0. | 0. |
| 0. | 0. | 0. | 0. | 0.483057E+04 | 0. | 0. | 0. |
| 0.111094E+02 | 0. | 0.111094E+02 | 0.111094E+02 | 0.434035E+01 | 0.434035E+01 | 0.375089E+01 | 0.375089E+01 |
| 0.355121E+01 | 0.238264E+00 | 0.985000E+00 | 0.985000E+00 | 0. | 0. | 0. | 0. |
| 0.549670E+03 | 0.100000E+01 | 0.131340E+03 | 0.160493E+01 | 0.549668E+03 | 0.100000E+01 | 0.131340E+03 | 0.160493E+01 |
| 0.709440E+03 | 0.220000E+01 | 0.169750E+03 | 0.161219E+01 | 0.131143E+04 | 0.160000E+02 | 0.319790E+03 | 0.162873E+01 |
| 0.256000E+04 | 0.152000E+02 | 0.681178E+03 | 0.182692E+01 | 0.198030E+04 | 0.443787E+01 | 0.511319E+03 | 0.183624E+01 |
| 0.190256E+04 | 0.368588E+01 | 0.489107E+03 | 0.183754E+01 | 0. | 0. | 0. | 0. |
| 0.100000E+01 | 0.140000E+01 | 0.880000E+00 | 0.617671E+03 | 0.600000E+03 | 0.400004E+03 | 0.408198E+03 | 0.204855E-01 |
| 0.100000E+01 | 0.727273E+01 | 0.860000E+00 | 0.212645E+03 | 0.400004E+03 | 0.983000E+00 | 0.500000E-01 | 0. |
| 0.200000E+01 | 0.900000E+00 | 0.574328E-01 | 0.147028E+03 | 0. | 0.408198E+03 | 0.204855E-01 | 0.114970E+04 |
| 0.230000E+01 | 0.900000E+00 | 0.112166E-01 | 0.222122E+02 | 0. | 0.408198E+03 | 0.204855E-01 | 0. |
| 0. | 0. | 0.100000E+01 | 0.833333E+00 | 0.100000E+03 | 0.814332E+00 | 0.100000E+03 | 0.819427E+01 |
| 0.500000E+02 | 0.130000E+03 | 0. | 0. | 0. | 0. | 0. | 0. |
| 0.100000E+01 | 0.600000E+03 | 0.400004E+03 | 0. | 0. | 0.319790E+03 | 0. | 0. |
| 0.709440E+03 | 0.220000E+01 | 0.169750E+03 | 0.161219E+01 | 0.612687E+03 | 0.140000E+01 | 0.146452E+03 | 0.160788E+01 |
| 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 | 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 |
| 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 | 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 |
| 0.199997E+03 | 0. | 0.199997E+03 | 0. | 0. | 0.500000E-01 | 0.499987E+00 | 0. |
| 0.564699E+03 | 0.100000E+01 | 0.759245E+03 | 0.651605E+00 | 0.564699E+03 | 0.100000E+01 | 0.759245E+03 | 0.651605E+00 |
| 0.190256E+04 | 0.368588E+01 | 0.489107E+03 | 0.183754E+01 | 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 |
| 0.819427E+01 | 0.408198E+03 | 0.204855E-01 | 0. | 0.199997E+03 | 0. | 0.100000E+01 | 0. |
| 0.190256E+04 | 0.368588E+01 | 0.489107E+03 | 0.183754E+01 | 0.190256E+04 | 0.368588E+01 | 0.489106E+03 | 0.183754E+01 |
| 0.190256E+04 | 0.368588E+01 | 0.489106E+03 | 0.183754E+01 | 0.190256E+04 | 0.368588E+01 | 0.489106E+03 | 0.183754E+01 |
| 0.408198E+03 | 0. | 0.408198E+03 | 0.204855E-01 | 0. | 0. | 0.492279E+03 | 0. |
| 0.355121E+01 | 0.492279E+03 | 0.238264E+00 | 0.188551E+04 | 0.355092E+01 | 0.492274E+03 | 0.238264E+00 | 0. |
| 0.163715E+04 | 0.200961E+01 | 0.193326E+04 | 0.100000E+01 | 0.163715E+04 | 0.200961E+01 | 0.193326E+04 | 0.100000E+01 |
| 0. | 0. | 0.747856E+03 | 0.464873E+04 | 0.190426E+04 | 0.241597E+05 | 0. | 0.927342E+04 |
| 0.288084E+05 | 0.927342E+04 | 0.819427E+01 | 0.608194E+03 | 0.136571E-01 | 0.380818E+05 | 0.380818E+05 | 0.774631E+00 |
| 0.612687E+03 | 0.140000E+01 | 0.146452E+03 | 0.160788E+01 | 0.205966E+04 | 0.533120E+01 | 0.534150E+03 | 0.183496E+01 |
| 0.400004E+03 | 0.833333E+00 | 0.100000E+03 | 0.100000E+01 | 0.157143E+01 | 0.870000E+00 | 0.310535E+03 | 0.120000E+03 |
| 0.220000E+01 | 0.900000E+00 | 0.110847E-01 | 0.228307E+02 | 0. | 0. | 0.100000E+03 | 0.833333E+00 |
| 0.100000E+03 | 0.157143E+01 | 0.870000E+00 | 0.400004E+03 | 0.952381E+00 | 0.988636E+00 | 0.103512E+01 | 0.120000E+03 |
| 0.220000E+01 | 0.900000E+00 | 0.507501E+00 | 0.998436E+00 | 0. | 0.503851E+00 | 0.310535E+03 | 0.400004E+03 |
| 0.149012E-07 | 0. | 0.612687E+03 | 0.400004E+03 | | | | |
| 0.381470E-05 | 0.100000E+00 | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0.985000E+00 | 0. | 0. |
| 0. | 0.380818E+05 | 0. | 0. | 0. | 0. | 0. | 0. |
| 0.122072E+00 | 0.877928E+00 | 0.100000E+01 | 0.100000E+01 | 0. | 0. | 0.380818E+05 | 0. |
| 0.924537E+02 | 0.236453E+03 | 0.278524E+03 | 0.197642E+01 | 0.220345E+01 | 0.224716E+01 | 0.600000E-01 | 0.147028E+03 |

```
$D(1),AM=.6,ALTP=25000,IAMTP=0,T4=2260,# RUN AT ALTITUDE AT REDUCED T4-STD DAY

OUTPUT                  AM=  0.600        ALTP= 25000.          T4= 2260.00                          ETAR= 1.0000

THREE SPOOL ENGINE

NO AIRFLOW INTO WING

     PCNF            CNF             ZF              PRF             WAFC            WAF
0.944120E+02    0.103140E+01    0.775104E+00    0.139736E+01    0.654868E+03    0.328992E+03
     PCNI            CNI             ZI              PRI             WACI            WAI
0.936826E+02    0.102192E+01    0.821694E+00    0.159021E+01    0.321998E+03    0.213788E+03
     PCNC            CNC             ZC              PRC             WACC            WAC
0.934573E+02    0.101581E+01    0.831314E+00    0.761931E+01    0.218983E+03    0.214090E+03
     T2              P2              T22             P22             T21             P21
0.460573E+03    0.473409E+00    0.514897E+03    0.661525E+00    0.600508E+03    0.105196E+01
     T3              P3              PCBLF           BLF             PCBLC           BLC
0.113861E+04    0.801523E+01    0.              0.              0.              0.
     PCBLHP          BLHP            PCBLIP          BLIP            PCBLLP          BLLP
0.              0.              0.              0.              0.              0.
     WA3             WFB             WG4             FAR4            T4              P4
0.214090E+03    0.380269E+01    0.217893E+03    0.177621E-01    0.226000E+04    0.761627E+01
     TFFHP           CNHP            DHTCHP          DHTC            T50             P50
0.925457E+02    0.196589E+01    0.605788E-01    0.129798E+03    0.180704E+04    0.265522E+01
     TFFIP           CNIP            DHTCIP          DHTI            T5              P5
0.237371E+03    0.220382E+01    0.223231E-01    0.201260E+02    0.173511E+04    0.220700E+01
     TFFLP           CNLP            DHTCLP          DHTF            T55             P55
0.279837E+03    0.226654E+01    0.173347E-01    0.196211E+02    0.166447E+04    0.182993E+01
     ETAB            PCBLDU          ETAD            DPDUC           T24             P24
0.983000E+00    0.              0.              0.557311E-01    0.514897E+03    0.624657E+00
     WAD             WFD             WG24            FAR24           T25             P25
0.114902E+03    0.              0.114902E+03    0.              0.514897E+03    0.624657E+00
     ETAF            ETAI            ETAC            ETATHP          ETATIP          ETATLP
0.850443E+00    0.852141E+00    0.855233E+00    0.898165E+00    0.897880E+00    0.900068E+00
     T6              P6              PS6             AM6             V6              WG6
0.166447E+04    0.182993E+01    0.176503E+01    0.238501E+00    0.463022E+03    0.217893E+03
     T7              WFA             WG7             FAR7            ETAA            DPAFT
0.166447E+04    0.              0.217893E+03    0.177621E-01    0.              0.
     PS8             AM8             V8              PS9             AM9             V9
0.995600E+00    0.100000E+01    0.181211E+04    0.995600E+00    0.100000E+01    0.181211E+04
     PS28            AM28            V28             PS29            AM29            V29
0.371092E+00    0.893783E+00    0.923390E+03    0.371092E+00    0.893783E+00    0.923390E+03
     BPRINT          DPCOM           DPWING          PS38            AM38            V38
0.              0.497761E-01    0.              0.              0.              0.
     BYPASS          HPEXT           WFT             WGT             VA              FRD
0.538869E+00    0.              0.380269E+01    0.332795E+03    0.609938E+03    0.623685E+04
     PCBLI           WG37            VJW             PS39            AM39            V39
-0.141260E-02   0.              0.              0.              0.              0.
     CVDWNG          FGMWNG          FGPWNG          FNWING          FNMAIN          P28
0.985000E+00    0.              0.              0.              0.148299E+05    0.624657E+00
     FFOVFN          FWOVFN          FCOVFN          FMNOFN          FNOVFD          P38
0.721207E-01    0.              0.927493E+00    0.999614E+00    0.389572E+00    0.
     CVMNOZ          VJM             CVDNOZ          VJD             FGM             FGP
0.985000E+00    0.178492E+04    0.985000E+00    0.909539E+03    0.153363E+05    0.573618E+04

MAIN SONIC CONVERGENT NOZZLE    FG= 21072.47          FN= 14835.61                SFC= 0.92276
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER  24 LOOPS


     $D(1),IDES=1,# NOW GOING TO RUN 2 SPOOL-2 STREAM ENGINE (NORMAL TURBOFAN)
     $D(1),IDES=1,AM=0,ALTP=0,IAMTP=2,T2=31,DUMMYSPOOL=.T.,# (FIGURE 5) (PCBLIDS=0)
     PRCDS=16/1.4,      #  KEEP OVERALL PRESSURE RATIO THE SAME

FAN DESIGN              PRFCF= 0.10000000E+01 ETAFCF= 0.10000000E+01  WAFCF= 0.10294510E+01   T2DS= 0.54966819E+03

MIDDLE SPOOL DESIGN     PRICF= 0.10000000E+01 ETAICF= 0.10000000E+01  WAICF= 0.10000000E+01   T22DS= 0.61268656E+03

COMPRESSOR DESIGN       PRCCF= 0.14897959E+01 ETACCF= 0.10000000E+01  WACCF= 0.31053487E+01   T21DS= 0.61268656E+03

COMBUSTOR DESIGN       WA3CDS= 0.61393844E+02 ETABCF= 0.98300000E+00 DTCOCF= 0.10000000E+01

H.P. TURBINE DESIGN    CNHPCF= 0.10119289E+01 TFHPCF= 0.54070825E+00 ETHPCF= 0.10000000E+01 DHHPCF= 0.10909047E+01

L.P. TURBINE DESIGN    CNLPCF= 0.10256150E+01 TFLPCF= 0.47233292E+00 ETLPCF= 0.10201339E+01 DHLPCF= 0.65031519E+00

DUCT NOZZLE DESIGN        A28= 0.37508928E+01   AM28= 0.65160510E+00    A29= 0.37508928E+01   AM29= 0.65160510E+00

TURBINE AREA DESIGN       A55= 0.10971928E+02   AM55= 0.23826411E+00

NOZZLE DESIGN              A8= 0.42865705E+01    AM8= 0.10000000E+01     A9= 0.42865705E+01    AM9= 0.10000000E+01

OUTPUT                  AM=  0.           ALTP=      0.          T4= 2560.00                          ETAR= 1.0000

MIDDLE SPOOL IS DUMMY
```

```
NO AIRFLOW INTO WING
```

| PCNF | CNF | ZF | PRF | WAFC | WAF |
|---|---|---|---|---|---|
| 0.100000E+03 | 0.100000E+01 | 0.833333E+00 | 0.140000E+01 | 0.617671E+03 | 0.600000E+03 |
| PCNI | CNI | ZI | PRI | WACI | WAI |
| 0.100000E+01 | 0. | 0.571429E+00 | 0.100000E+01 | 0.310535E+03 | 0.400004E+03 |
| PCNC | CNC | ZC | PRC | WACC | WAC |
| 0.100000E+03 | 0.100000E+01 | 0.814332E+00 | 0.114286E+02 | 0.310535E+03 | 0.400004E+03 |
| T2 | P2 | T22 | P22 | T21 | P21 |
| 0.549668E+03 | 0.100000E+01 | 0.612687E+03 | 0.140000E+01 | 0.612687E+03 | 0.140000E+01 |
| T3 | P3 | PCBLF | BLF | PCBLC | BLC |
| 0.130245E+04 | 0.160000E+02 | 0. | 0. | 0. | 0. |
| PCBLHP | BLHP | PCBLIP | BLIP | PCBLLP | BLLP |
| 0. | 0. | 0. | 0. | 0. | 0. |
| WA3 | WFB | WG4 | FAR4 | T4 | P4 |
| 0.400004E+03 | 0.824969E+01 | 0.408253E+03 | 0.206240E-01 | 0.256000E+04 | 0.152000E+02 |
| TFFHP | CNHP | DHTCHP | DHTC | T50 | P50 |
| 0.924713E+02 | 0.197642E+01 | 0.600000E-01 | 0.167563E+03 | 0.198844E+04 | 0.450082E+01 |
| TFFIP | CNIP | DHTCIP | DHTI | T5 | P5 |
| 0. | 0. | 0. | 0. | 0.198844E+04 | 0.450082E+01 |
| TFFLP | CNLP | DHTCLP | DHTF | T55 | P55 |
| 0.275230E+03 | 0.224256E+01 | 0.171750E-01 | 0.222092E+02 | 0.191079E+04 | 0.374119E+01 |
| ETAB | PCBLDU | ETAD | DPDUC | T24 | P24 |
| 0.983000E+00 | 0. | 0. | 0.500000E-01 | 0.612687E+03 | 0.133000E+01 |
| WAD | WFD | WG24 | FAR24 | T25 | P25 |
| 0.199996E+03 | 0. | 0.199996E+03 | 0. | 0.612687E+03 | 0.133000E+01 |
| ETAF | ETAI | ETAC | ETATHP | ETATIP | ETATLP |
| 0.880000E+00 | 0.100000E+01 | 0.860000E+00 | 0.900000E+00 | 0. | 0.900000E+00 |
| T6 | P6 | PS6 | AM6 | V6 | WG6 |
| 0.191079E+04 | 0.374119E+01 | 0.360454E+01 | 0.238264E+00 | 0.493269E+03 | 0.408253E+03 |
| T7 | WFA | WG7 | FAR7 | ETAA | DPAFT |
| 0.191079E+04 | 0. | 0.408253E+03 | 0.206240E-01 | 0. | 0. |
| PS8 | AM8 | V8 | PS9 | AM9 | V9 |
| 0.204005E+01 | 0.100000E+01 | 0.193729E+04 | 0.204005E+01 | 0.100000E+01 | 0.193729E+04 |
| PS28 | AM28 | V28 | PS29 | AM29 | V29 |
| 0.100000E+01 | 0.651605E+00 | 0.759245E+03 | 0.100000E+01 | 0.651605E+00 | 0.759245E+03 |
| BPRINT | DPCOM | DPWING | PS38 | AM38 | V38 |
| 0. | 0.500000E-01 | 0. | 0. | 0. | 0. |
| BYPASS | HPEXT | WFT | WGT | VA | FRD |
| 0.499987E+00 | 0. | 0.824969E+01 | 0.608250E+03 | 0. | 0. |
| PCBLI | WG37 | VJW | PS39 | AM39 | V39 |
| -0. | 0. | 0. | 0. | 0. | 0. |
| CVDWNG | FGMWNG | FGPWNG | FNWING | FNMAIN | P28 |
| 0.985000E+00 | 0. | 0. | 0. | 0.382967E+05 | 0.133000E+01 |
| FFOVFN | FWOVFN | FCOVFN | FMNOFN | FNOVFD | P38 |
| 0.121387E+00 | 0. | 0.878613E+00 | 0.100000E+01 | 0.100000E+01 | 0. |
| CVMNOZ | VJM | CVDNOZ | VJD | FGM | FGP |
| 0.985000E+00 | 0.190823E+04 | 0.985000E+00 | 0.747856E+03 | 0.288621E+05 | 0.943459E+04 |

```
MAIN SCNIC CONVERGENT NOZZLE          FG= 38296.70                    FN= 38296.70                    SFC= 0.77545
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER   1 LOOPS
```

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| COMMON | 0.833333E+00 | 0.100000E+03 | 0.571429E+00 | 0.100000E+01 | 0.814332E+00 | 0.100000E+03 | 0.256000E+04 | 0 |
| 0.100000E+03 | 0.100000E+03 | 0.256000E+04 | 0.100000E+03 | 0. | 0.100000E+01 | 0.100000E+01 | 0.100000E+01 | |
| 0.833333E+00 | 0.100000E+03 | 0.140000E+01 | 0.880000E+00 | 0.600000E+03 | 0.100000E+01 | 0.100000E+01 | 0.102945E+01 | |
| 0.814332E+00 | 0.100000E+03 | 0.114286E+02 | 0.860000E+00 | 0.400004E+03 | 0.148980E+01 | 0.100000E+01 | 0.310535E+01 | |
| 0.256000E+04 | 0. | 0.125755E+04 | 0.983000E+00 | 0.613938E+02 | 0.500000E-01 | 0.100000E+01 | 0.983000E+00 | |
| 0.500000E+02 | 0.200000E+01 | 0.900000E+00 | 0.540708E+00 | 0.101193E+01 | 0.100000E+01 | 0.109090E+01 | 0.549668E+03 | |
| 0.130000E+03 | 0.230000E+01 | 0.900000E+00 | 0.472333E+00 | 0.102551E+01 | 0.102013E+01 | 0.650315E+00 | 0.612687E+03 | |
| 0. | 0. | 0. | 0. | 0.353601E+04 | 0.500000E-01 | 0. | 0. | |
| 0. | 0. | 0. | 0. | 0.477008E+04 | 0. | 0. | 0. | |
| 0.109719E+02 | 0. | 0.109719E+02 | 0.109719E+02 | 0.428657E+01 | 0.428657E+01 | 0.375089E+01 | 0.375089E+01 | |
| 0.360454E+01 | 0.238264E+00 | 0.985000E+00 | 0.985000E+00 | 0. | 0. | 0. | 0. | |
| 0.549670E+03 | 0.100000E+01 | 0.131340E+03 | 0.160493E+01 | 0.549668E+03 | 0.100000E+01 | 0.131340E+03 | 0.160493E+01 | |
| 0.612687E+03 | 0.140000E+01 | 0.146452E+03 | 0.160788E+01 | 0.130245E+04 | 0.160000E+02 | 0.317471E+03 | 0.162695E+01 | |
| 0.256000E+04 | 0.152000E+02 | 0.681299E+03 | 0.182700E+01 | 0.198844E+04 | 0.450082E+01 | 0.513736E+03 | 0.183651E+01 | |
| 0.191079E+04 | 0.374119E+01 | 0.491527E+03 | 0.183781E+01 | 0. | 0. | 0. | 0. | |
| 0.100000E+01 | 0.140000E+01 | 0.880000E+00 | 0.617671E+03 | 0.600000E+03 | 0.400004E+03 | 0.408253E+03 | 0.206240E-01 | |
| 0.100000E+01 | 0.114286E+02 | 0.860000E+00 | 0.310535E+03 | 0.400004E+03 | 0.983000E+00 | 0.500000E-01 | 0. | |
| 0.200000E+01 | 0.900000E+00 | 0.654543E-01 | 0.167563E+03 | 0. | 0.408253E+03 | 0.206240E-01 | 0.114970E+04 | |
| 0.230000E+01 | 0.900000E+00 | 0.111691E-01 | 0.222092E+02 | 0. | 0.408253E+03 | 0.206240E-01 | 0. | |
| 0. | 0. | 0.100000E+01 | 0.833333E+00 | 0.100000E+03 | 0.814332E+00 | 0.100000E+03 | 0.824969E+01 | |
| 0.500000E+02 | 0.130000E+03 | 0. | 0. | 0. | 0. | 0. | 0. | |
| 0.100000E+01 | 0.600000E+03 | 0.400004E+03 | 0. | 0. | 0.317471E+03 | 0. | 0. | |
| 0.612687E+03 | 0.140000E+01 | 0.146452E+03 | 0.160788E+01 | 0.612687E+03 | 0.140000E+01 | 0.146452E+03 | 0.160788E+01 | |
| 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 | 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 | |
| 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 | 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 | |
| 0.199996E+03 | 0. | 0.199996E+03 | 0. | 0. | 0.500000E-01 | 0.499987E+00 | 0. | |
| 0.564699E+03 | 0.100000E+01 | 0.759245E+03 | 0.651605E+00 | 0.564699E+03 | 0.100000E+01 | 0.759245E+03 | 0.651605E+00 | |

```
 0.191079E+04  0.374119E+01  0.491527E+03  0.183781E+01  0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01
 0.824959E+01  0.408253E+03  0.206240E-01  0.           0.199996E+03  0.           0.100000E+01  0.
 0.191079E+04  0.374119E+01  0.491527E+03  0.183781E+01  0.191079E+04  0.374119E+01  0.491526E+03  0.183781E+01
 0.191079E+04  0.374119E+01  0.491526E+03  0.183781E+01  0.191079E+04  0.374119E+01  0.491526E+03  0.183781E+01
 0.408253E+03  0.           0.408253E+03  0.206240E-01  0.           0.           0.493269E+03  0.
 0.360454E+01  0.493269E+03  0.238264E+00  0.189369E+04  0.360425E+01  0.493264E+03  0.238264E+00  0.
 0.164454E+04  0.204005E+01  0.193729E+04  0.100000E+01  0.164454E+04  0.204005E+01  0.193729E+04  0.100000E+01
 0.           0.           0.747856E+03  0.464873E+04  0.190823E+04  0.242134E+05  0.           0.943459E+04
 0.288621E+05  0.943459E+04  0.824969E+01  0.608250E+03  0.137495E-01  0.382967E+05  0.382967E+05  0.775494E+00

 0.612687E+03  0.140000E+01  0.146452E+03  0.160788E+01  0.198844E+04  0.450082E+01  0.513736E+03  0.183651E+01
 0.400004E+03  0.571429E+00  0.100000E+01  0.           0.100000E+01  0.100000E+01  0.310535E+03  0.120000E+03
 0.220037E+01  0.897880E+00  0.112475E-01  0.201260E+02  0.           0.           0.100000E+03  0.833333E+00
 0.100000E+03  0.157143E+01  0.870000E+00  0.400004E+03  0.100000E+01  0.100000E+01  0.100000E+01  0.120000E+03
 0.220000E+01  0.900000E+00  0.507501E+00  0.998436E+00  0.           0.503851E+00  0.310535E+03  0.400004E+03
-0.           0.           0.612687E+03  0.400004E+03

 0.           0.100000E+00  0.           0.           0.           0.           0.           0.
 0.           0.           0.           0.           0.           0.           0.           0.
 0.           0.           0.           0.           0.           0.985000E+00  0.           0.
 0.           0.382967E+05  0.           0.           0.           0.           0.           0.
 0.121387E+00  0.878613E+00  0.100000E+01  0.100000E+01  0.           0.000000E-38  0.382967E+05  0.
 0.924713E+02  0.           0.275230E+03  0.197642E+01  0.           0.224256E+01  0.600000E-01  0.167563E+03
```

```
    $D(1),AM=.6,ALTP=25000,IAMTP=0,T4=2260,* RUN AT ALTITUDE AT REDUCED T4-STD DAY

OUTPUT                  AM=  0.600        ALTP= 25000.          T4= 2260.00                        ETAR= 1.0000

MIDDLE SPOOL IS DUMMY

NO AIRFLOW INTO WING
```

| | | | | | |
|---|---|---|---|---|---|
| PCNF | CNF | ZF | PRF | WAFC | WAF |
| 0.947947E+02 | 0.103558E+01 | 0.770832E+00 | 0.139853E+01 | 0.659213E+03 | 0.331175E+03 |
| PCNI | CNI | ZI | PRI | WACI | WAI |
| 0.100000E+01 | 0. | 0.833333E+00 | 0.100000E+01 | 0.325217E+03 | 0.216035E+03 |
| PCNC | CNC | ZC | PRC | WACC | WAC |
| 0.939719E+02 | 0.102475E+01 | 0.832435E+00 | 0.122227E+02 | 0.325217E+03 | 0.216035E+03 |
| T2 | P2 | T22 | P22 | T21 | P21 |
| 0.460573E+03 | 0.473409E+00 | 0.515231E+03 | 0.662075E+00 | 0.515231E+03 | 0.662075E+00 |
| T3 | P3 | PCBLF | BLF | PCBLC | BLC |
| 0.113145E+04 | 0.809237E+01 | 0. | 0. | 0. | 0. |
| PCBLHP | BLHP | PCBLIP | BLIP | PCBLLP | BLLP |
| 0. | 0. | 0. | 0. | 0. | 0. |
| WA3 | WFB | WG4 | FAR4 | T4 | P4 |
| 0.216035E+03 | 0.386023E+01 | 0.219895E+03 | 0.178685E-01 | 0.226000E+04 | 0.768966E+01 |
| TFFHP | CNHP | DHTCHP | DHTC | T50 | P50 |
| 0.925046E+02 | 0.197671E+01 | 0.606063E-01 | 0.148082E+03 | 0.174181E+04 | 0.225796E+01 |
| TFFIP | CNIP | DHTCIP | DHTI | T5 | P5 |
| 0. | 0. | 0. | 0. | 0.174181E+04 | 0.225796E+01 |
| TFFLP | CNLP | DHTCLP | DHTF | T55 | P55 |
| 0.276568E+03 | 0.227135E+01 | 0.173802E-01 | 0.195919E+02 | 0.167097E+04 | 0.187221E+01 |
| ETAB | PCBLDU | ETAD | DPDUC | T24 | P24 |
| 0.983000E+00 | 0. | 0. | 0.558184E-01 | 0.515231E+03 | 0.625119E+00 |
| WAD | WFD | WG24 | FAR24 | T25 | P25 |
| 0.115140E+03 | 0. | 0.115140E+03 | 0. | 0.515231E+03 | 0.625119E+00 |
| ETAF | ETAI | ETAC | ETATHP | ETATIP | ETATLP |
| 0.847442E+00 | 0.100000E+01 | 0.855182E+00 | 0.898798E+00 | 0. | 0.899885E+00 |
| T6 | P6 | PS6 | AM6 | V6 | WG6 |
| 0.167097E+04 | 0.187221E+01 | 0.180570E+01 | 0.238717E+00 | 0.464280E+03 | 0.219895E+03 |
| T7 | WFA | WG7 | FAR7 | ETAA | DPAFT |
| 0.167097E+04 | 0. | 0.219895E+03 | 0.178685E-01 | 0. | 0. |
| PS8 | AM8 | V8 | PS9 | AM9 | V9 |
| 0.101958E+01 | 0.100000E+01 | 0.181553E+04 | 0.101958E+01 | 0.100000E+01 | 0.181553E+04 |
| PS28 | AM28 | V28 | PS29 | AM29 | V29 |
| 0.371092E+00 | 0.895664E+00 | 0.925362E+03 | 0.371092E+00 | 0.895664E+00 | 0.925362E+03 |
| BPRINT | DPCOM | DPWING | PS38 | AM38 | V38 |
| 0. | 0.497637E-01 | 0. | 0. | 0. | 0. |
| BYPASS | HPEXT | WFT | WGT | VA | FRD |
| 0.532976E+00 | 0. | 0.386023E+01 | 0.335035E+03 | 0.609938E+03 | 0.627824E+04 |
| PCBLI | WG37 | VJW | PS39 | AM39 | V39 |
| -0. | 0. | 0. | 0. | 0. | 0. |
| CVDWNG | FGMWNG | FGPWNG | FNWING | FNMAIN | P28 |
| 0.985000E+00 | 0. | 0. | 0. | 0.150885E+05 | 0.625119E+00 |
| FFOVFN | FWOVFN | FCOVFN | FMNOFN | FNOVFD | P38 |
| 0.715196E-01 | 0. | 0.928480E+00 | 0.100000E+01 | 0.393990E+00 | 0. |
| CVMNOZ | VJM | CVDNOZ | VJD | FGM | FGP |
| 0.985000E+00 | 0.178830E+04 | 0.985000E+00 | 0.911482E+03 | 0.154841E+05 | 0.588267E+04 |

```
MAIN SONIC CONVERGENT NOZZLE          FG= 21366.77          FN= 15088.53          SFC= 0.92102
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER  15 LOOPS
```

```
$D(1),IDES=1,* NOW RUN 3 SPOOL, 3 STREAM AFTFAN ENGINE
$D(1),IDES=1,DUMMYSPOOL=.F.,AFTFAN=.T.,PCBLIDS=.5,IAMTP=2,T2=31,PRCDS=16/2.2,
WAFCDS=200*TROPICALDAY,WAICDS=400*TROPICALDAY, * SEE FIG 6 FOR CHANGED AIRFLOWS
AM=0,ALTP=0,PRIDS=2.2, * EXIT P FROM FAN=1.4,1ST COMP 2.2, 2ND COMP 16

FAN DESIGN              PRFCF= 0.10000000E+01 ETAFCF= 0.10000000E+01  WAFCF= 0.34315033E+00   T2DS= 0.54966819E+03

MIDDLE SPOOL DESIGN     PRICF= 0.20000000E+01 ETAICF= 0.98863635E+00  WAICF= 0.13726013E+01  T22DS= 0.54966819E+03

COMPRESSOR DESIGN       PRCCF= 0.89610390E+00 ETACCF= 0.10000000E+01  WACCF= 0.10630393E+01  T21DS= 0.70920736E+03

INTER DUCT DESIGN        A38= 0.23855523E+01   AM38= 0.10000000E+01    A39= 0.23855523E+01   AM39= 0.10000000E+01

COMBUSTOR DESIGN       WA3CDS= 0.30797648E+02 ETABCF= 0.98300000E+00 DTCOCF= 0.10000000E+01

H.P. TURBINE DESIGN    CNHPCF= 0.10119289E+01 TFHPCF= 0.10815664E+01 ETHPCF= 0.10000000E+01 DHHPCF= 0.95650290E+00

I.P. TURBINE DESIGN    CNIPCF= 0.99847737E+00 TFIPCF= 0.10153566E+01 ETIPCF= 0.10000000E+01 DHIPCF= 0.16587348E+01

L.P. TURBINE DESIGN    CNLPCF= 0.97482939E+00 TFLPCF= 0.62291450E+00 ETLPCF= 0.10201339E+01 DHLPCF= 0.47995920E+00

DUCT NOZZLE DESIGN       A28= 0.37509597E+01   AM28= 0.65160510E+00    A29= 0.37509597E+01   AM29= 0.65160510E+00

TURBINE AREA DESIGN      A55= 0.79397937E+01   AM55= 0.23826586E+00

NOZZLE DESIGN             A8= 0.31030816E+01    AM8= 0.10000000E+01     A9= 0.31030816E+01    AM9= 0.10000000E+01

OUTPUT                 AM=  0.          ALTP=      0.          T4= 2560.00                          ETAR= 1.0000

THREE SPOOL ENGINE

 AFT-TURBOFAN
```

| | | | | | |
|---|---|---|---|---|---|
| PCNF | CNF | ZF | PRF | WAFC | WAF |
| 0.100000E+03 | 0.100000E+01 | 0.833333E+00 | 0.140000E+01 | 0.205890E+03 | 0.200000E+03 |
| PCNI | CNI | ZI | PRI | WACI | WAI |
| 0.100000E+03 | 0.100000E+01 | 0.833333E+00 | 0.220000E+01 | 0.411780E+03 | 0.400000E+03 |
| PCNC | CNC | ZC | PRC | WACC | WAC |
| 0.100000E+03 | 0.100000E+01 | 0.814332E+00 | 0.727273E+01 | 0.106304E+03 | 0.200000E+03 |
| T2 | P2 | T22 | P22 | T21 | P21 |
| 0.549668E+03 | 0.100000E+01 | 0.612687E+03 | 0.140000E+01 | 0.709207E+03 | 0.220000E+01 |
| T3 | P3 | PCBLF | BLF | PCBLC | BLC |
| 0.131103E+04 | 0.160000E+02 | 0. | 0. | 0. | 0. |
| PCBLHP | BLHP | PCBLIP | BLIP | PCBLLP | BLLP |
| 0. | 0. | 0. | 0. | 0. | 0. |
| WA3 | WFB | WG4 | FAR4 | T4 | P4 |
| 0.200000E+03 | 0.409834E+01 | 0.204098E+03 | 0.204917E-01 | 0.256000E+04 | 0.152000E+02 |
| TFFHP | CNHP | DHTCHP | DHTC | T50 | P50 |
| 0.462292E+02 | 0.197642E+01 | 0.600000E-01 | 0.146980E+03 | 0.205983E+04 | 0.533327E+01 |
| TFFIP | CNIP | DHTCIP | DHTI | T5 | P5 |
| 0.118185E+03 | 0.220335E+01 | 0.220000E-01 | 0.751676E+02 | 0.179639E+04 | 0.282050E+01 |
| TFFLP | CNLP | DHTCLP | DHTF | T55 | P55 |
| 0.208696E+03 | 0.235939E+01 | 0.171750E-01 | 0.148082E+02 | 0.174370E+04 | 0.246262E+01 |
| ETAB | PCBLDU | ETAD | DPDUC | T24 | P24 |
| 0.983000E+00 | 0. | 0. | 0.500000E-01 | 0.612687E+03 | 0.133000E+01 |
| WAD | WFD | WG24 | FAR24 | T25 | P25 |
| 0.200000E+03 | 0. | 0.200000E+03 | 0. | 0.612687E+03 | 0.133000E+01 |
| ETAF | ETAI | ETAC | ETATHP | ETATIP | ETATLP |
| 0.880000E+00 | 0.870000E+00 | 0.860000E+00 | 0.900000E+00 | 0.900000E+00 | 0.900000E+00 |
| T6 | P6 | PS6 | AM6 | V6 | WG6 |
| 0.174370E+04 | 0.246262E+01 | 0.237214E+01 | 0.238266E+00 | 0.472437E+03 | 0.204098E+03 |
| T7 | WFA | WG7 | FAR7 | ETAA | DPAFT |
| 0.174370E+04 | 0. | 0.204098E+03 | 0.204917E-01 | 0. | 0. |
| PS8 | AM8 | V8 | PS9 | AM9 | V9 |
| 0.133970E+01 | 0.100000E+01 | 0.185307E+04 | 0.133970E+01 | 0.100000E+01 | 0.185307E+04 |
| PS28 | AM28 | V28 | PS29 | AM29 | V29 |
| 0.100000E+01 | 0.651605E+00 | 0.759245E+03 | 0.100000E+01 | 0.651605E+00 | 0.759245E+03 |
| BPRINT | DPCOM | DPWING | PS38 | AM38 | V38 |
| 0.100000E+01 | 0.500000E-01 | 0.100000E+00 | 0.104873E+01 | 0.100000E+01 | 0.119217E+04 |
| BYPASS | HPEXT | WFT | WGT | VA | FRD |
| 0.500000E+00 | 0. | 0.409834E+01 | 0.604098E+03 | 0. | 0. |
| PCBLI | WG37 | VJW | PS39 | AM39 | V39 |
| 0.500000E+00 | 0.200000E+03 | 0.117429E+04 | 0.104873E+01 | 0.100000E+01 | 0.119217E+04 |
| CVDWNG | FGMWNG | FGPWNG | FNWING | FNMAIN | P28 |
| 0.985000E+00 | 0.729961E+04 | 0.246010E+03 | 0.754562E+04 | 0.184583E+05 | 0.133000E+01 |
| FFOVFN | FWOVFN | FCOVFN | FMNOFN | FNOVFD | P38 |
| 0.178774E+00 | 0.290172E+00 | 0.531054E+00 | 0.709828E+00 | 0.100000E+01 | 0.198000E+01 |
| CVMNOZ | VJM | CVDNOZ | VJD | FGM | FGP |
| 0.985000E+00 | 0.182527E+04 | 0.985000E+00 | 0.747856E+03 | 0.235272E+05 | 0.247676E+04 |

```
MAIN SCNIC CONVERGENT NOZZLE          FG= 26003.93                  FN= 26003.93                  SFC= 0.56738
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER   1 LOOPS
```

```
COMMON          0.833333E+00  0.100000E+03  0.833333E+00  0.100000E+03  0.814332E+00  0.100000E+03  0.256000E+04   0

   0.100000E+03  0.100000E+03  0.256000E+04  0.100000E+03  0.           0.100000E+01  0.100000E+01  0.100000E+01
   0.833333E+00  0.100000E+03  0.140000E+01  0.880000E+00  0.200000E+03  0.100000E+01  0.100000E+01  0.343150E+00
   0.814332E+00  0.100000E+03  0.727273E+01  0.860000E+00  0.200000E+03  0.896104E+00  0.100000E+01  0.106304E+01
   0.256000E+04  0.           0.124897E+04  0.983000E+00  0.307976E+02  0.500000E-01  0.100000E+01  0.983000E+00
   0.500000E+02  0.200000E+01  0.900000E+00  0.108157E+01  0.101193E+01  0.100000E+01  0.956903E+00  0.549668E+03
   0.130000E+03  0.230000E+01  0.900000E+00  0.622915E+00  0.974829E+00  0.102013E+01  0.479959E+00  0.709207E+03
   0.            0.            0.            0.            0.353607E+04  0.500000E-01  0.            0.
   0.            0.            0.            0.            0.346081E+04  0.            0.            0.
   0.793979E+01  0.           0.793979E+01  0.793979E+01  0.310308E+01  0.310308E+01  0.375096E+01  0.375096E+01
   0.237214E+01  0.238266E+00  0.985000E+00  0.985000E+00  0.            0.            0.            0.

   0.549670E+03  0.100000E+01  0.131340E+03  0.160493E+01  0.549668E+03  0.100000E+01  0.131340E+03  0.160493E+01
   0.709207E+03  0.220000E+01  0.169694E+03  0.161211E+01  0.131103E+04  0.160000E+02  0.319686E+03  0.162865E+01
   0.256000E+04  0.152000E+02  0.681183E+03  0.182692E+01  0.179639E+04  0.282050E+01  0.459035E+03  0.183965E+01
   0.174370E+04  0.246262E+01  0.444227E+03  0.184059E+01  0.           0.            0.            0.
   0.100000E+01  0.140000E+01  0.880000E+00  0.205890E+03  0.200000E+03  0.200000E+03  0.204098E+03  0.204917E-01
   0.100000E+01  0.727273E+01  0.860000E+00  0.106304E+03  0.200000E+03  0.983000E+00  0.500000E-01  0.
   0.200000E+01  0.900000E+00  0.574142E-01  0.146980E+03  0.           0.204098E+03  0.204917E-01  0.114970E+04
   0.230000E+01  0.900000E+00  0.824328E-02  0.148082E+02  0.           0.204098E+03  0.204917E-01  0.
   0.            0.            0.100000E+01  0.833333E+00  0.100000E+03  0.814332E+00  0.100000E+03  0.409834E+01
   0.500000E+02  0.130000E+03  0.            0.            0.            0.            0.            0.

   0.100000E+01  0.200000E+03  0.200000E+03  0.           0.           0.319686E+03  0.           0.
   0.709207E+03  0.220000E+01  0.169694E+03  0.161211E+01  0.612687E+03  0.140000E+01  0.146452E+03  0.160788E+01
   0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01  0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01
   0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01  0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01
   0.200000E+03  0.           0.200000E+03  0.           0.           0.500000E-01  0.500000E+00  0.
   0.564699E+03  0.100000E+01  0.759245E+03  0.651605E+00  0.564699E+03  0.100000E+01  0.759245E+03  0.651605E+00

   0.174370E+04  0.246262E+01  0.444227E+03  0.184059E+01  0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01
   0.409834E+01  0.204098E+03  0.204917E-01  0.           0.200000E+03  0.           0.100000E+01  0.
   0.174370E+04  0.246262E+01  0.444227E+03  0.184059E+01  0.174370E+04  0.246262E+01  0.444229E+03  0.184059E+01
   0.174370E+04  0.246262E+01  0.444229E+03  0.184059E+01  0.174370E+04  0.246262E+01  0.444229E+03  0.184059E+01
   0.204098E+03  0.           0.204098E+03  0.204917E-01  0.           0.            0.472437E+03  0.
   0.237214E+01  0.472437E+03  0.238266E+00  0.172774E+04  0.237194E+01  0.472433E+03  0.238266E+00  0.
   0.149584E+04  0.133970E+01  0.185307E+04  0.100000E+01  0.149584E+04  0.133970E+01  0.185307E+04  0.100000E+01
   0.            0.            0.747856E+03  0.464882E+04  0.182527E+04  0.115787E+05  0.            0.223075E+04
   0.235272E+05  0.247676E+04  0.409834E+01  0.604098E+03  0.683057E-02  0.260039E+05  0.260039E+05  0.567377E+00

   0.612687E+03  0.140000E+01  0.146452E+03  0.160788E+01  0.205983E+04  0.533327E+01  0.534203E+03  0.183496E+01
   0.400000E+03  0.833333E+00  0.100000E+03  0.100000E+01  0.220000E+01  0.870000E+00  0.411780E+03  0.120000E+03
   0.220000E+01  0.900000E+00  0.364922E-01  0.751676E+02  0.           0.            0.100000E+03  0.833333E+00
   0.100000E+03  0.220000E+01  0.870000E+00  0.400000E+03  0.200000E+01  0.988636E+00  0.137260E+01  0.120000E+03
   0.220000E+01  0.900000E+00  0.101536E+01  0.998477E+00  0.           0.165873E+01  0.411780E+03  0.400000E+03
   0.500000E+00  0.200000E+03  0.549668E+03  0.200000E+03

   0.200000E+03  0.100000E+00  0.100000E+00  0.242100E+04  0.238555E+01  0.100000E+01  0.119217E+04  0.709207E+03
   0.169694E+03  0.198000E+01  0.591405E+03  0.104873E+01  0.709207E+03  0.169694E+03  0.198000E+01  0.591405E+03
   0.119217E+04  0.100000E+01  0.238555E+01  0.100000E+01  0.200000E+03  0.985000E+00  0.729961E+04  0.246010E+03
   0.754562E+04  0.184583E+05  0.290172E+00  0.104873E+01  0.           0.            0.            0.
   0.178774E+00  0.531054E+00  0.709828E+00  0.100000E+01  0.000000E-38  0.           0.260039E+05  0.500000E+00
   0.462292E+02  0.118185E+03  0.208696E+03  0.197642E+01  0.220335E+01  0.235939E+01  0.600000E-01  0.146980E+03
```

```
$D(1),AM=.6,ALTP=25000,IAMTP=0,T4=2260,* RUN AT ALTITUDE AT REDUCED T4-STD DAY

OUTPUT                  AM=  0.600        ALTP= 25000.          T4= 2260.00                    ETAR= 1.0000

THREE SPOOL ENGINE

 AFT-TURBOFAN

        PCNF          CNF           ZF            PRF           WAFC          WAF
    0.962072E+02  0.105101E+01  0.714685E+00  0.138097E+01  0.225997E+03  0.113536E+03
        PCNI          CNI           ZI            PRI           WACI          WAI
    0.934717E+02  0.102113E+01  0.836950E+00  0.226038E+01  0.425061E+03  0.213542E+03
        PCNC          CNC           ZC            PRC           WACC          WAC
    0.933542E+02  0.101276E+01  0.829775E+00  0.756550E+01  0.108849E+03  0.108062E+03
        T2            P2            T22           P22           T21           P21
    0.460573E+03  0.473409E+00  0.514072E+03  0.653762E+00  0.602600E+03  0.107009E+01
        T3            P3            PCBLF         BLF           PCBLC         BLC
    0.113975E+04  0.809574E+01  0.            0.            0.            0.
        PCBLHP        BLHP          PCBLIP        BLIP          PCBLLP        BLLP
    0.            0.            0.            0.            0.            0.
        WA3           WFB           WG4           FAR4          T4            P4
    0.108062E+03  0.191758E+01  0.109980E+03  0.177451E-01  0.226000E+04  0.769271E+01
        TFFHP         CNHP          DHTCHP        DHTC          T50           P50
    0.462476E+02  0.196372E+01  0.599475E-01  0.129591E+03  0.180776E+04  0.269097E+01
        TFFIP         CNIP          DHTCIP        DHTI          T5            P5
    0.118243E+03  0.219841E+01  0.220249E-01  0.660349E+02  0.156967E+04  0.141927E+01
        TFFLP         CNLP          DHTCLP        DHTF          T55           P55
    0.208907E+03  0.242830E+01  0.175304E-01  0.132117E+02  0.152127E+04  0.123532E+01
        ETAB          PCBLDU        ETAD          DPDUC         T24           P24
    0.983000E+00  0.            0.            0.556770E-01  0.514072E+03  0.617362E+00
        WAD           WFD           WG24          FAR24         T25           P25
    0.113536E+03  0.            0.113536E+03  0.            0.514072E+03  0.617362E+00
        ETAF          ETAI          ETAC          ETATHP        ETATIP        ETATLP
    0.831650E+00  0.853040E+00  0.855615E+00  0.899274E+00  0.899467E+00  0.898991E+00
        T6            P6            PS6           AM6           V6            WG6
```

```
0.152127E+04   0.123532E+01   0.119153E+01   0.237865E+00   0.442666E+03   0.109980E+03
  T7             WFA            WG7            FAR7           ETAA           DPAFT
0.152127E+04   0.             0.109980E+03   0.177451E-01   0.             0.
  PS8            AM8            V8             PS9            AM9            V9
0.669006E+00   0.100000E+01   0.173448E+04   0.669006E+00   0.100000E+01   0.173448E+04
  PS28           AM28           V28            PS29           AM29           V29
0.371092E+00   0.883805E+00   0.913767E+03   0.371092E+00   0.883805E+00   0.913767E+03
  BPRINT         DPCOM          DPWING         PS38           AM38           V38
0.976098E+00   0.497825E-01   0.999471E-01   0.509290E+00   0.100000E+01   0.109892E+04
  BYPASS         HPEXT          WFT            WGT            VA             FRD
0.531681E+00   0.             0.191758E+01   0.328996E+03   0.609938E+03   0.215236E+04
  PC8LI          WG37           VJW            PS39           AM39           V39
0.493952E+00   0.105480E+03   0.108244E+04   0.509290E+00   0.100000E+01   0.109892E+04
  CVDWNG         FGMWNG         FGPWNG         FNWING         FNMAIN         P28
0.985000E+00   0.354867E+04   0.697668E+03   0.224671E+04   0.108198E+05   0.617362E+00
  FFOVFN         FWOVFN         FCOVFN         FMNOFN         FNOVFD         P38
0.783524E-01   0.171945E+00   0.749703E+00   0.828055E+00   0.502481E+00   0.963134E+00
  CVMNOZ         VJM            CVDNOZ         VJD            FGM            FGP
0.985000E+00   0.170846E+04   0.985000E+00   0.900061E+03   0.125648E+05   0.265401E+04

MAIN SONIC CONVERGENT NOZZLE          FG= 15218.84                  FN= 13066.49                  SFC= 0.52832
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER  24 LOOPS
```

```
      $D(1),IDES=1,# NOW RUN SUPERCHARGED COMPRESSOR AFTFAN, SEE FIGURE 7
      $D(1),IDES=1,AM=0,ALTP=0,IAMTP=2,T2=31,FIXMIDDLETOCOMP=.T.,# AFTFAN STILL TRUE

FAN DESIGN              PRFCF= 0.10000000E+01 ETAFCF= 0.10000000E+01  WAFCF= 0.34315033E+00   T2DS= 0.54966819E+03

MIDDLE SPOOL DESIGN     PRICF= 0.20000000E+01 ETAICF= 0.98863635E+00  WAICF= 0.13726013E+01  T22DS= 0.54966819E+03

COMPRESSOR DESIGN       PRCCF= 0.10336619E+01 ETACCF= 0.10267859E+01  WACCF= 0.12042486E+01  T21DS= 0.70920736E+03

INTER DUCT DESIGN        A38= 0.23855523E+01   AM38= 0.10000000E+01    A39= 0.23855523E+01   AM39= 0.10000000E+01

COMBUSTOR DESIGN       WA3CDS= 0.30797647E+02 ETABCF= 0.98300000E+00 DTCOCF= 0.10000000E+01

I.P. TURBINE DESIGN    CNIPCF= 0.10119288E+01 TFIPCF= 0.10815664E+01 ETIPCF= 0.10000000E+01 DHIPCF= 0.14462754E+01

L.P. TURBINE DESIGN    CNLPCF= 0.97482939E+00 TFLPCF= 0.61068156E+00 ETLPCF= 0.10201339E+01 DHLPCF= 0.47995920E+00

DUCT NOZZLE DESIGN       A28= 0.37509597E+01   AM28= 0.65160510E+00    A29= 0.37509597E+01   AM29= 0.65160510E+00

TURBINE AREA DESIGN      A55= 0.80988405E+01   AM55= 0.23826586E+00

NOZZLE DESIGN             A8= 0.31652414E+01    AM8= 0.10000000E+01     A9= 0.31652414E+01    AM9= 0.10000000E+01

OUTPUT                 AM=  0.          ALTP=     0.          T4= 2560.00                    ETAR= 1.0000

MIDDLE AND COMPRESSOR SPOOLS ARE ATTACHED , USE MIDDLE AND OUTER TURBINES

 AFT-TURBOFAN
                  PCNF           CNF            ZF             PRF            WAFC           WAF
               0.100000E+03   0.100000E+01   0.833333E+00   0.140000E+01   0.205890E+03   0.200000E+03
                  PCNI           CNI            ZI             PRI            WACI           WAI
               0.100000E+03   0.100000E+01   0.833333E+00   0.220000E+01   0.411780E+03   0.400000E+03
                  PCNC           CNC            ZC             PRC            WACC           WAC
               0.929464E+02   0.929464E+00   0.814332E+00   0.727273E+01   0.106304E+03   0.200000E+03
                  T2             P2             T22            P22            T21            P21
               0.549668E+03   0.100000E+01   0.612687E+03   0.140000E+01   0.709207E+03   0.220000E+01
                  T3             P3             PCBLF          BLF            PCBLC          BLC
               0.131103E+04   0.160000E+02   0.             0.             0.             0.
                  PCBLHP         BLHP           PCBLIP         BLIP           PCBLLP         BLLP
               0.             0.             0.             0.             0.             0.
                  WA3            WFB            WG4            FAR4           T4             P4
               0.200000E+03   0.409834E+01   0.204098E+03   0.204917E-01   0.256000E+04   0.152000E+02
                  TFFHP          CNHP           DHTCHP         DHTC           T50            P50
               0.             0.             0.             0.             0.256000E+04   0.152000E+02
                  TFFIP          CNIP           DHTCIP         DHTI           T5             P5
               0.462292E+02   0.197642E+01   0.600000E-01   0.222148E+03   0.179639E+04   0.276511E+01
                  TFFLP          CNLP           DHTCLP         DHTF           T55            P55
               0.212877E+03   0.235939E+01   0.171750E-01   0.148082E+02   0.174370E+04   0.241426E+01
                  ETAB           PCBLDU         ETAD           DPDUC          T24            P24
               0.983000E+00   0.             0.             0.500000E-01   0.612687E+03   0.133000E+01
                  WAD            WFD            WG24           FAR24          T25            P25
               0.200000E+03   0.             0.200000E+03   0.             0.612687E+03   0.133000E+01
                  ETAF           ETAI           ETAC           ETATHP         ETATIP         ETATLP
               0.880000E+00   0.870000E+00   0.860000E+00   0.             0.900000E+00   0.900000E+00
                  T6             P6             PS6            AM6            V6             WG6
               0.174376E+04   0.241426E+01   0.232556E+01   0.238266E+00   0.472437E+03   0.204098E+03
                  T7             WFA            WG7            FAR7           ETAA           DPAFT
               0.174376E+04   0.             0.204098E+03   0.204917E-01   0.             0.
                  PS8            AM8            V8             PS9            AM9            V9
```

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.131339E+01 | 0.100000E+01 | 0.185307E+04 | 0.131339E+01 | 0.100000E+01 | 0.185307E+04 |
| PS28 | AM28 | V28 | PS29 | AM29 | V29 |
| 0.100000E+01 | 0.651605E+00 | 0.759245E+03 | 0.100000E+01 | 0.651605E+00 | 0.759245E+03 |
| BPRINT | DPCOM | DPWING | PS38 | AM38 | V38 |
| 0.100000E+01 | 0.500000E-01 | 0.100000E+00 | 0.104873E+01 | 0.100000E+01 | 0.119217E+04 |
| BYPASS | HPEXT | WFT | WGT | VA | FRD |
| 0.500000E+00 | 0. | 0.409834E+01 | 0.604098E+03 | 0. | 0. |
| PCBLI | WG37 | VJW | PS39 | AM39 | V39 |
| 0.500000E+00 | 0.200000E+03 | 0.117429E+04 | 0.104873E+01 | 0.100000E+01 | 0.119217E+04 |
| CVOWNG | FGMWNG | FGPWNG | FNWING | FNMAIN | P28 |
| 0.985000E+00 | 0.729961E+04 | 0.246010E+03 | 0.754562E+04 | 0.183268E+05 | 0.133000E+01 |
| FFOVFN | FWOVFN | FCOVFN | FMNOFN | FNOVFD | P38 |
| 0.179683E+00 | 0.291648E+00 | 0.528670E+00 | 0.708352E+00 | 0.100000E+01 | 0.198000E+01 |
| CVMNOZ | VJM | CVDNOZ | VJD | FGM | FGP |
| 0.985000E+00 | 0.182527E+04 | 0.985000E+00 | 0.747856E+03 | 0.235272E+05 | 0.234521E+04 |

MAIN SONIC CONVERGENT NOZZLE FG= 25872.39 FN= 25872.39 SFC= 0.57026
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER 1 LOOPS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| COMMON | 0.833333E+00 | 0.100000E+03 | 0.833333E+00 | 0.100000E+03 | 0.814332E+00 | 0.929464E+02 | 0.256000E+04 | 0 |
| 0.100000E+03 | 0.100000E+03 | 0.256000E+04 | 0.100000E+03 | 0. | 0.100000E+01 | 0.100000E+01 | 0.100000E+01 | |
| 0.833333E+00 | 0.100000E+03 | 0.140000E+01 | 0.880000E+00 | 0.200000E+03 | 0.100000E+01 | 0.100000E+01 | 0.343150E+00 | |
| 0.814332E+00 | 0.929464E+02 | 0.727273E+01 | 0.860000E+00 | 0.200000E+03 | 0.103366E+01 | 0.102679E+01 | 0.120425E+01 | |
| 0.256000E+04 | 0. | 0.124897E+04 | 0.983000E+00 | 0.307976E+02 | 0.500000E-01 | 0.100000E+01 | 0.983000E+00 | |
| 0.500000E+02 | 0.200000E+01 | 0.900000E+00 | 0. | 0. | 0. | 0. | 0.549668E+03 | |
| 0.130000E+03 | 0.230000E+01 | 0.900000E+00 | 0.610682E+00 | 0.974829E+00 | 0.102013E+01 | 0.479959E+00 | 0.709207E+03 | |
| 0. | 0. | 0. | 0. | 0.353607E+04 | 0.500000E-01 | 0. | 0. | |
| 0. | 0. | 0. | 0. | 0.353014E+04 | 0. | 0. | 0. | |
| 0.809884E+01 | 0. | 0.809884E+01 | 0.809884E+01 | 0.316524E+01 | 0.316524E+01 | 0.375096E+01 | 0.375096E+01 | |
| 0.232556E+01 | 0.238266E+00 | 0.985000E+00 | 0.985000E+00 | 0. | 0. | 0. | 0. | |
| 0.549670E+03 | 0.100000E+01 | 0.131340E+03 | 0.160493E+01 | 0.549668E+03 | 0.100000E+01 | 0.131340E+03 | 0.160493E+01 | |
| 0.709207E+03 | 0.220000E+01 | 0.169694E+03 | 0.161211E+01 | 0.131103E+04 | 0.160000E+02 | 0.319686E+03 | 0.162865E+01 | |
| 0.256000E+04 | 0.152000E+02 | 0.681183E+03 | 0.182692E+01 | 0.179639E+04 | 0.276511E+01 | 0.459035E+03 | 0.184101E+01 | |
| 0.174370E+04 | 0.241426E+01 | 0.444227E+03 | 0.184195E+01 | 0. | 0. | 0. | 0. | |
| 0.100000E+01 | 0.140000E+01 | 0.880000E+00 | 0.205890E+03 | 0.200000E+03 | 0.200000E+03 | 0.204098E+03 | 0.204917E-01 | |
| 0.929464E+00 | 0.727273E+01 | 0.860000E+00 | 0.106304E+03 | 0.200000E+03 | 0.983000E+00 | 0.500000E-01 | 0. | |
| 0. | 0. | 0. | 0. | 0. | 0.204098E+03 | 0.204917E-01 | 0.114970E+04 | |
| 0.230000E+01 | 0.900000E+00 | 0.824328E-02 | 0.148082E+02 | 0. | 0.204098E+03 | 0.204917E-01 | 0. | |
| 0. | 0. | 0.100000E+01 | 0.833333E+00 | 0.100000E+03 | 0.814332E+00 | 0.929464E+02 | 0.409834E+01 | |
| 0.500000E+02 | 0.130000E+03 | 0. | 0. | 0. | 0. | 0. | 0. | |
| 0.100000E+01 | 0.200000E+03 | 0.200000E+03 | 0. | 0. | 0.319686E+03 | 0. | 0. | |
| 0.709207E+03 | 0.220000E+01 | 0.169694E+03 | 0.161211E+01 | 0.612687E+03 | 0.140000E+01 | 0.146452E+03 | 0.160788E+01 | |
| 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 | 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 | |
| 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 | 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 | |
| 0.200000E+03 | 0. | 0.200000E+03 | 0. | 0. | 0.500000E-01 | 0.500000E+00 | 0. | |
| 0.564699E+03 | 0.100000E+01 | 0.759245E+03 | 0.651605E+00 | 0.564699E+03 | 0.100000E+01 | 0.759245E+03 | 0.651605E+00 | |
| 0.174370E+04 | 0.241426E+01 | 0.444227E+03 | 0.184195E+01 | 0.612687E+03 | 0.133000E+01 | 0.146451E+03 | 0.161140E+01 | |
| 0.409834E+01 | 0.204098E+03 | 0.204917E-01 | 0. | 0.200000E+03 | 0. | 0.100000E+01 | 0. | |
| 0.174370E+04 | 0.241426E+01 | 0.444227E+03 | 0.184195E+01 | 0.174370E+04 | 0.241426E+01 | 0.444229E+03 | 0.184195E+01 | |
| 0.174370E+04 | 0.241426E+01 | 0.444229E+03 | 0.184195E+01 | 0.174370E+04 | 0.241426E+01 | 0.444229E+03 | 0.184195E+01 | |
| 0.204098E+03 | 0. | 0.204098E+03 | 0.204917E-01 | 0. | 0. | 0.472437E+03 | 0. | |
| 0.232556E+01 | 0.472437E+03 | 0.238266E+00 | 0.172774E+04 | 0.232536E+01 | 0.472433E+03 | 0.238266E+00 | 0. | |
| 0.149584E+04 | 0.131339E+01 | 0.185307E+04 | 0.100000E+01 | 0.149584E+04 | 0.131339E+01 | 0.185307E+04 | 0.100000E+01 | |
| 0. | 0. | 0.747856E+03 | 0.464882E+04 | 0.182527E+04 | 0.115787E+05 | 0. | 0.209920E+04 | |
| 0.235272E+05 | 0.234521E+04 | 0.409834E+01 | 0.604098E+03 | 0.683057E-02 | 0.258724E+05 | 0.258724E+05 | 0.570262E+00 | |
| 0.612687E+03 | 0.140000E+01 | 0.146452E+03 | 0.160788E+01 | 0.256000E+04 | 0.152000E+02 | 0.681183E+03 | 0.182692E+01 | |
| 0.400000E+03 | 0.833333E+00 | 0.100000E+03 | 0.100000E+01 | 0.220000E+01 | 0.870000E+00 | 0.411780E+03 | 0.500000E+02 | |
| 0.200000E+01 | 0.900000E+00 | 0.867765E-01 | 0.222148E+03 | 0. | 0. | 0.100000E+03 | 0.833333E+00 | |
| 0.100000E+03 | 0.220000E+01 | 0.870000E+00 | 0.400000E+03 | 0.200000E+01 | 0.988636E+00 | 0.137260E+01 | 0.120000E+03 | |
| 0.220000E+01 | 0.900000E+00 | 0.108157E+01 | 0.101193E+01 | 0. | 0.144628E+01 | 0.411780E+03 | 0.400000E+03 | |
| 0.500000E+00 | 0.200000E+03 | 0.549668E+03 | 0.200000E+03 | | | | | |
| 0.200000E+03 | 0.100000E+00 | 0.100000E+00 | 0.242100E+04 | 0.238555E+01 | 0.100000E+01 | 0.119217E+04 | 0.709207E+03 | |
| 0.169694E+03 | 0.198000E+01 | 0.591405E+03 | 0.104873E+01 | 0.709207E+03 | 0.169694E+03 | 0.198000E+01 | 0.591405E+03 | |
| 0.119217E+04 | 0.100000E+01 | 0.238555E+01 | 0.100000E+01 | 0.200000E+03 | 0.985000E+00 | 0.729961E+04 | 0.246010E+03 | |
| 0.754562E+04 | 0.183268E+05 | 0.291648E+00 | 0.104873E+01 | 0. | 0.000000E-38 | 0. | 0. | |
| 0.179683E+00 | 0.528670E+00 | 0.708352E+00 | 0.100000E+01 | 0.000000E-38 | 0. | 0.258724E+05 | 0.500000E+00 | |
| 0. | 0.462292E+02 | 0.212877E+03 | 0. | 0.197642E+01 | 0.235939E+01 | 0. | 0. | |

```
     $D(1),AM=.6,ALTP=25000,IAMTP=0,T4=2260,# RUN AT ALTITUDE AT REDUCED T4-STD DAY

OUTPUT                    AM=  0.600        ALTP= 25000.          T4= 2260.00                    ETAR= 1.0000

MIDDLE AND COMPRESSOR SPOOLS ARE ATTACHED , USE MIDDLE AND OUTER TURBINES

 AFT-TURBOFAN
                    PCNF          CNF           ZF            PRF           WAFC          WAF
                0.966327E+02  0.105566E+01  0.717809E+00  0.138610E+01  0.227254E+03  0.114168E+03
                    PCNI          CNI           ZI            PRI           WACI          WAI
                0.938762E+02  0.102555E+01  0.835402E+00  0.226957E+01  0.428150E+03  0.215094E+03
                    PCNC          CNC           ZC            PRC           WACC          WAC
                0.873807E+02  0.946960E+00  0.827554E+00  0.761729E+01  0.109648E+03  0.109184E+03
                    T2            P2            T22           P22           T21           P21
                0.460573E+03  0.473409E+00  0.514862E+03  0.656193E+00  0.603867E+03  0.107444E+01
                    T3            P3            PCBLF         BLF           PCBLC         BLC
                0.114009E+04  0.818429E+01  0.            0.            0.            0.
                    PCBLHP        BLHP          PCBLIP        BLIP          PCBLLP        BLLP
                0.            0.            0.            0.            0.            0.
                    WA3           WFB           WG4           FAR4          T4            P4
                0.109184E+03  0.193692E+01  0.111120E+03  0.177401E-01  0.226000E+04  0.777702E+01
                    TFFHP         CNHP          DHTCHP        DHTC          T50           P50
                0.            0.            0.            0.            0.226000E+04  0.777702E+01
                    TFFIP         CNIP          DHTCIP        DHTI          T5            P5
                0.462206E+02  0.197470E+01  0.599642E-01  0.195798E+03  0.156904E+04  0.140467E+01
                    TFFLP         CNLP          DHTCLP        DHTF          T55           P55
                0.213224E+03  0.243953E+01  0.175766E-01  0.133431E+02  0.152015E+04  0.122077E+01
                    ETAB          PCBLDU        ETAD          OPDUC         T24           P24
                0.983000E+00  0.            0.            0.558221E-01  0.514862E+03  0.619563E+00
                    WAD           WFD           WG24          FAR24         T25           P25
                0.114168E+03  0.            0.114168E+03  0.            0.514862E+03  0.619563E+00
                    ETAF          ETAI          ETAC          ETATHP        ETATIP        ETATLP
                0.829416E+00  0.850199E+00  0.862589E+00  0.            0.899947E+00  0.898741E+00
                    T6            P6            PS6           AM6           V6            WG6
                0.152015E+04  0.122077E+01  0.117732E+01  0.238357E+00  0.443421E+03  0.111120E+03
                    T7            WFA           WG7           FAR7          ETAA          DPAFT
                0.152015E+04  0.            0.111120E+03  0.177401E-01  0.            0.
                    PS8           AM8           V8            PS9           AM9           V9
                0.662400E+00  0.100000E+01  0.173386E+04  0.662400E+00  0.100000E+01  0.173386E+04
                    PS28          AM28          V28           PS29          AM29          V29
                0.371092E+00  0.888725E+00  0.918858E+03  0.371092E+00  0.888725E+00  0.918858E+03
                    BPRINT        DPCOM         DPWING        PS38          AM38          V38
                0.970021E+00  0.497621E-01  0.100054E+00  0.511908E+00  0.100000E+01  0.110007E+04
                    BYPASS        HPEXT         WFT           WGT           VA            FRD
                0.530781E+00  0.            0.193692E+01  0.331198E+03  0.609938E+03  0.216433E+04
                    PCBLI         WG37          VJW           PS39          AM39          V39
                0.492391E+00  0.105910E+03  0.108357E+04  0.511908E+00  0.100000E+01  0.110007E+04
                    CVDWNG        FGMWNG        FGPWNG        FNWING        FNMAIN        P28
                0.985000E+00  0.356689E+04  0.710889E+03  0.226999E+04  0.109048E+05  0.619563E+00
                    FFOVFN        FWOVFN        FCOVFN        FMNOFN        FNOVFD        P38
                0.794910E-01  0.172298E+00  0.748211E+00  0.827702E+00  0.509222E+00  0.966935E+00
                    CVMNOZ        VJM           CVDNOZ        VJD           FGM           FGP
                0.985000E+00  0.170785E+04  0.985000E+00  0.905075E+03  0.126770E+05  0.266217E+04

MAIN SCNIC CONVERGENT NOZZLE          FG= 15339.13                FN= 13174.80                SFC= 0.52926
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER  11 LOOPS



     $D(1),IDES=1,# NOW RUN 2 SPOOL-2 STREAM ENGINE WITH ONLY 1 COMPRESSOR
     $D(1),IDES=1,PRCDS=16,AM=0,ALTP=0,PCBLIDS=0,FIXMIDDLETOCOMP=.F.,PCNCDS=100,
     PCNIDS=100,DUMMYSPOOL=.T.,IAMTP=2,T2=31, # SEE FIGURE 8

FAN DESIGN            PRFCF= 0.10000000E+01 ETAFCF= 0.10000000E+01  WAFCF= 0.34315033E+00   T2DS= 0.54966819E+03

MIDDLE SPOOL DESIGN   PRICF= 0.10000000E+01 ETAICF= 0.10000000E+01  WAICF= 0.10000000E+01  T22DS= 0.54966819E+03

COMPRESSOR DESIGN     PRCCF= 0.21428571E+01 ETACCF= 0.10000000E+01  WACCF= 0.41178042E+01  T21DS= 0.54966819E+03

COMBUSTOR DESIGN     WA3CDS= 0.61230686E+02 ETABCF= 0.98300000E+00 DTCOCF= 0.10000000E+01

H.P. TURBINE DESIGN  CNHPCF= 0.10119289E+01 TFHPCF= 0.54065683E+00 ETHPCF= 0.10000000E+01 DHHPCF= 0.11758439E+01

L.P. TURBINE DESIGN  CNLPCF= 0.10138291E+01 TFLPCF= 0.42747655E+00 ETLPCF= 0.10201339E+01 DHLPCF= 0.22181950E+00

DUCT NOZZLE DESIGN      A28= 0.37509597E+01   AM28= 0.65160510E+00    A29= 0.37509597E+01   AM29= 0.65160510E+00

TURBINE AREA DESIGN     A55= 0.10866958E+02   AM55= 0.23826395E+00

NOZZLE DESIGN            A8= 0.42454950E+01    AM8= 0.10000000E+01     A9= 0.42454950E+01    AM9= 0.10CCCOCOE+01

OUTPUT                AM=  0.           ALTP=     0.          T4= 2560.00                    ETAR= 1.0000

MIDDLE SPOOL IS DUMMY
```

```
NO AIRFLOW INTO WING  , AFT-TURBOFAN
        PCNF            CNF             ZF              PRF             WAFC            WAF
    0.100000E+03    0.100000E+01    0.833333E+00    0.140000E+01    0.205890E+03    0.200000E+03
        PCNI            CNI             ZI              PRI             WACI            WAI
    0.100000E+01    0.              0.571429E+00    0.100000E+01    0.411780E+03    0.400000E+03
        PCNC            CNC             ZC              PRC             WACC            WAC
    0.100000E+03    0.100000E+01    0.814332E+00    0.160000E+02    0.411780E+03    0.400000E+03
        T2              P2              T22             P22             T21             P21
    0.549668E+03    0.100000E+01    0.612687E+03    0.140000E+01    0.549668E+03    0.100000E+01
        T3              P3              PCBLF           BLF             PCBLC           BLC
    0.129556E+04    0.160000E+02    0.              0.              0.              0.
        PCBLHP          BLHP            PCBLIP          BLIP            PCBLLP          BLLP
    0.              0.              0.              0.              0.              0.
        WA3             WFB             WG4             FAR4            T4              P4
    0.400000E+03    0.829205E+01    0.408292E+03    0.207301E-01    0.256000E+04    0.152000E+02
        TFFHP           CNHP            DHTCHP          DHTC            T50             P50
    0.924801E+02    0.197642E+01    0.600000E-01    0.180610E+03    0.194300E+04    0.402696E+01
        TFFIP           CNIP            DHTCIP          DHTI            T5              P5
    0.              0.              0.              0.              0.194300E+04    0.402696E+01
        TFFLP           CNLP            DHTCLP          DHTF            T55             P55
    0.304110E+03    0.226863E+01    0.171750E-01    0.740236E+01    0.191708E+04    0.378435E+01
        ETAB            PCBLDU          ETAD            DPDUC           T24             P24
    0.983000E+00    0.              0.              0.500000E-01    0.612687E+03    0.133000E+01
        WAD             WFD             WG24            FAR24           T25             P25
    0.200000E+03    0.              0.200000E+03    0.              0.612687E+03    0.133000E+01
        ETAF            ETAI            ETAC            ETATHP          ETATIP          ETATLP
    0.880000E+00    0.100000E+01    0.860000E+00    0.900000E+00    0.              0.900000E+00
        T6              P6              PS6             AM6             V6              WG6
    0.191708E+04    0.378435E+01    0.364616E+01    0.238264E+00    0.494024E+03    0.408292E+03
        T7              WFA             WG7             FAR7            ETAA            DPAFT
    0.191708E+04    0.              0.408292E+03    0.207301E-01    0.              0.
        PS8             AM8             V8              PS9             AM9             V9
    0.206379E+01    0.100000E+01    0.194037E+04    0.206379E+01    0.100000E+01    0.194037E+04
        PS28            AM28            V28             PS29            AM29            V29
    0.100000E+01    0.651605E+00    0.759245E+03    0.100000E+01    0.651605E+00    0.759245E+03
        BPRINT          DPCOM           DPWING          PS38            AM38            V38
    0.              0.500000E-01    0.              0.              0.              0.
        BYPASS          HPEXT           WFT             WGT             VA              FRD
    0.500000E+00    0.              0.829205E+01    0.608292E+03    0.              0.
        PCBLI           WG37            VJW             PS39            AM39            V39
   -0.              0.              0.              0.              0.              0.
        CVDWNG          FGMWNG          FGPWNG          FNWING          FNMAIN          P28
    0.985000E+00    0.              0.              0.              0.384605E+05    0.133000E+01
        FFOVFN          FWOVFN          FCOVFN          FMNOFN          FNOVFD          P38
    0.120872E+00    0.              0.879128E+00    0.100000E+01    0.100000E+01    0.
        CVMNOZ          VJM             CVDNOZ          VJD             FGM             FGP
    0.985000E+00    0.191127E+04    0.985000E+00    0.747856E+03    0.289030E+05    0.955753E+04

MAIN SONIC CONVERGENT NOZZLE          FG= 38460.51                    FN= 38460.51                    SFC= 0.77616
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER   1 LOOPS



COMMON          0.833333E+00    0.100000E+03    0.571429E+00    0.100000E+01    0.814332E+00    0.100000E+03    0.256000E+04    0

    0.100000E+03    0.100000E+03    0.256000E+04    0.100000E+03    0.              0.100000E+01    0.100000E+01    0.100000E+01
    0.833333E+00    0.100000E+03    0.140000E+01    0.880000E+00    0.200000E+03    0.100000E+01    0.100000E+01    0.343150E+00
    0.814332E+00    0.100000E+03    0.160000E+02    0.860000E+00    0.400000E+03    0.214286E+01    0.100000E+01    0.411780E+01
    0.256000E+04    0.              0.126444E+04    0.983000E+00    0.612307E+02    0.500000E-01    0.100000E+01    0.983000E+00
    0.500000E+02    0.200000E+01    0.900000E+00    0.540657E+00    0.101193E+01    0.100000E+01    0.117584E+01    0.549668E+03
    0.130000E+03    0.230000E+01    0.900000E+00    0.427477E+00    0.101383E+01    0.102013E+01    0.221820E+00    0.549668E+03
    0.              0.              0.              0.              0.353607E+04    0.500000E-01    0.              0.
    0.              0.              0.              0.              0.472389E+04    0.              0.              0.
    0.108670E+02    0.              0.108670E+02    0.108670E+02    0.424549E+01    0.424549E+01    0.375096E+01    0.375096E+01
    0.364616E+01    0.238264E+00    0.985000E+00    0.985000E+00    0.              0.              0.              0.

    0.549670E+03    0.100000E+01    0.131340E+03    0.160493E+01    0.549668E+03    0.100000E+01    0.131340E+03    0.160493E+01
    0.549668E+03    0.100000E+01    0.131340E+03    0.160493E+01    0.129556E+04    0.160000E+02    0.315694E+03    0.162558E+01
    0.256000E+04    0.152000E+02    0.681393E+03    0.182706E+01    0.194300E+04    0.402696E+01    0.500783E+03    0.183758E+01
    0.191708E+04    0.378435E+01    0.493381E+03    0.183800E+01    0.              0.              0.              0.
    0.100000E+01    0.140000E+01    0.880000E+00    0.205890E+03    0.200000E+03    0.400000E+03    0.408292E+03    0.207301E-01
    0.100000E+01    0.160000E+02    0.860000E+00    0.411780E+03    0.400000E+03    0.983000E+00    0.500000E-01    0.
    0.200000E+01    0.900000E+00    0.705506E-01    0.180610E+03    0.              0.408292E+03    0.207301E-01    0.114970E+04
    0.230000E+01    0.900000E+00    0.380975E-02    0.740236E+01    0.              0.408292E+03    0.207301E-01    0.
    0.              0.              0.100000E+01    0.833333E+00    0.100000E+03    0.814332E+00    0.100000E+03    0.829205E+01
    0.500000E+02    0.130000E+03    0.              0.              0.              0.              0.              0.

    0.100000E+01    0.200000E+03    0.400000E+03    0.              0.              0.315694E+03    0.              0.
    0.549668E+03    0.100000E+01    0.131340E+03    0.160493E+01    0.612687E+03    0.140000E+01    0.146452E+03    0.160788E+01
    0.612687E+03    0.133000E+01    0.146451E+03    0.161140E+01    0.612687E+03    0.133000E+01    0.146451E+03    0.161140E+01
    0.612687E+03    0.133000E+01    0.146451E+03    0.161140E+01    0.612687E+03    0.133000E+01    0.146451E+03    0.161140E+01
    0.200000E+03    0.              0.200000E+03    0.              0.              0.500000E-01    0.500000E+00    0.
    0.564699E+03    0.100000E+01    0.759245E+03    0.651605E+00    0.564699E+03    0.100000E+01    0.759245E+03    0.651605E+00
```

```
 0.191708E+04  0.378435E+01  0.493381E+03  0.183800E+01  0.612687E+03  0.133000E+01  0.146451E+03  0.161140E+01
 0.829205E+01  0.408292E+03  0.207301E-01  0.            0.200000E+03  0.            0.100000E+01  0.
 0.191708E+04  0.378435E+01  0.493381E+03  0.183800E+01  0.191708E+04  0.378435E+01  0.493380E+03  0.183800E+01
 0.191708E+04  0.378435E+01  0.493380E+03  0.183800E+01  0.191708E+04  0.378435E+01  0.493380E+03  0.183800E+01
 0.408292E+03  0.            0.408292E+03  0.207301E-01  0.            0.            0.494024E+03  0.
 0.364616E+01  0.494024E+03  0.238264E+00  0.189994E+04  0.364586E+01  0.494020E+03  0.238264E+00  0.
 0.165020E+04  0.206379E+01  0.194037E+04  0.100000E+01  0.165020E+04  0.206379E+01  0.194037E+04  0.100000E+01
 0.            0.            0.747856E+03  0.464882E+04  0.191127E+04  0.242542E+05  0.            0.955753E+04
 0.289030E+05  0.955753E+04  0.829205E+01  0.608292E+03  0.138201E-01  0.384605E+05  0.384605E+05  0.776157E+00

 0.612687E+03  0.140000E+01  0.146452E+03  0.160788E+01  0.194300E+04  0.402696E+01  0.500783E+03  0.183758E+01
 0.400000E+03  0.571429E+00  0.100000E+01  0.            0.100000E+01  0.100000E+01  0.411780E+03  0.120000E+03
 0.199826E+01  0.899947E+00  0.867247E-01  0.195798E+03  0.            0.            0.100000E+03  0.833333E+00
 0.100000E+03  0.220000E+01  0.870000E+00  0.400000E+03  0.100000E+01  0.100000E+01  0.100000E+01  0.120000E+03
 0.220000E+01  0.900000E+00  0.108157E+01  0.101193E+01  0.            0.144628E+01  0.411780E+03  0.400000E+03
-0.            0.            0.549668E+03  0.400000E+03

 0.            0.100000E+00  0.            0.            0.            0.            0.            0.
 0.            0.            0.            0.            0.            0.            0.            0.
 0.            0.            0.            0.            0.            0.985000E+00  0.            0.
 0.            0.384605E+05  0.            0.            0.            0.            0.            0.
 0.120872E+00  0.879128E+00  0.100000E+01  0.100000E+01  0.000000E-38  0.000000E-38  0.384605E+05  0.
 0.924801E+02  0.            0.304110E+03  0.197642E+01  0.            0.226863E+01  0.600000E-01  0.180610E+03
```

```
    $D(1),AM=.6,ALTP=25000,IAMTP=0,T4=2260,$ RUN AT ALTITUDE AT REDUCED T4-STD DAY

OUTPUT                  AM=  0.600       ALTP= 25000.         T4= 2260.00                    ETAR= 1.0000

MIDDLE SPOOL IS DUMMY

NO AIRFLOW INTO WING  , AFT-TURBOFAN
     PCNF          CNF           ZF            PRF           WAFC          WAF
  0.965218E+02  0.105445E+01  0.719983E+00  0.138636E+01  0.226850E+03  0.113965E+03
     PCNI          CNI           ZI            PRI           WACI          WAI
  0.100000E+01  0.            0.833333E+00  0.100000E+01  0.435673E+03  0.218873E+03
     PCNC          CNC           ZC            PRC           WACC          WAC
  0.943035E+02  0.103022E+01  0.832563E+00  0.173236E+02  0.435673E+03  0.218873E+03
     T2            P2            T22           P22           T21           P21
  0.460573E+03  0.473409E+00  0.514835E+03  0.656317E+00  0.460573E+03  0.473409E+00
     T3            P3            PCBLF         BLF           PCBLC         BLC
  0.112613E+04  0.820116E+01  0.            0.            0.            0.
     PCBLHP        BLHP          PCBLIP        BLIP          PCBLLP        BLLP
  0.            0.            0.            0.            0.            0.
     WA3           WFB           WG4           FAR4          T4            P4
  0.218873E+03  0.392827E+01  0.222802E+03  0.179477E-01  0.226000E+04  0.779304E+01
     TFFHP         CNHP          DHTCHP        DHTC          T50           P50
  0.924839E+02  0.198369E+01  0.604594E-01  0.159594E+03  0.170054E+04  0.204749E+01
     TFFIP         CNIP          DHTCIP        DHTI          T5            P5
  0.            0.            0.            0.            0.170054E+04  0.204749E+01
     TFFLP         CNLP          DHTCLP        DHTF          T55           P55
  0.305344E+03  0.234063E+01  0.176003E-01  0.663962E+01  0.167661E+04  0.192098E+01
     ETAB          PCBLDU        ETAD          DPDUC         T24           P24
  0.983000E+00  0.            0.            0.557109E-01  0.514835E+03  0.619753E+00
     WAD           WFD           WG24          FAR24         T25           P25
  0.113965E+03  0.            0.113965E+03  0.            0.514835E+03  0.619753E+00
     ETAF          ETAI          ETAC          ETATHP        ETATIP        ETATLP
  0.830336E+00  0.100000E+01  0.855328E+00  0.899537E+00  0.            0.899171E+00
     T6            P6            PS6           AM6           V6            WG6
  0.167661E+04  0.192098E+01  0.185293E+01  0.238418E+00  0.464430E+03  0.222802E+03
     T7            WFA           WG7           FAR7          ETAA          DPAFT
  0.167661E+04  0.            0.222802E+03  0.179477E-01  0.            0.
     PS8           AM8           V8            PS9           AM9           V9
  0.104502E+01  0.100000E+01  0.181849E+04  0.104502E+01  0.100000E+01  0.181849E+04
     PS28          AM28          V28           PS29          AM29          V29
  0.371092E+00  0.887317E+00  0.917579E+03  0.371092E+00  0.887317E+00  0.917579E+03
     BPRINT        DPCOM         DPWING        PS38          AM38          V38
  0.            0.497637E-01  0.            0.            0.            0.
     BYPASS        HPEXT         WFT           WGT           VA            FRD
  0.520689E+00  0.            0.392827E+01  0.336767E+03  0.609938E+03  0.216048E+04
     PCBLI         WG37          VJW           PS39          AM39          V39
 -0.            0.            0.            0.            0.            0.
     CVDWNG        FGMWNG        FGPWNG        FNWING        FNMAIN        P28
  0.985000E+00  0.            0.            0.            0.194998E+05  0.619753E+00
     FFOVFN        FWOVFN        FCOVFN        FMNOFN        FNOVFD        P38
  0.533830E-01  0.            0.946617E+00  0.100000E+01  0.507007E+00  0.
     CVMNOZ        VJM           CVDNOZ        VJD           FGM           FGP
  0.985000E+00  0.179122E+04  0.985000E+00  0.903816E+03  0.156054E+05  0.605485E+04

MAIN SCNIC CONVERGENT NOZZLE          FG= 21660.25                FN= 19499.77                SFC= 0.72523
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER  10 LOOPS
```

```
$D(1),IDES=1,* NOW RUN 3 SPOOL- 2 STREAM AFTFAN, FIGURE 9
$D(1),IDES=1,IAMTP=2,T2=31,AM=0,ALTP=0,DUMMYSPOOL=.F.,PCNIDS=100,
PRIDS=2.2,PRCDS=16/2.2,

FAN DESIGN              PRFCF= 0.10000000E+01 ETAFCF= 0.10000000E+01  WAFCF= 0.34315033E+00   T2DS= 0.54966819E+03

MIDDLE SPOOL DESIGN     PRICF= 0.20000000E+01 ETAICF= 0.98863635E+00  WAICF= 0.13726013E+01   T22DS= 0.54966819E+03

COMPRESSOR DESIGN       PRCCF= 0.89610390E+00 ETACCF= 0.10000000E+01  WACCF= 0.21260785E+01   T21DS= 0.70920736E+03

COMBUSTOR DESIGN       WA3CDS= 0.61595295E+02 ETABCF= 0.98300000E+00 DTCOCF= 0.10000000E+01

H.P. TURBINE DESIGN    CNHPCF= 0.10119289E+01 TFHPCF= 0.54078318E+00 ETHPCF= 0.10000000E+01 DHHPCF= 0.95690290E+00

I.P. TURBINE DESIGN    CNIPCF= 0.99847737E+00 TFIPCF= 0.50767828E+00 ETIPCF= 0.10000000E+01 DHIPCF= 0.82936738E+00

L.P. TURBINE DESIGN    CNLPCF= 0.10101420E+01 TFLPCF= 0.41838630E+00 ETLPCF= 0.10201339E+01 DHLPCF= 0.22349441E+00

DUCT NOZZLE DESIGN        A28= 0.37509597E+01   AM28= 0.65160510E+00     A29= 0.37509597E+01   AM29= 0.65160510E+00

TURBINE AREA DESIGN       A55= 0.11104701E+02   AM55= 0.23826402E+00

NOZZLE DESIGN              A8= 0.43385243E+01    AM8= 0.10000000E+01      A9= 0.43385243E+01    AM9= 0.10000000E+01

OUTPUT                 AM=  0.          ALTP=      0.          T4= 2560.00                          ETAR= 1.0000

THREE SPOOL ENGINE

NO AIRFLOW INTO WING  , AFT-TURBOFAN
```

| | | | | | |
|---|---|---|---|---|---|
| PCNF | CNF | ZF | PRF | WAFC | WAF |
| 0.100000E+03 | 0.100000E+01 | 0.833333E+00 | 0.140000E+01 | 0.205890E+03 | 0.200000E+03 |
| PCNI | CNI | ZI | PRI | WACI | WAI |
| 0.100000E+03 | 0.100000E+01 | 0.833333E+00 | 0.220000E+01 | 0.411780E+03 | 0.400000E+03 |
| PCNC | CNC | ZC | PRC | WACC | WAC |
| 0.100000E+03 | 0.100000E+01 | 0.814332E+00 | 0.727273E+01 | 0.212608E+03 | 0.400000E+03 |
| T2 | P2 | T22 | P22 | T21 | P21 |
| 0.549668E+03 | 0.100000E+01 | 0.612687E+03 | 0.140000E+01 | 0.709207E+03 | 0.220000E+01 |
| T3 | P3 | PCBLF | BLF | PCBLC | BLC |
| 0.131103E+04 | 0.160000E+02 | 0. | 0. | 0. | 0. |
| PCBLHP | BLHP | PCBLIP | BLIP | PCBLLP | BLLP |
| 0. | 0. | 0. | 0. | 0. | 0. |
| WA3 | WFB | WG4 | FAR4 | T4 | P4 |
| 0.400000E+03 | 0.819668E+01 | 0.408197E+03 | 0.204917E-01 | 0.256000E+04 | 0.152000E+02 |
| TFFHP | CNHP | DHTCHP | DHTC | T50 | P50 |
| 0.924585E+02 | 0.197642E+01 | 0.600000E-01 | 0.146980E+03 | 0.205983E+04 | 0.533327E+01 |
| TFFIP | CNIP | DHTCIP | DHTI | T5 | P5 |
| 0.236370E+03 | 0.220335E+01 | 0.220000E-01 | 0.375838E+02 | 0.192890E+04 | 0.392608E+01 |
| TFFLP | CNLP | DHTCLP | DHTF | T55 | P55 |
| 0.310718E+03 | 0.227691E+01 | 0.171750E-01 | 0.740409E+01 | 0.190292E+04 | 0.368780E+01 |
| ETAB | PCBLDU | ETAD | DPDUC | T24 | P24 |
| 0.983000E+00 | 0. | 0. | 0.500000E-01 | 0.612687E+03 | 0.133000E+01 |
| WAD | WFD | WG24 | FAR24 | T25 | P25 |
| 0.200000E+03 | 0. | 0.200000E+03 | 0. | 0.612687E+03 | 0.133000E+01 |
| ETAF | ETAI | ETAC | ETATHP | ETATIP | ETATLP |
| 0.880000E+00 | 0.870000E+00 | 0.860000E+00 | 0.900000E+00 | 0.900000E+00 | 0.900000E+00 |
| T6 | P6 | PS6 | AM6 | V6 | WG6 |
| 0.190292E+04 | 0.368780E+01 | 0.355306E+01 | 0.238264E+00 | 0.492323E+03 | 0.408197E+03 |
| T7 | WFA | WG7 | FAR7 | ETAA | DPAFT |
| 0.190292E+04 | 0. | 0.408197E+03 | 0.204917E-01 | 0. | 0. |
| PS8 | AM8 | V8 | PS9 | AM9 | V9 |
| 0.201067E+01 | 0.100000E+01 | 0.193344E+04 | 0.201067E+01 | 0.100000E+01 | 0.193344E+04 |
| PS28 | AM28 | V28 | PS29 | AM29 | V29 |
| 0.100000E+01 | 0.651605E+00 | 0.759245E+03 | 0.100000E+01 | 0.651605E+00 | 0.759245E+03 |
| BPRINT | DPCOM | DPWING | PS38 | AM38 | V38 |
| 0. | 0.500000E-01 | 0. | 0. | 0. | 0. |
| BYPASS | HPEXT | WFT | WGT | VA | FRD |
| 0.500000E+00 | 0. | 0.819668E+01 | 0.608197E+03 | 0. | 0. |
| PCBLI | WG37 | VJW | PS39 | AM39 | V39 |
| 0.149012E-07 | 0. | 0. | 0. | 0. | 0. |
| CVDWNG | FGMWNG | FGPWNG | FNWING | FNMAIN | P28 |
| 0.985000E+00 | 0. | 0. | 0. | 0.380899E+05 | 0.133000E+01 |
| FFOVFN | FWOVFN | FCOVFN | FMNOFN | FNOVFD | P38 |
| 0.122049E+00 | 0. | 0.877952E+00 | 0.100000E+01 | 0.100000E+01 | 0. |
| CVMNOZ | VJM | CVDNOZ | VJD | FGM | FGP |
| 0.985000E+00 | 0.190444E+04 | 0.985000E+00 | 0.747856E+03 | 0.288107E+05 | 0.927924E+04 |

```
MAIN SONIC CONVERGENT NOZZLE          FG= 38089.93                FN= 38089.93                SFC= 0.7746
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER   1 LOOPS
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```
COMMON          0.833333E+00  0.100000E+03  0.833333E+00  0.100000E+03  0.814332E+00  0.100000E+03  0.2560C0E+04  0

   0.1C0000E+03 0.100000E+03  0.256000E+04  0.100000E+03  0.           0.100000E+01  0.100000E+01  0.1000C0E+01
   0.833333E+00 0.100000E+03  0.140000E+01  0.880000E+00  0.200000E+03 0.100000E+01  0.100000E+01  0.343150E+00
   0.814332E+00 0.100000E+03  0.727273E+01  0.860000E+00  0.400000E+03 0.896104E+00  0.1C0000E+01  0.2126C8E+01
   0.256000E+04 0.           0.124897E+04  0.983000E+00  0.615953E+02 0.500000E-01  0.100000E+01  0.983C00E+00
   0.500000E+02 0.200000E+01  0.900000E+00  0.540783E+00  0.101193E+01 0.100000E+01  0.956903E+00  0.549668E+03
   0.130000E+03 0.230000E+01  0.900000E+00  0.418386E+00  0.101014E+01 0.102013E+01  0.223494E+00  0.709207E+03
   0.           0.           0.           0.           0.353607E+04  0.500000E-01  0.           0.
   0.           0.           0.           0.           0.482851E+04  0.           0.           C.
   0.111047E+02 0.           0.111047E+02  0.111047E+02  0.433852E+01  0.433852E+01  0.375096E+01  0.375096E+01
   0.355306E+01 0.238264E+00  0.985000E+00  0.985000E+00  0.           0.           0.           0.

   0.549670E+03 0.100000E+01  0.131340E+03  0.160493E+01  0.549668E+03 0.100000E+01  0.131340E+03  0.160493E+01
   0.709207E+03 0.220000E+01  0.169694E+03  0.161211E+01  0.131103E+04 0.160000E+02  0.319686E+03  0.162865E+01
   0.256000E+04 0.152000E+02  0.681183E+03  0.182692E+01  0.192890E+04 0.392608E+01  0.496619E+03  0.183713E+01
   0.190292E+04 0.368780E+01  0.489215E+03  0.183756E+01  0.           0.           0.           0.
   0.100000E+01 0.140000E+01  0.880000E+00  0.205890E+03  0.200000E+03 0.400000E+03  0.408197E+03  0.204917E-01
   0.100000E+01 0.727273E+01  0.860000E+00  0.212608E+03  0.400000E+03 0.983000E+00  0.500000E-01  0.
   0.200000E+01 0.900000E+00  0.574142E-01  0.146980E+03  0.           0.408197E+03  0.204917E-01  0.114970E+04
   0.230000E+01 0.900000E+00  0.383851E-02  0.740409E+01  0.           0.408197E+03  0.204917E-01  0.
   0.           0.           0.100000E+01  0.833333E+00  0.100000E+03  0.814332E+00  0.100000E+03  0.819668E+01
   0.5C0000E+02 0.130000E+03  0.           0.           0.           0.           0.           0.

   0.1C0000E+01 0.200000E+03  0.400000E+03  0.           0.           0.319686E+03  0.           0.
   0.709207E+03 0.220000E+01  0.169694E+03  0.161211E+01  0.612687E+03 0.140000E+01  0.146452E+03  0.160788E+01
   0.612687E+03 0.133000E+01  0.146451E+03  0.161140E+01  0.612687E+03 0.133000E+01  0.146451E+03  0.161140E+01
   0.612687E+03 0.133000E+01  0.146451E+03  0.161140E+01  0.612687E+03 0.133000E+01  0.146451E+03  0.161140E+01
   0.200000E+03 0.           0.200000E+03  0.           0.           0.500000E-01  0.50C000E+00  0.
   0.564699E+03 0.100000E+01  0.759245E+03  0.651605E+00  0.564699E+03 0.100000E+01  0.759245E+03  0.651605E+00

   0.190292E+04 0.368780E+01  0.489215E+03  0.183756E+01  0.612687E+03 0.133000E+01  0.146451E+03  0.161140E+01
   0.819668E+01 0.408197E+03  0.204917E-01  0.           0.200000E+03 0.           0.100000E+01  0.
   0.190292E+04 0.368780E+01  0.489215E+03  0.183756E+01  0.190292E+04 0.368780E+01  0.489214E+03  0.183756E+01
   0.190292E+04 0.368780E+01  0.489214E+03  0.183756E+01  0.190292E+04 0.368780E+01  0.489214E+03  0.183756E+01
   0.408197E+03 0.           0.408197E+03  0.204917E-01  0.           0.           0.492323E+03  0.
   0.355306E+01 0.492323E+03  0.238264E+00  0.188588E+04  0.355277E+01 0.492318E+03  0.238264E+00  0.
   0.163748E+04 0.201067E+01  0.193344E+04  0.100000E+01  0.163748E+04 0.201067E+01  0.193344E+04  0.100000E+01
   0.           0.           0.747856E+03  0.464882E+04  0.190444E+04 0.241619E+05  0.           0.927924E+04
   0.288107E+05 0.927924E+04  0.819668E+01  0.608197E+03  0.136611E-01 0.380899E+05  0.380899E+05  0.774694E+00

   0.612687E+03 0.140000E+01  0.146452E+03  0.160788E+01  0.205983E+04 0.533327E+01  0.534203E+03  0.183496E+01
   0.4C0000E+03 0.833333E+00  0.100000E+03  0.100000E+01  0.220000E+01 0.870000E+00  0.411780E+03  0.1200C0E+03
   0.220000E+01 0.900000E+00  0.182461E-01  0.375838E+02  0.           0.           0.100000E+03  0.833333E+00
   0.100000E+03 0.220000E+01  0.870000E+00  0.400000E+03  0.200000E+01 0.988636E+00  0.137260E+01  0.120000E+03
   0.220000E+01 0.900000E+00  0.507678E+00  0.998477E+00  0.           0.829367E+00  0.411780E+03  0.4000C0E+03
   0.149012E-07 0.           0.549668E+03  0.400000E+03

   0.381470E-05 0.100000E+00  0.           0.           0.           0.           0.           0.
   0.           0.           0.           0.           0.           0.           0.           0.
   0.           0.           0.           0.           0.           0.985000E+00  0.           0.
   0.           0.380899E+05  0.           0.           0.           0.           0.           C.
   0.122048E+00 0.877952E+00  0.100000E+01  0.100000E+01  0.000000E-38 0.           0.380899E+05  0.
   0.924585E+02 0.236370E+03  0.310718E+03  0.197642E+01  0.220335E+01 0.227691E+01  0.600000E-01  0.146980E+03
```

```
    $D(1),AM=.6,ALTP=25000,IAMTP=0,T4=2260,# RUN AT ALTITUDE AT REDUCED T4-STD DAY

OUTPUT                  AM=  0.600        ALTP= 25000.          T4= 2260.00                        ETAR= 1.0000

THREE SPOOL ENGINE

NO AIRFLOW INTO WING  , AFT-TURBOFAN
                    PCNF          CNF           ZF            PRF           WAFC          WAF
                  0.962024E+02  0.105096E+01  0.714546E+00  0.138085E+01  0.225986E+03  0.113531E+03
                    PCNI          CNI           ZI            PRI           WACI          WAI
                  0.937649E+02  0.102433E+01  0.822534E+00  0.224690E+01  0.428468E+03  0.215254E+03
                    PCNC          CNC           ZC            PRC           WACC          WAC
                  0.933548E+02  0.101339E+01  0.830442E+00  0.757939E+01  0.217951E+03  0.215216E+03
                    T2            P2            T22           P22           T21           P21
                  0.460573E+03  0.473409E+00  0.514057E+03  0.653708E+00  0.601857E+03  0.106370E+01
                    T3            P3            PCBLF         BLF           PCBLC         BLC
                  0.113915E+04  0.806220E+01  0.            0.            0.            0.
                    PCBLHP        BLHP          PCBLIP        BLIP          PCBLLP        BLLP
                  0.            0.            0.            0.            0.            0.
                    WA3           WFR           WG4           FAR4          T4            P4
                  0.215216E+03  0.382096E+01  0.219037E+03  0.177540E-01  0.226000E+04  0.766098E+01
                    TFFHP         CNHP          DHTCHP        DHTC          T50           P50
                  0.924888E+02  0.196373E+01  0.599702E-01  0.129616E+03  0.180768E+04  0.267912E+01
                    TFFIP         CNIP          DHTCIP        DHTI          T5            P5
                  0.236531E+03  0.220536E+01  0.221711E-01  0.332470E+02  0.168858E+04  0.196577E+01
                    TFFLP         CNLP          DHTCLP        DHTF          T55           P55
                  0.311565E+03  0.234113E+01  0.175597E-01  0.663149E+01  0.166464E+04  0.184363E+01
                    ETAB          PCBLDU        ETAD          DPDUC         T24           P24
                  0.983000E+00  0.            0.            0.556780E-01  0.514057E+03  0.617311E+CC
                    WA0           WFD           WG24          FAR24         T25           P25
                  0.113531E+03  0.            0.113531E+03  0.            0.514057E+03  0.617311E+C0
                    ETAF          ETAI          ETAC          ETATHP        ETATIP        FTATLP
                  0.831663E+00  0.850485E+00  0.855426E+00  0.899232E+00  0.899013E+00  0.899308E+00
                    T6            P6            PS6           AMS           V6            WG6
```

```
                    0.166464E+04    0.184363E+01    0.177848E+01    0.238056E+00    0.462190E+03    0.219037E+03
                      T7              WFA             WG7             FAR7            ETAA            DPAFT
                    0.166464E+04    0.              0.219037E+03    0.177540E-01    0.              0.
                      PS8             AM8             V8              PS9             AM9             V9
                    0.100131E+01    0.100000E+01    0.181220E+04    0.100131E+01    0.100000E+01    0.181220E+04
                      PS28            AM28            V28             PS29            AM29            V29
                    0.371092E+00    0.883755E+00    0.913709E+03    0.371092E+00    0.883755E+00    0.913709E+03
                      BPRINT          DPCOM           DPWING          PS38            AM38            V38
                    0.              0.497663E-01    0.              0.              0.              0.
                      BYPASS          HPEXT           WFT             WGT             VA              FRD
                    0.527427E+00    0.              0.382096E+01    0.332605E+03    0.609938E+03    0.215225E+04
                      PCBLI           WG37            VJW             PS39            AM39            V39
                    0.172958E-03    0.              0.              0.              0.              0.
                      CVDWNG          FGMWNG          FGPWNG          FNWING          FNMAIN          P28
                    0.985000E+00    0.              0.              0.              0.189626E+05    0.617311E+00
                      FFOVFN          FWOVFN          FCOVFN          FMVOFN          FNOVFD          P38
                    0.539786E-01    0.              0.946059E+00    0.100004E+01    0.497819E+00    0.
                      CVMNOZ          VJM             CVDNOZ          VJO             FGM             FGP
                    0.985000E+00    0.178502E+04    0.985000E+00    0.900003E+03    0.153280E+05    0.578615E+04

MAIN SCNIC CONVERGENT NOZZLE          FG= 21114.14                  FN= 18961.89                  SFC= 0.72543
DUCT SUBSONIC CONVERG. NOZZLE

CONVERGED AFTER  24 LOOPS

     $END, #0 THIS CARD TERMINATES THE READING IN OF THE DATA, A $D(1) CARD WITHOUT
     # ANY DATA FOLLOWING WOULD DO THE SAME, WITHOUT ONE OF THESE THE LAST CASE
     # WOULDNT RUN

*01* UNIT05, EOF.                                                  REC=  00000 FIL=  00002
```

# CONCLUDING REMARKS

The computer code (GENENG II) presented herein has proved to be an indispensable tool for steady-state cycle analysis of various types of jet engines. Nine basic engine types have been illustrated:

(1) Three-spool, three-stream turbofan

(2) Two-spool, three-stream, boost-fan turbofan

(3) Two-spool, three-stream, supercharged-compressor turbofan

(4) Three-spool, two-stream turbofan

(5) Two-spool, two-stream turbofan

(6) Three-spool, three-stream aft-fan turbofan

(7) Two-spool, three-stream, aft-fan turbofan

(8) Two-spool, two-stream, aft-fan turbofan

(9) Three-spool, two-stream aft-fan turbofan

Some of these engines are candidates for STOL aircraft propulsion.

This program is valuable for many applications because it has the capability of studying a broad range of engine types with different design characteristics, while it also has low-execution-time characteristics. By appropriately choosing among the options built into the program, other engine types can be simulated.

The program has proven itself to be easy to use especially in terms of input requirements. It is felt that with a minimum of effort, the reader can become proficient in using the computer code. The code is available to be reproduced on the requestor's tape upon application to the authors.

Lewis Research Center,
National Aeronautics and Space Administration,
Cleveland, Ohio, October 1, 1971,
132-15.

# APPENDIX A

## PROGRAM LISTING

```
$IBFTC GEN2    DECK
      COMMON/LOOPPR/KKGO,PRFNEW,PRCNEW                                    1
      DATAIII/0/                                                          2
      COMMON/TERBHI/DHHISV,TFHISV,CNHISV,ETHISV,DHHPDS                    3
      COMMON/TERBLO/DHLOSV,TFLOSV,CNLOSV,ETLOSV,DHLPDS                    4
      COMMON/TERBMD/DHMDSV,TFMDSV,CNMDSV,ETMDSV,DHMDDS                    5
      DIMENSION XLO(5),XMD(5),XHI(5)                                      6
      EQUIVALENCE (XLO,DHLOSV),(XMD,DHMDSV),(XHI,DHHISV)                  7
      COMMON/ALL/X(28)/DESIGN/Y(80)/FRONT/Z(80)/SIDE/W(48)/BACK/V(72)     8
      COMMON/DUMMYS/DUMMY(100)                                            9
      COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI  10
     1,ETAI,WACI,TFFIP,CNIP,ETATIP,DHTCIP,DHTI,BLIP,PCBLIP,PCNIGU,ZIDS,   11
     2PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS,  12
     3TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI ,T22DS,WA21        13
      EQUIVALENCE (ERR,DUMMY(11))                                         14
      DIMENSION ERR(9)                                                    15
      LOGICAL ERRER,CLEAR                                                 16
      DATA CLEAR/.TRUE./                                                  17
      COMMON/ERER/ERRER                                                   18
      ERRER=.FALSE.                                                       19
      IF (.NOT.CLEAR) CALL ENGBAL                                         20
      CLEAR=.FALSE.                                                       21
      DO 1 J=1,452                                                        22
1     X(J)=0.                                                             23
C     SET ARBITRARY VALUES FOR INTERMEDIATE SPOOL DESIGN PARAMETERS TO    24
C     AVOID ERROR WHEN RUNNING A DUMMYSPOOL ENGINE                        25
      PRIDS=1.5                                                           26
      ETAIDS=1.0                                                          27
      PCNIDS=100.                                                         28
      ZIDS=.75                                                            29
      IF (III.EQ.0) KKGO=0                                                30
      CALL CONOUT (1)                                                     31
      DO 2 I=1,5                                                          32
      XLO(I)=100.                                                         33
      XMD(I)=100.                                                         34
2     XHI(I)=100.                                                         35
      DO 3 I=7,10                                                         36
3     DUMMY(I)=1.0                                                        37
      CALL ENGBAL                                                         38
      STOP                                                                39
      END                                                                 40
```

```
$IBFTC ENGBOL  DECK
      SUBROUTINE ENGBAL                                                   1
      COMMON /   ALL/                                                     2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,           3
     2IGASMK,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,           4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                    5
      COMMON /DESIGN/                                                     6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,           7
```

```
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,                  8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,                  9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,                 10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,                 11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,                 12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,                 13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,                 14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,                 15
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV                  16
      COMMON / FRONT/                                                          17
     1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,                18
     2T21   ,P21   ,H21   ,S21   ,T3    ,P3    ,H3    ,S3    ,                19
     3T4    ,P4    ,H4    ,S4    ,T5    ,P5    ,H5    ,S5    ,                20
     4T55   ,P55   ,H55   ,S55   ,BLF   ,BLC   ,BLDU  ,BLOB  ,                21
     5CNF   ,PRF   ,ETAF  ,WAFC  ,WAF   ,WA3   ,WG4   ,FAR4  ,                22
     6CNC   ,PRC   ,ETAC  ,WACC  ,WAC   ,ETAB  ,DPCOM ,DUMF  ,                23
     7CNHP  ,ETATHP,DHTCHP,DHTC  ,BLHP  ,WG5   ,FAR5  ,CS    ,                24
     8CNLP  ,ETATLP,DHTCLP,DHTF  ,BLLP  ,WG55  ,FAR55 ,HPEXT ,                25
     9AM    ,ALTP  ,ETAR  ,ZF    ,PCNF  ,ZC    ,PCNC  ,WFB   ,                26
     $TFFHP ,TFFLP ,PCBLF ,PCBLC ,PCBLDU,PCBLOB,PCBLHP,PCBLLP                  27
      COMMON /  SIDE/                                                          28
     1XP1   ,XWAF  ,XWAC  ,XBLF  ,XBLDU ,XH3   ,DUMS1 ,DUMS2 ,                29
     2XT21  ,XP21  ,XH21  ,XS21  ,T23   ,P23   ,H23   ,S23   ,                30
     3T24   ,P24   ,H24   ,S24   ,T25   ,P25   ,H25   ,S25   ,                31
     4T28   ,P28   ,H28   ,S28   ,T29   ,P29   ,H29   ,S29   ,                32
     5WAD   ,WFD   ,WG24  ,FAR24 ,ETAD  ,DPDUC ,BYPASS,DUMS3 ,                33
     6TS28  ,PS28  ,V28   ,AM28  ,TS29  ,PS29  ,V29   ,AM29                   34
      COMMON /  BACK/                                                          35
     1XT55  ,XP55  ,XH55  ,XS55  ,XT25  ,XP25  ,XH25  ,XS25  ,                36
     2XWFB  ,XWG55 ,XFAR55,XWFD  ,XWG24 ,XFAR24,XXP1  ,DUMB  ,                37
     3T6    ,P6    ,H6    ,S6    ,T7    ,P7    ,H7    ,S7    ,                38
     4T8    ,P8    ,H8    ,S8    ,T9    ,P9    ,H9    ,S9    ,                39
     5WG6   ,WFA   ,WG7   ,FAR7  ,ETAA  ,DPAFT ,V55   ,V25   ,                40
     6PS6   ,V6    ,AM6   ,TS7   ,PS7   ,V7    ,AM7   ,AM25  ,                41
     7TS8   ,PS8   ,V8    ,AM8   ,TS9   ,PS9   ,V9    ,AM9   ,                42
     8VA    ,FRD   ,VJD   ,FGMD  ,VJM   ,FGMM  ,FGPD  ,FGPM  ,                43
     9FGM   ,FGP   ,WFT   ,WGT   ,FART  ,FG    ,FN    ,SFC                    44
      COMMON/DUMMYS/DUMMY(100)                                                 45
      COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI       46
     1,ETAI,WACI,TFFIP,CNIP,ETATIP,DHTCIP,DHTI,BLIP,PCBLIP,PCNIGU,ZIDS,       47
     2PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS,      48
     3TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI ,T22DS,WA21            49
      DIMENSION ERR(9)                                                         50
      EQUIVALENCE (ERR,DUMMY(11)),(DUMSPL,DUMMY(59))                           51
      EQUIVALENCE (FXFN2M,DUMMY(50)),(FXM2CP,DUMMY(51))                        52
      LOGICAL ERRER,FXFN2M,FXM2CP,DUMSPL                                       53
      DIMENSION DELSAV(9)                                                      54
      COMMON/ERER/ERRER                                                        55
      DIMENSIONVAR(9),DEL(9),ERRB(9),DELVAR(9),EMAT(9,9),VMAT(9),AMAT(9)       56
      DATA AWORD/6HENGBAL/                                                     57
      DATA VDELTA,VLIM,VCHNGE,NOMISX/                                          58
     1 0.001,0.100,0.850,4/                                                    59
      DATA DEL/9*0./                                                           60
      DATA DELSAV/9*.001/                                                      61
      CALL PUTIN                                                               62
      IF (INIT.EQ.1) GO TO 1                                                   63
      TFFHP=TFHPDS                                                             64
      TFFIP=TFIPDS                                                             65
      IF (FXM2CP) TFFIP=TFHPDS                                                 66
      TFFLP=TFLPDS                                                             67
1     LOOPER=0                                                                 68
      NUMMAP=0                                                                 69
      NOMISS=0                                                                 70
```

```
2       LOOP=0                                                          71
        MISMAT=0                                                        72
        NOMAP=0                                                         73
        IGO=2                                                           74
        DO 3 I=1,9                                                      75
        VMAT(I)=0.                                                      76
        AMAT(I)=0.                                                      77
        DELVAR(I)=0.                                                    78
        DO 3 L=1,9                                                      79
3       EMAT(I,L)=0.                                                    80
4       LOOPER=LOOPER+1                                                 81
        CALL SOFAN                                                      82
        WORD=AWORD                                                      83
        IF (LOOPER.GT.ITRYS) ERRER=.TRUE.                               84
        IF (LOOPER.GT.ITRYS) GO TO 26                                   85
        IF (NOMAP.GT.0) GO TO 2                                         86
        NUMMAP=0                                                        87
5       VAR(1)=ZF*100.                                                  88
        IF (MODE.NE.3) VAR(2)=PCNF                                      89
        IF (MODE.EQ.3) VAR(2)=T4/10.                                    90
        VAR(3)=ZC*100.                                                  91
        IF (MODE.NE.1) VAR(4)=PCNC                                      92
        IF (MODE.EQ.1) VAR(4)=T4/10.                                    93
        VAR(5)=TFFHP                                                    94
        VAR(6)=TFFLP                                                    95
        VAR(7)=ZI*100.                                                  96
        VAR(8)=PCNI                                                     97
        VAR(9)=TFFIP                                                    98
        NMAX=9                                                          99
        IF (.NOT.FXFN2M.AND.(.NOT.DUMSPL)) GO TO 6                     100
        NMAX=7                                                         101
        IF (DUMSPL) NMAX=6                                             102
6       IF (.NOT.FXM2CP) GO TO 7                                       103
        NMAX=7                                                         104
        VAR(4)=PCNI                                                    105
        VAR(5)=TFFIP                                                   106
7       CONTINUE                                                       107
        DO 8 I=1,NMAX                                                  108
8       IF (ABS(ERR(I)).GT.TOLALL) GO TO 9                             109
        CALL PERF                                                      110
        CALL ERROR                                                     111
9       IF (LOOP.GT.0) GO TO 11                                        112
        MAPEDG=0                                                       113
        MAPSET=0                                                       114
        DO 10 I=1,NMAX                                                 115
        ERRB(I)=ERR(I)                                                 116
10      DEL(I)=VDELTA*VAR(I)                                           117
        GO TO 14                                                       118
11      IF (MISMAT.GT.0) GO TO 29                                      119
        IF (MAPEDG.EQ.0) GO TO 12                                      120
        MAPEDG=0                                                       121
        MAPSET=1                                                       122
        VAR(LOOP)=VAR(LOOP)+2.*DEL(LOOP)                               123
        GO TO 15                                                       124
12      IF (MAPSET.EQ.0) VAR(LOOP)=VAR(LOOP)+DEL(LOOP)                 125
        IF (MAPSET.EQ.1) VAR(LOOP)=VAR(LOOP)-DEL(LOOP)                 126
        MAPSET=0                                                       127
        DO 13 I=1,NMAX                                                 128
        IF (DEL(LOOP).NE.0.) DELSAV(LOOP)=DEL(LOOP)                    129
        IF (DEL(LOOP).EQ.0.) DEL(LOOP)=DELSAV(LOOP)                    130
        EMAT(I,LOOP)=(ERRB(I)-ERR(I))/DEL(LOOP)                        131
13      CONTINUE                                                       132
```

```
14    LOOP=LOOP+1                                                          133
      IF (LOOP.GT.NMAX) GO TO 17                                           134
      IF (LOOP.GT.9) GO TO 17                                              135
      VAR(LOOP)=VAR(LOOP)-DEL(LOOP)                                        136
15    ZF=VAR(1)/100.                                                       137
      IF (MODE.NE.3) PCNF=VAR(2)                                           138
      IF (MODE.EQ.3) T4=VAR(2)*10.                                         139
      ZC=VAR(3)/100.                                                       140
      IF (MODE.NE.1) PCNC=VAR(4)                                           141
      IF (MODE.EQ.1) T4=VAR(4)*10.                                         142
      TFFHP=VAR(5)                                                         143
      TFFLP=VAR(6)                                                         144
      ZI=VAR(7)/100.                                                       145
      PCNI=VAR(8)                                                          146
      TFFIP=VAR(9)                                                         147
      IF (.NOT.FXM2CP) GO TO 16                                            148
      PCNI=VAR(4)                                                          149
      TFFIP=VAR(5)                                                         150
16    CONTINUE                                                             151
      IF (ZI.LT.0.) ZI=0.05                                                152
      IF (ZF.LT.0.) ZF=0.05                                                153
      IF (ZC.LT.0.) ZC=0.05                                                154
      GO TO (2,4),IGO                                                      155
17    DO 18 I=1,NMAX                                                       156
18    AMAT(I)=-ERRB(I)                                                     157
      DO 20 I=1,NMAX                                                       158
      IZERO=0                                                              159
      DO 19 LOOP=1,NMAX                                                    160
19    IF (EMAT(I,LOOP).EQ.0.) IZERO=IZERO+1                                161
      IF (IZERO.LT.NMAX) GO TO 20                                          162
      WRITE (6,32) I                                                       163
      LOOPER=ITRYS+100                                                     164
      GO TO 26                                                             165
20    CONTINUE                                                             166
      DO 22 LOOP=1,NMAX                                                    167
      IZERO=0                                                              168
      DO 21 I=1,NMAX                                                       169
21    IF (EMAT(I,LOOP).EQ.0.) IZERO=IZERO+1                                170
      IF (IZERO.LT.NMAX) GO TO 22                                          171
      WRITE (6,33) LOOP                                                    172
      LOOPER=ITRYS+100                                                     173
      GO TO 26                                                             174
22    CONTINUE                                                             175
23    CALL MATRIX (EMAT,VMAT,AMAT,NMAX)                                    176
      LBIG=0                                                               177
      VARBIG=0.                                                            178
      DO 24 L=1,NMAX                                                       179
      ABSVAR=ABS(VMAT(L))                                                  180
      IF (ABSVAR.LE.VLIM*VAR(L)) GO TO 24                                  181
      IF (ABSVAR.LE.VARBIG) GO TO 24                                       182
      LBIG=L                                                               183
      VARBIG=ABSVAR                                                        184
24    CONTINUE                                                             185
      VRATIO=1.0                                                           186
      IF (LBIG.GT.0) VRATIO=VLIM*VAR(LBIG)/VARBIG                          187
      ERRAVE=0.0                                                           188
      VMTAVE=0.0                                                           189
      DELAVE=0.0                                                           190
      DO 25 L=1,NMAX                                                       191
      DELVAR(L)=VRATIO*VMAT(L)                                             192
      ERRAVE=ERRAVE+ABS(AMAT(L))/FLOAT(NMAX)                               193
      VAR(L)=VAR(L)+DELVAR(L)                                              194
      VMTAVE=VMTAVE+ABS(VMAT(L))/FLOAT(NMAX)                               195
```

```
25    DELAVE=DELAVE+ABS(DELVAR(L))/FLOAT(NMAX)                                  195
      IF (MISMAT.GT.0) GO TO 31                                                 197
      IF (NOMISS.EQ.0) MISMAT=1                                                 198
      IF (MISMAT.EQ.0) IGO=1                                                    199
26    WRITE (8,34) LOOPER                                                       200
      DO 27 I=1,NMAX                                                            201
27    WRITE (8,35) AMAT(I),(EMAT(I,L),L=1,9),VMAT(I),DELVAR(I),VAR(I)           202
      WRITE (8,36) ERRAVE,VMTAVE,DELAVE                                         203
28    IF (LOOPER.LT.ITRYS) GO TO 15                                             204
      CALL ERROR                                                                205
      RETURN                                                                    206
29    VMTAVX=VMTAVE                                                             207
      DO 30 I=1,NMAX                                                            208
30    AMAT(I)=-ERR(I)                                                           209
      GO TO 23                                                                  210
31    WRITE (8,37) AMAT,ERRAVE,DELVAR,DELAVE,VMAT,VMTAVE,VAR                    211
      MISMAT=MISMAT+1                                                           212
      IF (VMTAVE.LT.VCHNGE*VMTAVX) GO TO 28                                     213
      WRITE (8,38)                                                              214
      IF (MISMAT.LT.NOMISX) NOMISS=1                                            215
      MISMAT=0                                                                  216
      LOOP=0                                                                    217
      IGO=2                                                                     218
      GO TO 5                                                                   219
C                                                                               220
C                                                                               221
32    FORMAT (4HOROW,I2,16H IS ZERO IN EMAT)                                    222
33    FORMAT (7HOCOLUMN,I2,16H IS ZERO IN EMAT)                                 223
34    FORMAT (8HB   ERRB,28X23HERROR MATRIX AFTER LOOP,I4,29X4HVMAT,6X6H        224
     1DELVAR,7X14HVARIABLE$$$$$$)                                               225
35    FORMAT (1HO,F8.4,10F9.3,2F11.4,6H$$$$$$)                                  226
36    FORMAT (1HO,F8.4,32X14HAVERAGE VALUES,31X,2F11.4,6H$$$$$$)                227
37    FORMAT (12HO-----  AMAT,10F11.6,6H$$$$$$,/,12H -----DELVAR,10F11.6       228
     1,6H$$$$$$,/,12H -----  VMAT,10F11.6,6H$$$$$$,/,12H -----   VAR,9F1       229
     21.6,6H$$$$$$)                                                             230
38    FORMAT (1HO,50X22HCHANGE TOO SMALL$$$$$$)                                 231
      END                                                                       232
```

```
$IBFTC GUESSS  DECK
      FUNCTION GUESS(M,T,TD,P,PD,W,WD,D,DD,VD)                                    1
      IF (M.EQ.0) GUESS=VD*((T/TD)**1.60)*((DD/D)**0.50)                          2
      IF (M.EQ.1) GUESS=VD*((P/PD)**1.80)*((DD/D)**0.33)                          3
      IF (M.EQ.2) GUESS=VD*((W/WD)**0.33)*((DD/D)**1.00)                          4
      IF (M.EQ.3) GUESS=VD*((W/WD)**0.00)*((P/PD)**0.50)                          5
      IF (M.EQ.4) GUESS=VD*((W/WD)**0.00)*((P/PD)**0.50)                          6
      IF (M.EQ.5) GUESS=VD*((T/TD)**1.1)*((DD/D)**.7)                             7
      IF (M.EQ.6) GUESS=VD*((P/PD)**1.00)*((D/DD)**0.25)                          8
      IF (M.EQ.7) GUESS=VD*((P/PD)**0.62)*((D/DD)**0.31)                          9
      IF (M.EQ.8) GUESS=VD*((T/TD)**1.2)*DD/D                                    10
      IF (M.EQ.9) GUESS=VD*P/PD*((D/DD)**1.5)                                    11
      RETURN                                                                     12
      END                                                                        13
```

```
$IBFTC MATRIX  DECK
      SUBROUTINE MATRIX (E,V,A,N)                                        1
      DIMENSION E(9,9),V(9),A(9),PIV(10),T(9,10)                         2
      NN=N+1                                                             3
      NM=N-1                                                             4
      DO 1 I=1,N                                                         5
      T(I,NN)=A(I)                                                       6
      DO 1 J=1,N                                                         7
1     T(I,J)=E(I,J)                                                      8
      DO 7 I=1,N                                                         9
      TEMP=0.                                                           10
      DO 2 J=I,N                                                        11
      IF (TEMP.GT.ABS(T(J,I))) GO TO 2                                  12
      TEMP=ABS(T(J,I))                                                  13
      IPIV=J                                                            14
2     CONTINUE                                                          15
      IP1=I+1                                                           16
      DO 3 J=IP1,NN                                                     17
3     PIV(J)=T(IPIV,J)/T(IPIV,I)                                        18
      IFROM=N                                                           19
      ITO=N                                                             20
4     IF (IFROM.EQ.IPIV) GO TO 6                                        21
      RM=-T(IFROM,I)                                                    22
      DO 5 J=IP1,NN                                                     23
5     T(ITO,J)=T(IFROM,J)+RM*PIV(J)                                     24
      ITO=ITO-1                                                         25
6     IFROM=IFROM-1                                                     26
      IF (IFROM.GE.I) GO TO 4                                           27
      DO 7 J=IP1,NN                                                     28
7     T(I,J)=PIV(J)                                                     29
      DO 8 I=1,NM                                                       30
      J=NN-I                                                            31
      K=N-I                                                             32
      DO 8 L=J,N                                                        33
8     T(K,NN)=T(K,NN)-T(K,L)*T(L,NN)                                    34
      DO 9 I=1,N                                                        35
9     V(I)=T(I,NN)                                                      36
      RETURN                                                            37
      END                                                               38
```

```
$IBFTC PUTIN   DECK
      SUBROUTINE PUTIN                                                   1
      COMMON /   ALL/                                                    2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,          3
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,          4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                  5
      COMMON /DESIGN/                                                    6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,          7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,          8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,          9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,         10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,         11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,         12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,         13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,         14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,         15
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV          16
      COMMON / FRONT/                                                   17
     1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,         18
```

```
     2T21    ,P21    ,H21    ,S21    ,T3     ,P3     ,H3     ,S3     ,                19
     3T4     ,P4     ,H4     ,S4     ,T5     ,P5     ,H5     ,S5     ,                20
     4T55    ,P55    ,H55    ,S55    ,BLF    ,BLC    ,BLDU   ,BLDB   ,                21
     5CNF    ,PRF    ,ETAF   ,WAFC   ,WAF    ,WA3    ,WG4    ,FAR4   ,                22
     6CNC    ,PRC    ,ETAC   ,WACC   ,WAC    ,ETAB   ,DPCOM  ,DUMF   ,                23
     7CNHP   ,ETATHP,DHTCHP,DHTC   ,BLHP   ,WG5    ,FAR5   ,CS     ,                24
     8CNLP   ,ETATLP,DHTCLP,DHTF   ,BLLP   ,WG55   ,FAR55  ,HPEXT  ,                25
     9AM     ,ALTP   ,ETAR   ,ZF     ,PCNF   ,ZC     ,PCNC   ,WFB    ,                26
     $TFFHP  ,TFFLP  ,PCBLF  ,PCBLC  ,PCBLDU,PCBLDB,PCBLHP,PCBLLP                     27
      COMMON /  SIDE/                                                                 28
     1XP1    ,XWAF   ,XWAC   ,XBLF   ,XBLDU  ,XH3    ,DUMS1  ,DUMS2  ,                29
     2XT21   ,XP21   ,XH21   ,XS21   ,T23    ,P23    ,H23    ,S23    ,                30
     3T24    ,P24    ,H24    ,S24    ,T25    ,P25    ,H25    ,S25    ,                31
     4T28    ,P28    ,H28    ,S28    ,T29    ,P29    ,H29    ,S29    ,                32
     5WAD    ,WFD    ,WG24   ,FAR24  ,ETAD   ,DPDUC  ,BYPASS,DUMS3  ,                33
     6TS28   ,PS28   ,V28    ,AM28   ,TS29   ,PS29   ,V29    ,AM29                    34
      COMMON /  BACK/                                                                 35
     1XT55   ,XP55   ,XH55   ,XS55   ,XT25   ,XP25   ,XH25   ,XS25   ,                36
     2XWFB   ,XWG55  ,XFAR55,XWFD   ,XWG24  ,XFAR24,XXP1   ,DUMB   ,                37
     3T6     ,P6     ,H6     ,S6     ,T7     ,P7     ,H7     ,S7     ,                38
     4T8     ,P8     ,H8     ,S8     ,T9     ,P9     ,H9     ,S9     ,                39
     5WG6    ,WFA    ,WG7    ,FAR7   ,ETAA   ,DPAFT  ,V55    ,V25    ,                40
     6PS6    ,V6     ,AM6    ,TS7    ,PS7    ,V7     ,AM7    ,AM25   ,                41
     7TS8    ,PS8    ,V8     ,AM8    ,TS9    ,PS9    ,V9     ,AM9    ,                42
     8VA     ,FRD    ,VJD    ,FGMD   ,VJM    ,FGMM   ,FGPD   ,FGPM   ,                43
     9FGM    ,FGP    ,WFT    ,WGT    ,FART   ,FG     ,FN     ,SFC                     44
      COMMON/DUMMYS/DUMMY(100)                                                        45
      COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI               46
     1,ETAI,WACI,TFFIP,CNIP,ETATIP,DHTCIP,DHTI,BLIP,PCBLIP,PCNIGU,ZIDS,               47
     2PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS,              48
     3TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI ,T22DS,WA21                    49
      DIMENSION ERR(9)                                                                50
      EQUIVALENCE (ERR,DUMMY(11))                                                     51
      COMMON/LOOPPR/KKGO,PRFNEW,PRCNEW                                                52
      DIMENSION XSAVE(308),XFILL(1)                                                   53
      EQUIVALENCE (XFILL,WORD)                                                        54
      LOGICAL ERRER                                                                   55
      COMMON/ERER/ERRER                                                               56
C *** IDES  =1  FOR CALCULATING DESIGN POINT                                          57
C *** MODE  =0  FOR CONSTANT T4                                                       58
C *** MODE  =1  FOR CONSTANT PCNC                                                     59
C *** MODE  =2  FOR CONSTANT WFB                                                      60
C***  MODE=3  FOR  CONSTANT PCNF                                                      61
C *** INIT  =1  WILL NOT INITIALIZE POINT                                             62
C *** IDUMP =1  WILL DUMP LOOPING WRITE-OUTS IF ERROR OCCURS                          63
C *** IDUMP =2  WILL DUMP LOOPING WRITE-OUTS AFTER EVERY POINT                        64
C *** IAMTP =0  WILL USE INPUT AM AND MIL SPEC ETAR                                   65
C *** IAMTP =1  WILL USE INPUT AM AND INPUT ETAR                                      66
C *** IAMTP =2  WILL USE T2 AS T1=T1+T2 AND STANDARD P1                               67
C *** IAMTP =3  WILL USE P2 AND STANDARD T1                                           68
C *** IAMTP =4  WILL USE T2 AND P2                                                    69
C *** IAMTP =5 WILL USE RAM2 FOR SPECIAL RECOVERY                                     70
C *** IGASMX=-1 SEPARATE FLOW, INPUT A6                                               71
C *** IGASMX=0  SEPARATE FLOW, A6=A55                                                 72
C *** IGASMX=1  WILL MIX DUCT AND MAIN STREAMS, A6=A25+A55                            73
C *** IGASMX=2  WILL MIX DUCT AND MAIN STREAMS, INPUT A6                              74
C *** IDBURN=1  FOR DUCT BURNING, INPUT T24                                           75
C *** IDBURN=2  FOR DUCT BURNING, INPUT WFD                                           76
C *** IAFTBN=1  FOR AFTERBURNING, INPUT T7                                            77
C *** IAFTBN=2  FOR AFTERBURNING, INPUT WFA                                           78
C *** IDCD  =1  DUCT NOZZLE WILL BE C-D                                               79
C *** IMCD  =1  MAIN NOZZLE WILL BE C-D                                               80
C *** NOZFLT=1  FOR FLOATING MAIN NOZZLE                                              81
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C *** NOZFLT=2  FOR FLOATING DUCT NOZZLE                                  82
C *** NOZFLT=3  FOR FLOATING MAIN AND DUCT NOZZLES                        83
C *** ITRYS =N  NUMBER OF PASSES THRU ENGINE BEFORE QUITTING              84
      DIMENSION ITABLE (500)                                              85
      DATA (ITABLE(I),I=1,3)/0,500,0/                                     86
1     CALL ZERO                                                           87
      IF (KKGO.EQ.1) GO TO 5                                              88
      IDES=0                                                              89
      CALL INPUT (5,6,1,WORD,ITABLE)                                      90
      IF (ERRER.AND.IAFTBN.GT.0) GO TO 1                                  91
      IF (ERRER.AND.IDBURN.GT.0) GO TO 1                                  92
      ERRER=.FALSE.                                                       93
C     TABLE IS REFERENCED TO COMMON/ALL/FIRST ENTRY                       94
      IF (IDES.EQ.0) GO TO 7                                              95
      IF (KKGO.NE.2) GO TO 3                                              96
      DO 2 I=1,308                                                        97
2     XFILL(I)=XSAVE(I)                                                   98
      CALL INPUT (5,6,1,WORD,ITABLE)                                      99
3     CONTINUE                                                           100
C     SAVE INPUT IN CASE OF LOOP ON PRESSURE RATIOS                      101
      DO 4 I=1,308                                                       102
4     XSAVE(I)=XFILL(I)                                                  103
      GO TO 7                                                            104
5     DO 6 I=1,308                                                       105
6     XFILL(I)=XSAVE(I)                                                  106
      WRITE (6,8) PRFDS,PRFNEW,PRCDS,PRCNEW                              107
      PRCDS=PRCNEW                                                       108
      PRFDS=PRFNEW                                                       109
7     CONTINUE                                                           110
      KKGO=2                                                             111
      IF (IAFTBN.GT.0.OR.IDBURN.GT.0) INIT=1                             112
      IF (MODE.EQ.0) WRITE (8,9) IDES,AM,ALTP,T4,T24,T7                  113
      IF (MODE.EQ.1) WRITE (8,10) IDES,AM,ALTP,PCNC,T24,T7               114
      IF (MODE.EQ.2) WRITE (8,11) IDES,AM,ALTP,WFB,T24,T7                115
C     DUMMY ROUTINE TO RESTORE WORKING PART OF PROGRAM TO CORE           116
      CALL OVLAY                                                         117
      CALL COINLT                                                        118
      RETURN                                                             119
C                                                                        120
C                                                                        121
8     FORMAT (18HOCHANGE PRFDS FROM,F9.3,4H  TO,F9.3,16H  AND PRCDS FROM 122
     1,F10.3,4H  TO,F10.3)                                               123
9     FORMAT (1HO,7H  IDES=,I3,10X7H    AM=,F7.3,6X7H  ALTP=,F7.0,6X7H   124
     1  T4=,F8.2,5X7H   T24=,F8.2,5X7H    T7=,F8.2,6H$$$$$$)             125
10    FORMAT (1HO,7H  IDES=,I3,10X7H    AM=,F7.3,6X7H  ALTP=,F7.0,6X7H   126
     1PCNC=,F8.3,5X7H   T24=,F8.2,5X7H    T7=,F8.2,6H$$$$$$)             127
11    FORMAT (1HO,7H  IDES=,I3,10X7H    AM=,F7.3,6X7H  ALTP=,F7.0,6X7H   128
     1 WFB=,F8.4,5X7H   T24=,F8.2,5X7H    T7=,F8.2,6H$$$$$$)             129
      END                                                                130
```

```
$IBFTC ZERO    DECK
      SUBROUTINE ZERO                                                     1
      COMMON /   ALL/                                                     2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,           3
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,           4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                    5
      COMMON/DESIGN/QXQ(80)                                               6
      COMMON / FRONT/                                                     7
```

```
     1T1     ,P1     ,H1     ,S1     ,T2     ,P2     ,H2     ,S2     ,                8
     2T21    ,P21    ,H21    ,S21    ,T3     ,P3     ,H3     ,S3     ,                9
     3T4     ,P4     ,H4     ,S4     ,T5     ,P5     ,H5     ,S5     ,               10
     4T55    ,P55    ,H55    ,S55    ,BLF    ,BLC    ,BLDU   ,BLOB   ,               11
     5CNF    ,PRF    ,ETAF   ,WAFC   ,WAF    ,WA3    ,WG4    ,FAR4   ,               12
     6CNC    ,PRC    ,ETAC   ,WACC   ,WAC    ,ETAB   ,DPCOM  ,DUMF   ,               13
     7CNHP   ,ETATHP,DHTCHP,DHTC   ,BLHP   ,WG5    ,FAR5   ,CS     ,               14
     8CNLP   ,ETATLP,DHTCLP,DHTF   ,BLLP   ,WG55   ,FAR55  ,HPEXT  ,               15
     9AM     ,ALTP   ,ETAR   ,ZF     ,PCNF   ,ZC     ,PCNC   ,WFB    ,               16
     $TFFHP  ,TFFLP  ,PCBLF  ,PCBLC  ,PCBLDU,PCBLOB,PCBLHP,PCBLLP                    17
      COMMON /  SIDE/                                                               18
     1XP1    ,XWAF   ,XWAC   ,XBLF   ,XBLDU  ,XH3    ,DUMS1  ,DUMS2  ,               19
     2XT21   ,XP21   ,XH21   ,XS21   ,T23    ,P23    ,H23    ,S23    ,               20
     3T24    ,P24    ,H24    ,S24    ,T25    ,P25    ,H25    ,S25    ,               21
     4T28    ,P28    ,H28    ,S28    ,T29    ,P29    ,H29    ,S29    ,               22
     5WAD    ,WFD    ,WG24   ,FAR24  ,ETAD   ,DPDUC  ,BYPASS,DUMS3  ,               23
     6TS28   ,PS28   ,V28    ,AM28   ,TS29   ,PS29   ,V29    ,AM29                   24
      COMMON /  BACK/                                                               25
     1XT55   ,XP55   ,XH55   ,XS55   ,XT25   ,XP25   ,XH25   ,XS25   ,               26
     2XWFB   ,XWG55  ,XFAR55,XWFD   ,XWG24  ,XFAR24,XXP1   ,DUMB   ,               27
     3T6     ,P6     ,H6     ,S6     ,T7     ,P7     ,H7     ,S7     ,               28
     4T8     ,P8     ,H8     ,S8     ,T9     ,P9     ,H9     ,S9     ,               29
     5WG6    ,WFA    ,WG7    ,FAR7   ,ETAA   ,DPAFT  ,V55    ,V25    ,               30
     6PS6    ,V6     ,AM6    ,TS7    ,PS7    ,V7     ,AM7    ,AM25   ,               31
     7TS8    ,PS8    ,V8     ,AM8    ,TS9    ,PS9    ,V9     ,AM9    ,               32
     8VA     ,FRD    ,VJD    ,FGMD   ,VJM    ,FGMM   ,FGPD   ,FGPM   ,               33
     9FGM    ,FGP    ,WFT    ,WGT    ,FART   ,FG     ,FN     ,SFC                    34
      COMMON/DUMMYS/DUMMY(100)                                                      35
      COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI             36
     1,ETAI,WACI,TFFIP,CNIP,ETATIP,DHTCIP,DHTI,BLIP,PCBLIP,PCNIGU,ZIDS,             37
     2PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS,            38
     3TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI  ,T22DS,WA21                 39
      DIMENSION Z1(63),Z2(48),Z3(72)                                                40
      EQUIVALENCE (Z1,T1),(Z2,XP1),(Z3,XT55)                                        41
      IDES=0                                                                        42
      JDES=0                                                                        43
      INIT=0                                                                        44
      IDBURN=0                                                                      45
      IAFTBN=0                                                                      46
      IDSHOC=3                                                                      47
      IMSHOC=3                                                                      48
      T2Q=T2                                                                        49
      P2Q=P2                                                                        50
      T4Q=T4                                                                        51
      DO 1 I=1,63                                                                   52
1     Z1(I)=0.                                                                      53
      DO 2 I=1,48                                                                   54
2     Z2(I)=0.                                                                      55
      DO 3 I=1,72                                                                   56
3     Z3(I)=0.                                                                      57
      T2=T2Q                                                                        58
      P2=P2Q                                                                        59
      T4=T4Q                                                                        60
      CALL SYG (1)                                                                  61
      RETURN                                                                        62
      END                                                                           63
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```
$IBFTC COINLT  DECK
      SUBROUTINE COINLT                                                      1
      COMMON /   ALL/                                                        2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,              3
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,              4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                      5
      COMMON /DESIGN/                                                        6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,              7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,              8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,              9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,             10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,             11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,             12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,             13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,             14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,             15
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV              15
      COMMON / FRONT/                                                       17
     1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,             18
     2T21   ,P21   ,H21   ,S21   ,T3    ,P3    ,H3    ,S3    ,             19
     3T4    ,P4    ,H4    ,S4    ,T5    ,P5    ,H5    ,S5    ,             20
     4T55   ,P55   ,H55   ,S55   ,BLF   ,BLC   ,BLDU  ,BLOB  ,             21
     5CNF   ,PRF   ,ETAF  ,WAFC  ,WAF   ,WA3   ,WG4   ,FAR4  ,             22
     6CNC   ,PRC   ,ETAC  ,WACC  ,WAC   ,ETAB  ,DPCOM ,DUMF  ,             23
     7CNHP  ,ETATHP,DHTCHP,DHTC  ,BLHP  ,WG5   ,FAR5  ,CS    ,             24
     8CNLP  ,ETATLP,DHTCLP,DHTF  ,BLLP  ,WG55  ,FAR55 ,HPEXT ,             25
     9AM    ,ALTP  ,ETAR  ,ZF    ,PCNF  ,ZC    ,PCNC  ,WFB   ,             26
     $TFFHP ,TFFLP ,PCBLF ,PCBLC ,PCBLDU,PCBLOB,PCBLHP,PCBLLP              27
      COMMON/SIDE/ZYX(48)/BACK/YZX(72)                                      28
      COMMON/DUMMYS/DUMMY(100)                                              29
      COMMON/SPOOL2/TWOSPL(44)                                              30
      EQUIVALENCE (ERR,DUMMY(11))                                           31
      DIMENSION ERR(9)                                                      32
      DATA AWORD/6HCOINLT/                                                  33
      WORD=AWORD                                                            34
      AJ=778.26                                                             35
      G=32.174049                                                           36
      ALT=ALTP*2.0855531E+07/(2.0855531E+07-ALTP)                           37
      CALL ATMOS (ALT,T1,XX1,XX2,XX3,P1,CS,XX4,IIER)                        38
      IF (IAMTP.EQ.2) T1=T1+T2                                              39
      IF (IAMTP.EQ.5) CALL RAM2 (AM,ETAR)                                   40
      IF (IAMTP.NE.1.AND.IAMTP.NE.5) CALL RAM (AM,ETAR)                     41
      FAR=0.0                                                               42
      CALL PROCOM (FAR,T1,CS,XX2,XX3,R1,PHI1,H1)                            43
      S1=PHI1-R1*ALOG(P1)                                                   44
      H2=H1+(AM*CS)**2/(2.*AJ*G)                                            45
      P2T=1.                                                                46
      DO 1 I=1,10                                                           47
      CALL THERMO (P2T,H2,T2T,S2T,AW,0,0.0,1)                               48
      IF (ABS(S2T-S1).LE.0.0001*S1) GO TO 2                                 49
1     P2T=P1*EXP((AW/1.986375)*((S2T-S1)+(1.986375/AW)*ALOG(P2T/P1)))       50
      CALL ERROR                                                            51
      RETURN                                                                52
2     IF (IAMTP.EQ.3.OR.IAMTP.EQ.4) ETAR=P2/P2T                             53
      P2=ETAR*P2T                                                           54
      IF (IAMTP.NE.4) CALL THERMO (P2,H2,T2,S2,XX5,0,0.0,1)                 55
      IF (IAMTP.EQ.4) CALL THERMO (P2,H2,T2,S2,XX5,0,0.0,0)                 56
      IF (INIT.EQ.1) GO TO 5                                                57
      IF (IDES.EQ.1) GO TO 3                                                58
      IF (MODE.EQ.3) GO TO 4                                                59
      PCNF=GUESS(MODE,T4,T4DS,PCNC,PCNCDS,WFB,WFBDS,T2,T2DS,PCNFDS)         60
      PCNFGU=PCNF                                                           61
      GO TO 4                                                               62
```

```
3       PCNF=PCNFDS                                                     63
        PCNFGJ=PCNF                                                     64
        T2DS=T2                                                         65
4       ZF=ZFDS                                                         66
5       RETURN                                                          67
        END                                                             68



$IBFTC ATMOS   DECK
        SUBROUTINE ATMOS (ZFT,TM,SIGMA,RHO,THETA,DELTA,CA,AMU,K)         1
C    THIS IS A SUBROUTINE TO COMPUTE CERTAIN ELEMENTS OF THE 1962        2
C    U.S. STANDARD ATMOSPHERE UP TO 90 KILOMETERS.                       3
C     CALLING SEQUENCE...                                                4
C                                                                        5
C     CALL ATMOS (ZFT, TM, SIGMA, RHO, THETA, DELTA, CA, AMU, K)         6
C          ZFT   =   GEOMETRIC ALTITUDE (FEET)                           7
C          TM    =   MOLECULAR SCALE TEMPERATURE (DEGREES RANKINE)       8
C          SIGMA =   RATIO OF DENSITY TO THAT AT SEA LEVEL               9
C          RHO   =   DENSITY (LB-SEC**2-FT**(-4)   OR   SLUGS-FT**3)    10
C          THETA =   RATIO OF TEMPERATURE TO THAT AT SEA LEVEL           11
C          DELTA =   RATIO OF PRESSURE TO THAT AT SEA LEVEL              12
C          CA    =   SPEED OF SOUND (FT/SEC)                             13
C          AMU   =   VISCOSITY COEFFICIENT (LB-SEC/FT**2)                14
C                                                                        15
C          K = 1 NORMAL                                                  16
C            = 2 ALTITUDE LESS THAN -5000 METERS OR GREATER THAN 90 KM   17
C            = 3 FLOATING POINT OVERFLOW                                 18
C                                                                        19
C    ALL DATA AND FUNDAMENTAL CONSTANTS ARE IN THE METRIC SYSTEM AS      20
C    THESE QUANTITIES ARE DEFINED AS EXACT IN THIS SYSTEM.               21
C                                                                        22
C    THE RADIUS OF THE EARTH (REFT59) IS THE VALUE ASSOCIATED WITH THE   23
C    1959 ARDC ATMOSPHERE SO THAT PROGRAMS CURRENTLY USING THE LIBRARY   24
C    ROUTINE WILL NOT REQUIRE ALTERATION TO USE THIS ROUTINE.            25
        DIMENSION HB(10),TMB(10),DELTAB(10),ALM(10)                      26
        DATA(HB(I),   TMB(I),   DELTAB(I),    ALM(I),I=1,10)/            27
       1   -5.0,      320.65,   1.75363E 00,   -6.5,                     28
       2    0.0,      288.15,   1.00000E 00,   -6.5,                     29
       3   11.0,      216.65,   2.23361E-01,    0.0,                     30
       4   20.0,      216.65,   5.40328E-02,    1.0,                     31
       5   32.0,      228.65,   8.56663E-03,    2.8,                     32
       6   47.0,      270.65,   1.09455E-03,    0.0,                     33
       7   52.0,      270.65,   5.82289E-04,   -2.0,                     34
       8   61.0,      252.65,   1.79718E-04,   -4.0,                     35
       9   79.0,      180.65,   1.0241 E-05,    0.0,                     36
       $   88.743,    180.65,   1.6223 E-06,    0.0/                     37
        DATA  REFT59/2.0855531E 07/, GZ    /9.80665/,                    38
       1      AMZ   /28.9644      /, RSTAR /8.31432/,                    39
       2      FTTOKM/3.048E-04    /, S     /110.4  /,                    40
       3      AMUZ  /1.2024E-05   /, CAZ   /1116.45/,                    41
       4      RHOZ  /0.076474     /, GZENG /32.1741/                     42
C   CONVERT GEOMETRIC ALTITUDE TO GEOPOTENTIAL ALTITUDE                  43
        HFT=(REFT59/(REFT59+ZFT))*ZFT                                    44
C   CONVERT HFT AND ZFT TO KILOMETERS                                    45
        Z=FTTOKM*ZFT                                                     46
        H=FTTOKM*HFT                                                     47
        K=1                                                              48
        TMZ=TMB(2)                                                       49
        IF (H.LT.-5.0.OR.Z.GT.90.0) GO TO 7                              50
```

```
      DO 1 M=1,10                                                          51
      IF (H-HB(M)) 2,3,1                                                   52
1     CONTINUE                                                             53
      GO TO 7                                                              54
2     M=M-1                                                                55
3     DELH=H-HB(M)                                                         56
      IF (ALM(M).EQ.0.0) GO TO 4                                           57
      TMK=TMB(M)+ALM(M)*DELH                                               58
C  GRADIENT IS NON ZERO, PAGE 10, EQUATION I.2.10-(3)                      59
      DELTA=DELTAB(M)*((TMB(M)/TMK)**(GZ*AMZ/(RSTAR*ALM(M))))              60
      GO TO 5                                                              61
4     TMK=TMB(M)                                                           62
C  GRADIENT IS ZERO, PAGE 10, EQUATION I.2.10-(4)                          63
      DELTA=DELTAB(M)*EXP(-GZ*AMZ*DELH/(RSTAR*TMB(M)))                     64
5     THETA=TMK/TMZ                                                        65
      SIGMA=DELTA/THETA                                                    66
      ALPHA=SQRT(THETA**3)*((TMZ+S)/(TMK+S))                               67
C  CONVERSION TO ENGLISH UNITS                                             68
      TM=1.8*TMK                                                           69
      RHO=RHOZ*SIGMA/GZENG                                                 70
      CA=CAZ*SQRT(THETA)                                                   71
      AMU=AMUZ*ALPHA/GZENG                                                 72
      CALL OVERFL (J)                                                      73
      GO TO (6,8),J                                                        74
6     K=K+2                                                                75
      GO TO 8                                                              76
7     K=2                                                                  77
8     RETURN                                                               78
      END                                                                  79
```

```
$IBFTC RAMS    DECK
      SUBROUTINE RAM (AM,ETAR)                                              1
      IF (AM.GT.1.) GO TO 2                                                 2
      ETAR=1.                                                               3
1     RETURN                                                                4
2     IF (AM.GT.5.) GO TO 3                                                 5
      ETAR=1.-0.075*((AM-1.)**1.35)                                         6
      GO TO 1                                                               7
3     ETAR=300./((AM**4)+935.)                                              8
      GO TO 1                                                               9
      END                                                                  10
```

```
$IBFTC RAMTWO  DECK
      SUBROUTINE RAM2 (AM,ETAR)                                             1
      DIMENSION PRINLT(15),FMN(15)                                          2
      DIMENSION Y(3),X(3)                                                   3
      DATA FMN/0.,.1,.2,.3,.4,.5,.8,1.1,1.2,1.4,1.6,1.8,2.2,2.4,2.7/        4
      DATA PRINLT/.9,.932,.95,.961,.968,.97,.9701,.97,.9681,.958,.94,       5
     1.9181,.858,.8201,.75/                                                 6
      M=0                                                                   7
      DO 1 J=1,15                                                           8
1     IF (AM.GE.FMN(J)) M=J-1                                               9
      IF (M.EQ.0) M=1                                                      10
```

```
      IF (M.GE.14) M=13                                                 11
      DO 2 I=1,3                                                        12
      MM=M-1+I                                                          13
      X(I)=FMN(MM)                                                      14
2     Y(I)=PRINLT(MM)                                                   15
      CALL PARABO (X,Y,AM,ETAR)                                         16
      RETURN                                                            17
      END                                                               18
```

```
$IBFTC COFAN   DECK
      SUBROUTINE COFAN                                                   1
      COMMON /   ALL/                                                    2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,          3
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,          4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                  5
      COMMON /DESIGN/                                                    6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,          7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,          8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,          9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,         10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,         11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,         12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,         13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,         14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,         15
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV          16
      COMMON / FRONT/                                                   17
     1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,         18
     2T21   ,P21   ,H21   ,S21   ,T3    ,P3    ,H3    ,S3    ,         19
     3T4    ,P4    ,H4    ,S4    ,T5    ,P5    ,H5    ,S5    ,         20
     4T55   ,P55   ,H55   ,S55   ,BLF   ,BLC   ,BLDU  ,BLOB  ,         21
     5CNF   ,PRF   ,ETAF  ,WAFC  ,WAF   ,WA3   ,WG4   ,FAR4  ,         22
     6CNC   ,PRC   ,ETAC  ,WACC  ,WAC   ,ETAB  ,DPCOM ,DUMF  ,         23
     7CNHP  ,ETATHP,DHTCHP,DHTC  ,BLHP  ,WG5   ,FAR5  ,CS    ,         24
     8CNLP  ,ETATLP,DHTCLP,DHTF  ,BLLP  ,WG55  ,FAR55 ,HPEXT ,         25
     9AM    ,ALTP  ,ETAR  ,ZF    ,PCNF  ,ZC    ,PCNC  ,WFB   ,         26
     $TFFHP ,TFFLP ,PCBLF ,PCBLC ,PCBLDU,PCBLOB,PCBLHP,PCBLLP           27
      COMMON/SIDE/ZYX(48)/BACK/YZX(72)                                  28
      COMMON/DUMMYS/DUMMY(100)                                          29
      COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI .  30
     1,ETAI,WACI,TFFIP,CNIP,ETATIP,DHTCIP,DHTI,BLIP,PCBLIP,PCNIGU,ZIDS,  31
     2PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS,  32
     3TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI ,T22DS,WA21       33
      DIMENSION ERR(9)                                                  34
      EQUIVALENCE (ERR,DUMMY(11)),(FXM2CP,DUMMY(51))                    35
      LOGICAL FXM2CP                                                    36
      COMMON /  FAN/CNX(15),PRX(15,15),WACX(15,15),ETAX(15,15),         37
     1NCN,NPT(15)                                                       38
      DIMENSION WLH(2)                                                  39
      DATA AWORD,WLH/6H COFAN,6H (LO) ,6H (HI) /                        40
      WORD=AWORD                                                        41
      THETA=SQRT(T2/518.668)                                            42
      IF (IDES.NE.1) GO TO 1                                            43
      THETAD=THETA                                                      44
      WAFDS=WAFC*P2/THETA                                               45
```

```
1       CNF=PCNF*THETAD/(100.*THETA)                                          46
        IF (ZF.LT.0.) ZF=0.                                                   47
        IF (ZF.GT.1.) ZF=1.                                                   48
        CNFS=CNF                                                              49
        CALL SEARCH (ZF,CNF,PRF,WAFC,ETAF,CNX(1),NCN,PRX(1,1),WACX(1,1),ET    50
       1AX(1,1),NPT(1),15,15,IGO)                                             51
        IF ((CNF-CNFS).GT.0.0005*CNF) MAPEDG=1                                52
        IF (IGO.EQ.1.OR.IGO.EQ.2) WRITE (8,12) CNFS,WLH(IGO)                  53
        WAF=WAFC*P2/THETA                                                     54
        IF (IDES.NE.1) GO TO 2                                                55
        PRFCF=(PRFDS-1.)/(PRF-1.)                                             56
        ETAFCF=ETAFDS/ETAF                                                    57
        WAFCF=WAFDS/WAF                                                       58
        WRITE (6,13) PRFCF,ETAFCF,WAFCF,T2DS                                  59
2       PRF=PRFCF*(PRF-1.)+1.                                                 60
        ETAF=ETAFCF*ETAF                                                      61
        WAF=WAFCF*WAF                                                         62
        WAFC=WAFC*WAFCF                                                       63
        PCNF=100.*THETA*CNF/THETAD                                            64
        DUMD1=PCNF                                                            65
        CALL THCOMP (PRF,ETAF,T2,H2,S2,P2,T22,H22,S22,P22)                    66
        IF (PCBLF.GT.0.) BLF=PCBLF*WAF                                        67
        IF (JDES.EQ.1) GO TO 9                                                68
        JDES=1                                                                69
        IF (INIT.EQ.1) GO TO 8                                                70
        IF (IDES.EQ.1) GO TO 6                                                71
        IF (MODE.NE.2) GO TO 3                                                72
        T4=GUESS(3,Y1,Y2,PCNF,PCNFDS,WFB,WFBDS,Y7,Y8,T4DS)                    73
        PCNI=GUESS(8,T4,T4DS,Y3,Y4,Y5,Y6,T22,T22DS,PCNIDS)                    74
        PCNC=GUESS(4,Y1,Y2,PCNI,PCNIDS,WFB,WFBDS,Y7,Y8,PCNCDS)                75
        GO TO 7                                                               76
3       IF (MODE.EQ.1) GO TO 5                                                77
        IF (MODE.EQ.0) GO TO 4                                                78
        T4=GUESS(7,Y1,Y2,PCNF,PCNFDS,Y5,Y6,T2,T2DS,T4DS)                      79
4       CONTINUE                                                              80
        PCNC=GUESS(5,T4,T4DS,Y3,Y4,Y5,Y6,T22,T22DS,PCNCDS)                    81
        IF (FXM2CP) PCNC=PCNCDS*.99                                           82
        PCNCG1=PCNC                                                           83
        PCNCG2=PCNCDS                                                         84
        PCNI=GUESS(9,Y1,Y2,PCNCG1,PCNCG2,Y5,Y6,T22,T22DS,PCNIDS)              85
        GO TO 7                                                               86
5       T4=GUESS(6,Y1,Y2,PCNC,PCNCDS,Y5,Y6,T22,T22DS,T4DS)                    87
        PCNI=GUESS(8,T4,T4DS,Y3,Y4,Y5,Y6,T22,T22DS,PCNIDS)                    88
        GO TO 7                                                               89
6       PCNC=PCNCDS                                                           90
        PCNI=PCNIDS                                                           91
        T4=T4DS                                                               92
        WFB=WFBDS                                                             93
        T21DS=T21                                                             94
7       ZC=ZCDS                                                               95
        ZI=ZIDS                                                               96
        PCNIGJ=PCNI                                                           97
        PCNCGJ=PCNC                                                           98
        T4GU=T4                                                               99
8       INIT=0                                                               100
9       IF (MODE.NE.3) GO TO 10                                              101
        IF (ABS(CNF-CNFS).LE.0.001*CNFS) GO TO 11                            102
        WRITE (8,14) CNFS,CNF                                                103
        CALL ERROR                                                           104
10      PCNF=100.*THETA*CNF/THETAD                                           105
11      CALL COINTC                                                          106
        RETURN                                                               107
C                                                                            108
```

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C                                                                       109
12    FORMAT (19HO* * *  CNF OFF MAP,F10.4,2XA6,11H* * *$$$$$$)        110
13    FORMAT (11HOFAN DESIGN,13X8H  PRFCF=,E15.8,8H ETAFCF=,E15.8,8H  WA 111
     1FCF=,E15.8,8H   T2DS=,E15.8)                                      112
14    FORMAT (1OHOCNF WAS= ,E15.8,11H  AND NOW= ,E15.8,24H  CHECK PCNF I 113
     1NPUT$$$$$$)                                                      114
      END                                                               115



$IBFTC COINTC  DECK
      SUBROUTINE COINTC                                                  1
      COMMON /   ALL/                                                    2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,          3
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,          4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                  5
      COMMON /DESIGN/                                                    6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,          7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,          8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,          9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,         10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,         11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,         12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,         13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,         14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,         15
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV          16
      COMMON / FRONT/                                                   17
     1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,         18
     2T21   ,P21   ,H21   ,S21   ,T3    ,P3    ,H3    ,S3    ,         19
     3T4    ,P4    ,H4    ,S4    ,T5    ,P5    ,H5    ,S5    ,         20
     4T55   ,P55   ,H55   ,S55   ,BLF   ,BLC   ,BLDU  ,BLOB  ,         21
     5CNF   ,PRF   ,ETAF  ,WAFC  ,WAF   ,WA3   ,WG4   ,FAR4  ,         22
     6CNC   ,PRC   ,ETAC  ,WACC  ,WAC   ,ETAB  ,DPCOM ,DUMF  ,         23
     7CNHP  ,ETATHP,DHTCHP,DHTC  ,BLHP  ,WG5   ,FAR5  ,CS    ,         24
     8CNLP  ,ETATLP,DHTCLP,DHTF  ,BLLP  ,WG55  ,FAR55 ,HPEXT ,         25
     9AM    ,ALTP  ,ETAR  ,ZF    ,PCNF  ,ZC    ,PCNC  ,WFB   ,         26
     $TFFHP ,TFFLP ,PCBLF ,PCBLC ,PCBLDU,PCBLOB,PCBLHP,PCBLLP           27
      COMMON/SIDE/ZYX(48)/BACK/YZX(72)                                  28
      COMMON/DUMMYS/DUMMY(100)                                          29
      COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI 30
     1,ETAI,WACI,TFFIP,CNIP,ETATIP,DHTCIP,DHTI,BLIP,PCBLIP,PCNIGU,ZIDS, 31
     2PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS, 32
     3TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI ,T22DS,WA21      33
      COMMON/INT/CNX(15),PRX(15,15),WACX(15,15),ETAX(15,15),            34
     1NCN,NPT(15)                                                       35
      COMMON/DUMINT/CNXX(15),PRXX(15,15),WACXX(15,15),ETAXX(15,15),     36
     1NCNX,NPTX(15)                                                     37
      EQUIVALENCE (FXFN2M,DUMMY(50)),(FXM2CP,DUMMY(51)),                38
     1            (AFTFAN,DUMMY(58)),(DUMSPL,DUMMY(59))                 39
     2           ,(PCBLID,DUMMY(61))                                    40
      LOGICAL FXFN2M,FXM2CP,AFTFAN,DUMSPL                               41
      DIMENSION ERR(9)                                                  42
      EQUIVALENCE (ERR,DUMMY(11))                                       43
      DIMENSION WLH(2)                                                  44
      DATA AWORD,WLH/6HCOINTC,6H (LO) ,6H (HI) /                        45
      WORD=AWORD                                                        46
      IF (.NOT.AFTFAN) GO TO 1                                          47
      T22S=T22                                                          48
      H22S=H22                                                          49
```

```
      S22S=S22                                                          50
      P22S=P22                                                          51
      T22=T2                                                            52
      H22=H2                                                            53
      S22=S2                                                            54
      P22=P2                                                            55
1     THETA=SQRT(T22/518.668)                                           56
      IF (IDES.NE.1) GO TO 2                                            57
      PRI=PRIDS                                                         58
      PCBLI=PCBLID                                                      59
      WACI=WAICDS                                                       60
      THETAD=THETA                                                      61
      WAIDS=WACI*P22/THETA                                              62
      ETAI=ETAIDS                                                       63
2     IF (.NOT.FXFN2M) GO TO 3                                          64
C     FAN AND MIDDLE SPOOL ROTATE AT SAME SPEED                         65
      SPDFAN=CNF*SQRT(T2/518.668)                                       66
      CNI=SPDFAN/THETA                                                  67
      PCNI=100.*CNI*THETA/THETAD                                        68
      IF (IDES.EQ.1) PCNIDS=PCNI                                        69
3     CNI=PCNI*THETAD/(100.*THETA)                                      70
      ZI=AMAX1(ZI,0.)                                                   71
      ZI=AMIN1(ZI,1.)                                                   72
      CNIS=CNI                                                          73
      IF (.NOT.DUMSPL) GO TO 4                                          74
      CALL INDUMY (CNI,ZI,WAICDS,IDES)                                  75
      CALL SEARCH (ZI,CNI,PRI,WACI,ETAI,CNXX,NCNX,PRXX,WACXX,ETAXX,NPTX,  76
     115,15,IGO)                                                        77
      GO TO 5                                                           78
4     CONTINUE                                                          79
      CALL SEARCH (ZI,CNI,PRI,WACI,ETAI,CNX(1),NCN,PRX(1,1),WACX(1,1),ET  80
     1AX(1,1),NPT(1),15,15,IGO)                                         81
5     CONTINUE                                                          82
      IF ((CNI-CNIS).GT..0005*CNI) MAPEDG=1                             83
      IF (IGO.EQ.1.OR.IGO.EQ.2) WRITE (8,12) CNIS,WLH(IGO)              84
      WAI=WACI*P22/THETA                                                85
      WA22=WAI                                                          86
      IF (IDES.NE.1) GO TO 7                                            87
      T22DS=T22                                                         88
      IF (.NOT.DUMSPL) PRICF=(PRIDS-1.)/(PRI-1.)                        89
      ETAICF=ETAIDS/ETAI                                                90
      WAICF=WAIDS/WAI                                                   91
      IF (.NOT.DUMSPL) GO TO 6                                          92
      PRICF=1.                                                          93
      ETAICF=1.                                                         94
      WAICF=1.                                                          95
6     CONTINUE                                                          95
      WRITE (6,13) PRICF,ETAICF,WAICF,T22DS                             97
7     PRI=PRICF*(PRI-1.)+1.                                             98
      ETAI=ETAICF*ETAI                                                  99
      WAI=WAICF*WAI                                                    100
      WACI=WACI*WAICF                                                  101
      WA22=WAI                                                         102
      CALL THCOMP (PRI,ETAI,T22,H22,S22,P22,T21,H21,S21,P21)           103
      IF (.NOT.DUMSPL) GO TO 8                                         104
      PRI=1.                                                           105
      ETAI=1.                                                          106
      T21=T22                                                          107
      H21=H22                                                          108
      S21=S22                                                          109
      P21=P22                                                          110
8     CONTINUE                                                         111
      IF (IDES.NE.1) GO TO 9                                           112
      BLI=PCBLI*WAI                                                    113
```

```
      WA21=WA22-BLI                                                     114
      WA32=BLI                                                          115
      WAC=WA21                                                          116
9     CONTINUE                                                          117
      IF (ABS(CNI-CNIS).LE.0.001*CNIS) GO TO 10                         118
      WRITE (8,14) CNIS,CNI                                             119
      CALL ERROR                                                        120
      PCNI=100.*THETA*CNI/THETAD                                        121
10    IF (.NOT.AFTFAN) GO TO 11                                         122
      T22=T22S                                                          123
      H22=H22S                                                          124
      S22=S22S                                                          125
      P22=P22S                                                          126
11    CALL COCOMP                                                       127
      RETURN                                                            128
C                                                                       129
C                                                                       130
C                                                                       131
12    FORMAT (19H0* * *  CNI OFF MAP,F10.4,2XA6,11H* * *$$$$$$)        132
13    FORMAT (20H/MIDDLE SPOOL DESIGN,4X8H  PRICF=,E15.8,8H ETAICF=,E15.133
     18,8H  WAICF=,E15.8,8H  T22DS=,E15.8)                              134
14    FORMAT (10HOCNI WAS= ,E15.8,11H  AND NOW= ,E15.8,24H  CHECK PCNI I135
     1NPUT$$$$$$)                                                      136
      END                                                               137
```

```
$IBFTC INTDUM  DECK
      SUBROUTINE INDUMY (CNI,ZI,WACI,IDES)                               1
      COMMON/DUMINT/CNXX(15),PRXX(15,15),WACXX(15,15),ETAXX(15,15),      2
     1NCNX,NPTX(15)                                                      3
      DIMENSION WACAR(15),XCNXX(15)                                      4
      DATA XCNXX/.001,.1,.2,.3,.5,.8,1.,1.5,2.0,3.0,4.0,5.0,6.,7.,9./    5
      DATA WACAR/5.,4.5,4.,3.5,3.,2.5,2.,1.5,1.,.8,.6,.4,.25,.1,.05/     6
      IF (IDES.NE.1) GO TO 1                                             7
      WAIDS=WACI                                                         8
      CNIDS=CNI                                                          9
      ZI=2./3.5                                                         10
1     NCNX=15                                                           11
      DO 2 I=1,15                                                       12
      NPTX(I)=15                                                        13
      CNXX(I)=XCNXX(I)*CNIDS                                            14
      DO 2 J=1,15                                                       15
      PRXX(I,J)=FLOAT(J+3)/4.                                           16
      ETAXX(I,J)=1.                                                     17
2     WACXX(J,I)=WACAR(I)*(.993+.001*FLOAT(J))*WAIDS                    18
      RETURN                                                            19
      END                                                               20
```

```
$IBFTC COCOMP  DECK
      SUBROUTINE COCOMP                                                  1
      COMMON /   ALL/                                                    2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,          3
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,          4
```

```
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                          5
      COMMON /DESIGN/                                                           6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,                  7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,                  8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,                  9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,                 10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,                 11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,                 12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,                 13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,                 14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,                 15
     $PS55  ,AM55  ,CVDNDZ,CVMNDZ,A8SAV ,A9SAV ,A28SAV,A29SAV                  16
      COMMON / FRONT/                                                           17
     1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,                18
     2T21   ,P21   ,H21   ,S21   ,T3    ,P3    ,H3    ,S3    ,                19
     3T4    ,P4    ,H4    ,S4    ,T5    ,P5    ,H5    ,S5    ,                20
     4T55   ,P55   ,H55   ,S55   ,BLF   ,BLC   ,BLDU  ,BLOB  ,                21
     5CNF   ,PRF   ,ETAF  ,WAFC  ,WAF   ,WA3   ,WG4   ,FAR4  ,                22
     6CNC   ,PRC   ,ETAC  ,WACC  ,WAC   ,ETAB  ,DPCOM ,DUMF  ,                23
     7CNHP  ,ETATHP,DHTCHP,DHTC  ,BLHP  ,WG5   ,FAR5  ,CS    ,                24
     8CNLP  ,ETATLP,DHTCLP,DHTF  ,BLLP  ,WG55  ,FAR55 ,HPEXT ,                25
     9AM    ,ALTP  ,ETAR  ,ZF    ,PCNF  ,ZC    ,PCNC  ,WFB   ,                26
     $TFFHP ,TFFLP ,PCBLF ,PCBLC ,PCBLDU,PCBLOB,PCBLHP,PCBLLP                   27
      COMMON/SIDE/ZYX(48)/BACK/YZX(72)                                          28
      COMMON/DUMMYS/DUMMY(21),WA32,DPWGDS,DPWING,WA32DS,A38,AM38,V38,           29
     1T38,H38,P38,TS38,PS38,T39,H39,P39,TS39,V39,AM39,A39,BPRINT,WG37,           30
     2CVDWNG,FGMWNG,FGPWNG,FNWING,FNMAIN,FWOVFN,DIMMY(52)                       31
      COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI         32
     1,ETAI,WACI,TFFIP,CNIP,ETATIP,DHTCIP,DHTI,BLIP,PCBLIP,PCNIGU,ZIDS,         33
     2PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS,        34
     3TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI ,T22DS,WA21              35
      EQUIVALENCE(FXFN2M,DUMMY(50)),(FXM2CP,DUMMY(51))                          36
      EQUIVALENCE (PCBLID,DUMMY(61)),(DUMSPL,DUMMY(59))                         37
      LOGICAL FXFN2M,FXM2CP,DUMSPL                                              38
      DIMENSION ERR(9)                                                          39
      EQUIVALENCE (ERR,DUMMY(11))                                               40
      COMMON / COMP/CNX(15),PRX(15,15),WACX(15,15),ETAX(15,15),                 41
     1NCN,NPT(15)                                                               42
      DIMENSION WLH(2)                                                          43
      DATA AWORD,WLH/6HCOCOMP,6H (LO) ,6H (HI) /                                44
      WORD=AWORD                                                                45
      THETA=SQRT(T21/518.668)                                                   46
      IF (IDES.NE.1) GO TO 1                                                    47
      THETAD=THETA                                                              48
      WACDS=WAC                                                                 49
      WACC=WAC*THETA/P21                                                        50
      IF (.NOT.FXM2CP) PCNC=PCNCDS                                              51
1     IF (.NOT.FXM2CP) GO TO 2                                                  52
C     SPEEDS OF MIDDLE AND INNER SPOOL ARE THE SAME                             53
      SPDMID=CNI*SQRT(T22/518.668)                                              54
      CNC=SPDMID/THETA                                                          55
      PCNC=100.*CNC*THETA/THETAD                                                56
      IF (IDES.EQ.1) PCNCDS=PCNC                                                57
2     CNC=PCNC*THETAD/(100.*THETA)                                              58
      IF (IDES.NE.1) GO TO 3                                                    59
3     CONTINUE                                                                  60
      IF (ZC.LT.0.) ZC=0.                                                       61
      IF (ZC.GT.1.) ZC=1.                                                       62
      CNCS=CNC                                                                  63
      CALL SEARCH (ZC,CNC,PRC,WACC,ETAC,CNX(1),NCN,PRX(1,1),WACX(1,1),ET        64
     1AX(1,1),NPT(1),15,15,IGO)                                                 65
      IF (MODE.EQ.1) GO TO 4                                                    66
      IF ((CNC-CNCS).GT.0.0005*CNC) MAPEDG=1                                    67
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4     IF (IGO.EQ.1.OR.IGO.EQ.2) WRITE (8,9) CNCS,WLH(IGO)                    68
      WAC=WACC*P21/THETA                                                     69
      IF (IDES.NE.1) GO TO 5                                                 70
      T21DS=T21                                                              71
      PRCCF=(PRCDS-1.)/(PRC-1.)                                              72
      ETACCF=ETACDS/ETAC                                                     73
      WACCF=WACDS/WAC                                                        74
      WRITE (6,10) PRCCF,ETACCF,WACCF,T21DS                                  75
5     PRC=PRCCF*(PRC-1.)+1.                                                  76
      ETAC=ETACCF*ETAC                                                       77
      WAC=WACCF*WAC                                                          78
      IF (.NOT.DUMSPL.OR.PCBLID.NE.0.) GO TO 6                               79
      WA22=WAC                                                               80
      WAI=WA22                                                               81
      WACI=WACC*WACCF                                                        82
6     WA32=WA22-WAC                                                          83
      WA21=WAC                                                               84
      WACC=WACC*WACCF                                                        85
      PCBLI=1.-WA21/WA22                                                     86
      CALL WDUCTI                                                            87
      IF (PCBLID.EQ.0.) ERR(7)=(WAC-WAI)/WAC                                 88
      IF (IDES.EQ.1.AND.PCBLID.EQ.0.) ERR(7)=1.E-4                           89
      CALL THCOMP (PRC,ETAC,T21,H21,S21,P21,T3,H3,S3,P3)                     90
      IF (PCBLC.GT.0.) BLC=PCBLC*WAC                                         91
      WA3=WAC-BLC                                                            92
      BLDU=PCBLDU*BLC                                                        93
      BLOB=PCBLOB*BLC                                                        94
      BLHP=PCBLHP*BLC                                                        95
      BLIP=PCBLIP*BLC                                                        96
      BLLP=PCBLLP*BLC                                                        97
      IF (MODE.NE.1) GO TO 7                                                 98
      IF (ABS(CNC-CNCS).LE.0.001*CNCS) GO TO 8                               99
      WRITE (8,11) CNCS,CNC                                                 100
      CALL ERROR                                                            101
7     PCNC=100.*THETA*CNC/THETAD                                            102
8     CALL COCOMB                                                           103
      RETURN                                                                104
C                                                                           105
C                                                                           106
C                                                                           107
9     FORMAT (19H0* * *  CNC OFF MAP,F10.4,2XA6,11H* * *$$$$$$)             108
10    FORMAT (18HOCOMPRESSOR DESIGN,6X8H  PRCCF=,E15.8,8H ETACCF=,E15.8,    109
     18H  WACCF=,E15.8,8H  T21DS=,E15.8)                                    110
11    FORMAT (10HOCNC WAS= ,E15.8,11H  AND NOW= ,E15.8,24H  CHECK PCNC I    111
     1NPUT$$$$$$)                                                           112
      END                                                                   113
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```
$IBFTC WDUCT   DECK
      SUBROUTINE WDUCTI                                                      1
      COMMON /   ALL/                                                        2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,              3
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,              4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                      5
      COMMON /DESIGN/                                                        6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,              7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,              8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,              9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,             10
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     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,                11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,                12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,                13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,                14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,                15
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV                 15
      COMMON / FRONT/                                                         17
     1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,              18
     2T21   ,P21   ,H21   ,S21   ,T3    ,P3    ,H3    ,S3    ,              19
     3T4    ,P4    ,H4    ,S4    ,T5    ,P5    ,H5    ,S5    ,              20
     4T55   ,P55   ,H55   ,S55   ,BLF   ,BLC   ,BLDU  ,BLOB  ,              21
     5CNF   ,PRF   ,ETAF  ,WAFC  ,WAF   ,WA3   ,WG4   ,FAR4  ,              22
     6CNC   ,PRC   ,ETAC  ,WACC  ,WAC   ,ETAB  ,DPCOM ,DUMF  ,              23
     7CNHP  ,ETATHP,DHTCHP,DHTC  ,BLHP  ,WG5   ,FAR5  ,CS    ,              24
     8CNLP  ,ETATLP,DHTCLP,DHTF  ,BLLP  ,WG55  ,FAR55 ,HPEXT ,              25
     9AM    ,ALTP  ,ETAR  ,ZF    ,PCNF  ,ZC    ,PCNC  ,WFB   ,              26
     $TFFHP ,TFFLP ,PCBLF ,PCBLC ,PCBLDU,PCBLOB,PCBLHP,PCBLLP                 27
      COMMON/SIDE/ZYX(48)/BACK/YZX(72)                                        28
      COMMON/DUMMYS/DUMMY(21),WA32,DPWGDS,DPWING,WA32DS,A38,AM38,V38,         29
     1T38,H38,P38,TS38,PS38,T39,H39,P39,TS39,V39,AM39,A39,BPRINT,WG37,         30
     2CVDWNG,FGMWNG,FGPWNG,FNWING,FNMAIN,FWOVFN,PS39,DIMMY(51)                31
      COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI       32
     1,ETAI,WACI,TFFIP,CNIP,ETATIP,DHTCIP,DHTI,BLIP,PCBLIP,PCNIGU,ZIDS,       33
     2PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS,      34
     3TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI ,T22DS,WA21            35
      DIMENSION ERR(9)                                                        36
      EQUIVALENCE (ERR,DUMMY(11)),(PCBLID,DUMMY(61))                          37
      DATA AWORD/6HWDUCTI/                                                    38
      WORD=AWORD                                                              39
      IF (PCBLID.GT.0.) GO TO 3                                               40
      DO 1 I=24,42                                                            41
1     DUMMY(I)=0.                                                             42
      DO 2 I=44,49                                                            43
2     DUMMY(I)=0.                                                             44
      RETURN                                                                  45
3     CONTINUE                                                                46
      P32=P21                                                                 47
      H32=H21                                                                 48
      T32=T21                                                                 49
      BPRINT=WA32/WAC                                                         50
      WA32C=WA32*SQRT(T32)/P32                                                51
      IF (IDES.EQ.1) WA32DS=WA32C                                             52
      DPWING=DPWGDS*WA32C/WA32DS                                              53
      DPWING=AMIN1(1.0,DPWING)                                                54
      P36=P32*(1.-DPWING)                                                     55
      T36=T32                                                                 56
      H36=H32                                                                 57
      CALL THERMO (P36,H36,T36,S36,XX2,1,0.0,0)                               58
      WG37=WA32                                                               59
      T37=T36                                                                 60
      P37=P36                                                                 61
      H37=H36                                                                 62
      S37=S36                                                                 63
      NOZD=0                                                                  64
      CALL CONVRG (T37,H37,P37,S37,0.0,WG37,P1,IDES,A38,P38R,T38,H38,P38      65
     1,S38,TS38,PS38,V38,AM38,ICON)                                           65
      GO TO (5,5,5,4),ICON                                                    67
4     CALL ERROR                                                              68
5     T39=T38                                                                 69
      H39=H38                                                                 70
      P39=P38                                                                 71
      S39=S38                                                                 72
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```
      TS39=TS38                                                          73
      V39=V38                                                            74
      AM39=AM38                                                          75
      A39=A38                                                            76
      PS39=PS38                                                          77
      IDSHOC=ICON+3                                                      78
      ERR(7)=(P38R-P38)/P38R                                             79
      IF (IDES.EQ.1) WRITE (6,6) A38,AM38,A39,AM39                       80
      RETURN                                                             81
C                                                                        82
C                                                                        83
6     FORMAT (18HOINTER DUCT DESIGN,5X,8H    A38=,E15.8,8H   AM38=,E15.8 84
     1,8H    A39=,E15.8,8H   AM39=,E15.8)                                85
      END                                                                86
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$IBFTC COCOMB  DECK
      SUBROUTINE COCOMB                                                   1
      COMMON /   ALL/                                                     2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,           3
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,           4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                   5
      COMMON /DESIGN/                                                     6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,           7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,           8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,           9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,          10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,          11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,          12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,          13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,          14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,          15
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV          15
      COMMON / FRONT/                                                    17
     1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,          18
     2T21   ,P21   ,H21   ,S21   ,T3    ,P3    ,H3    ,S3    ,          19
     3T4    ,P4    ,H4    ,S4    ,T5    ,P5    ,H5    ,S5    ,          20
     4T55   ,P55   ,H55   ,S55   ,BLF   ,BLC   ,BLDU  ,BLOB  ,          21
     5CNF   ,PRF   ,ETAF  ,WAFC  ,WAF   ,WA3   ,WG4   ,FAR4  ,          22
     6CNC   ,PRC   ,ETAC  ,WACC  ,WAC   ,ETAB  ,DPCOM ,DUMF  ,          23
     7CNHP  ,ETATHP,DHTCHP,DHTC  ,BLHP  ,WG5   ,FAR5  ,CS    ,          24
     8CNLP  ,ETATLP,DHTCLP,DHTF  ,BLLP  ,WG55  ,FAR55 ,HPEXT ,          25
     9AM    ,ALTP  ,ETAR  ,ZF    ,PCNF  ,ZC    ,PCNC  ,WFB   ,          26
     $TFFHP ,TFFLP ,PCBLF ,PCBLC ,PCBLDU,PCBLOB,PCBLHP,PCBLLP           27
      COMMON/SIDE/ZYX(48)/BACK/YZX(72)                                   28
      COMMON/DUMMYS/DIMMY(100)                                           29
      COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI  30
     1,ETAI,WACI,TFFIP,CNIP,ETATIP,DHTCIP,DHTI,BLIP,PCBLIP,PCNIGU,ZIDS,  31
     2PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS, 32
     3TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI ,T22DS,WA21       33
      EQUIVALENCE(FAR50,DIMMY(21)),(WG50,DIMMY(20)),(FXFN2M,DIMMY(50)),  34
     1(FXM2CP,DIMMY(51))                                                 35
      EQUIVALENCE (HTF,DIMMY(62)),(HCN,DIMMY(65)),(HDH,DIMMY(68)),       36
     1(HDHC,DIMMY(69)),(HETA,DIMMY(74))                                  37
      LOGICAL FXFN2M,FXM2CP                                              38
      DIMENSION ERR(9)                                                   39
      EQUIVALENCE (ERR,DIMMY(11))                                        40
      COMMON / COMB/PSI(15),DELT(15,15),ETA(15,15),NPS,NPT(15)           41
```

```
      DIMENSION Q(9),DUMBO(15,15)                                          42
      DATA AWORD/6HCOCOMB/                                                 43
      WORD=AWORD                                                           44
      Q(2)=0.                                                              45
      Q(3)=0.                                                              46
      P3PSI=14.696*P3                                                      47
      WA3C=WA3*SQRT(T3)/P3PSI                                              48
      IF (IDES.EQ.1) WA3CDS=WA3C                                           49
      DPCOM=DPCODS*(WA3C/WA3CDS)                                           50
      IF (DPCOM.GT.1.) DPCOM=1.                                            51
      P4=P3*(1.-DPCOM)                                                     52
1     IF (T4.GT.4000.) T4=4000.                                            53
      IF (T4.GE.1000.) GO TO 2                                             54
      T4=1000.                                                             55
      IF (MODE.EQ.1) MAPEDG=1                                              56
2     DTCO=T4-T3                                                           57
      IF (IDES.NE.1) GO TO 3                                               58
      DTCODS=DTCO                                                          59
      DTCOCF=DTCODS/DTCO                                                   60
3     DTCO=DTCOCF*DTCO                                                     61
      P3PSIN=P3PSI                                                         62
      CALL SEARCH (-1.,P3PSIN,DTCO,ETAB,DUMMY,PSI(1),NPS,DELT(1,1),ETA(1   63
     1,1),DUMBO(1,1),NPT(1),15,15,IGO)                                     64
      IF (IGO.EQ.7) CALL ERROR                                             65
      IF (IDES.NE.1) GO TO 4                                               66
      ETABCF=ETABDS/ETAB                                                   67
4     ETAB=ETABCF*ETAB                                                     68
      HV=((((((-.4594317E-19*T4)-.2034116E-15)*T4+.2783643E-11)*T4+.2051   69
     1501E-07)*T4-.2453116E-03)*T4-.9433296E-01)*T4+.1845537E+05           70
      CALL THERMO (P4,HA,T4,XX1,XX2,0,0.0,0)                               71
      FAR4=(HA-H3)/(HV*ETAB)                                               72
      IF (FAR4.LT.0.) FAR4=0.                                              73
      WFBX=FAR4*WA3                                                        74
      IF (MODE.NE.2) GO TO 7                                               75
      ERRW=(WFB-WFBX)/WFB                                                  76
      DIR=SQRT(WFB/WFBX)                                                   77
      CALL AFQUIR (Q(1),T4,ERRW,0.,20.,0.0001,DIR,T4T,IGO)                 78
      GO TO (5,8,6),IGO                                                    79
5     T4=T4T                                                               80
      GO TO 1                                                              81
6     CALL ERROR                                                           82
7     WFB=WFBX                                                             83
8     CALL THERMO (P4,H4,T4,S4,XX2,1,FAR4,0)                               84
      WG4=WFB+WA3                                                          85
      IF (IDES.EQ.1) WRITE (6,10) WA3CDS,ETABCF,DTCOCF                     86
      IF (FXM2CP) GO TO 9                                                  87
      CALL COMPTB                                                          88
      RETURN                                                               89
9     P50=P4                                                               90
      H50=H4                                                               91
      T50=T4                                                               92
      S50=S4                                                               93
      FAR50=FAR4                                                           94
      WG50=WG4                                                             95
C     SET HIGH PRESSURE TURBINE PARAMETERS TO ZERO, NOT USED               96
      HTF=0.                                                               97
      HCN=0.                                                               98
      HDH=0.                                                               99
      HDHC=0.                                                             100
      HETA=0.                                                             101
      CALL COIPTB                                                         102
      RETURN                                                              103
C                                                                         104
```

```
C                                                                               105
C                                                                               106
10    FORMAT (17HOCOMBUSTOR DESIGN,7X8H WA3CDS=,E15.8,8H ETABCF=,E15.8,8        107
     1H DTCOCF=,E15.8)                                                          108
      END                                                                       109



$IBFTC COHPTB  DECK
      SUBROUTINE COHPTB                                                          1
      COMMON /   ALL/                                                            2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,                  3
     2IGASMX,IDBURN,IAFTBN,IOCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,                  4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                          5
      COMMON /DESIGN/                                                            6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,                  7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,                  8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,                  9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,                 10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,                 11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,                 12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,                 13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,                 14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,                 15
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV                  16
      COMMON / FRONT/                                                           17
     1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,                18
     2T21   ,P21   ,H21   ,S21   ,T3    ,P3    ,H3    ,S3    ,                19
     3T4    ,P4    ,H4    ,S4    ,T5    ,P5    ,H5    ,S5    ,                20
     4T55   ,P55   ,H55   ,S55   ,BLF   ,BLC   ,BLDU  ,BLOB  ,                21
     5CNF   ,PRF   ,ETAF  ,WAFC  ,WAF   ,WA3   ,WG4   ,FAR4  ,                22
     6CNC   ,PRC   ,ETAC  ,WACC  ,WAC   ,ETAB  ,DPCOM ,DUMF  ,                23
     7CNHP  ,ETATHP,DHTCHP,DHTC  ,BLHP  ,WG5   ,FAR5  ,CS    ,                24
     8CNLP  ,ETATLP,DHTCLP,DHTF  ,BLLP  ,WG55  ,FAR55 ,HPEXT ,                25
     9AM    ,ALTP  ,ETAR  ,ZF    ,PCNF  ,ZC    ,PCNC  ,WFB   ,                26
     $TFFHP ,TFFLP ,PCBLF ,PCBLC ,PCBLDU,PCBLOB,PCBLHP,PCBLLP                   27
      COMMON/SIDE/QXQ(48)/BACK/QWQ(72)                                          28
      COMMON/DUMMYS/DUMMY(100)                                                  29
      COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI        30
     1,ETAI,WACI,TFFIP,CNIP,ETATIP,DHTCIP,DHTI,BLIP,PCBLIP,PCNIGU,ZIDS,        31
     2PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS,       32
     3TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI ,T22DS,WA21             33
      DIMENSION ERR(9)                                                          34
      EQUIVALENCE (ERR,DUMMY(11)),(WG50,DUMMY(20)),(FAR50,DUMMY(21))            35
      EQUIVALENCE (FXFN2M,DUMMY(50)),(FXM2CP,DUMMY(51))                         36
      EQUIVALENCE (DUMSPL,DUMMY(59))                                            37
      EQUIVALENCE(TFFACT,DUMMY(62)),(CNACT,DUMMY(65)),(DHCACT,DUMMY(68))        38
     1,(DHTACT,DUMMY(69)),(ETAACT,DUMMY(74))                                    39
      EQUIVALENCE (ITF,DUMMY(63)),(ICN,DUMMY(66)),(IDH,DUMMY(70)),              40
     1(IDHC,DUMMY(71)),(IETA,DUMMY(75))                                         41
      LOGICAL FXFN2M,FXM2CP,DUMSPL                                              42
      COMMON /HTURB/TFFX(15),CNX(15,15),DHTCX(15,15),ETATX(15,15),              43
     1NTFFS,NPTTFF(15)                                                          44
      DATA AWORD,WLO,WHI/6HCOHPTB,6H (LO) ,6H (HI) /                            45
      WORD=AWORD                                                                46
      IF (IDES.EQ.0) GO TO 1                                                    47
      CNHPCF=CNHPDS*SQRT(T4)/PCNC                                               48
1     CNHP=CNHPCF*PCNC/SQRT(T4)                                                 49
      CNHPS=CNHP                                                                50
      TFFHPS=TFFHP                                                              51
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      CALL SEARCH (-1.,TFFHP,CNHP,DHTCHP,ETATHP,TFFX(1),NTFFS,CNX(1,1),D      52
     1HTCX(1,1),ETATX(1,1),NPTTFF(1),15,15,IGO)                               53
      IF (IGO.EQ.1.OR.IGO.EQ.11.OR.IGO.EQ.21) WRITE (8,9) TFFHPS,WLO           54
      IF (IGO.EQ.2.OR.IGO.EQ.12.OR.IGO.EQ.22) WRITE (8,9) TFFHPS,WHI           55
      IF (IGO.EQ.10.OR.IGO.EQ.11.OR.IGO.EQ.12) WRITE (8,10) CNHPS,WLO          56
      IF (IGO.EQ.20.OR.IGO.EQ.21.OR.IGO.EQ.22) WRITE (8,10) CNHPS,WHI          57
      IF (IGO.NE.7) GO TO 2                                                    58
      CALL ERROR                                                               59
      RETURN                                                                   60
2     MAPGO=0                                                                  61
      IF (ABS(TFFHPS-TFFHP).LE.0.001*TFFHPS) GO TO 3                           62
      MAPGO=1                                                                  63
      IF (ABS(CNHPS-CNHP).GT.0.001*CNHPS) MAPGO=3                              64
      GO TO 4                                                                  65
3     IF (ABS(CNHPS-CNHP).GT.0.001*CNHPS) MAPGO=2                              66
4     IF (MAPGO.GT.0) CALL MAPBAC (1,MAPGO,TFFHPS,TFFHP,CNHPS,CNHP,PCNC,      67
     1T4,MODE,NOMAP,NUMMAP)                                                   68
      IF (NOMAP.GT.0) RETURN                                                   69
      TFHCAL=WG4*SQRT(T4)/(14.696*P4)                                          70
      BTUEXT=0.706705*HPEXT                                                    71
      DHTCC=(BTUEXT+WAC*(H3-H21))/(WG4*T4)                                     72
      IF (IDES.EQ.0) GO TO 5                                                   73
      TFHPCF=TFHPDS/TFHCAL                                                     74
      DHHPCF=DHTCC/DHTCHP                                                      75
      ETHPCF=ETHPDS/ETATHP                                                     76
      WRITE (6,11) CNHPCF,TFHPCF,ETHPCF,DHHPCF                                 77
5     TFHCAL=TFHPCF*TFHCAL                                                     78
      DHTCHP=DHHPCF*DHTCHP                                                     79
      ETATHP=ETHPCF*ETATHP                                                     80
      DHTC=DHTCC*T4                                                            81
      TFFACT=TFHCAL/TFHPCF                                                     82
      CNACT=CNHP/CNHPCF                                                        83
      DHCACT=DHTCHP/DHHPCF                                                     84
      DHTACT=DHTC                                                              85
      ETAACT=ETATHP                                                            86
      ERR(1)=(TFHCAL-TFFHP)/TFHCAL                                             87
      ERR(2)=(DHTCC-DHTCHP)/DHTCC                                              88
      CALL THTURB (DHTC,ETATHP,FAR4,H4,S4,P4,T50,H50,S50,P50)                  89
      IF (BLHP.LE.0.) GO TO 6                                                  90
      FAR5=WFB/(WA3+BLHP)                                                      91
      FAR50=WFB/(WA3+BLHP)                                                     92
      WG50=WG4+BLHP                                                            93
      H50=(BLHP*H3+WG4*H50)/WG50                                               94
      CALL THERMO (P50,H50,T50,S50,XX2,1,FAR50,1)                              95
      GO TO 7                                                                  96
6     FAR50=FAR4                                                               97
      WG50=WG4                                                                 98
7     IF (FKFN2M.OR.DUMSPL) GO TO 8                                            99
      CALL COIPTB                                                             100
      RETURN                                                                  101
8     P5=P50                                                                  102
      H5=H50                                                                  103
      T5=T50                                                                  104
      S5=S50                                                                  105
      FAR5=FAR50                                                              106
      WG5=WG50                                                                107
C     SET MIDDLE TURBINE PARAMETERS TO ZERO, NOT USED                         108
      ITF=0                                                                   109
      ICN=0                                                                   110
      IDH=0                                                                   111
      IDHC=0                                                                  112
      IETA=0                                                                  113
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      CALL COLPTB                                                          114
      RETURN                                                               115
C                                                                          116
C                                                                          117
C                                                                          118
9     FORMAT (19H0*****TFFHP OFF MAP,F10.4,2XA6,11H*****$$$$$$)           119
10    FORMAT (19H0***** CNHP OFF MAP,F10.4,2XA6,11H*****$$$$$$)           120
11    FORMAT (20H0H.P. TURBINE DESIGN,5X7HCNHPCF=,E15.8,8H TFHPCF=,E15.8   121
     1,8H ETHPCF=,E15.8,8H DHHPCF=,E15.8)                                  122
      END                                                                  123
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$IBFTC COIPTB  DECK
      SUBROUTINE COIPTB                                                     1
      COMMON /   ALL/                                                       2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,             3
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,              4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                      5
      COMMON /DESIGN/                                                       6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,              7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,              8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,              9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,             10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,             11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,             12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,             13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,             14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,             15
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV              16
      COMMON / FRONT/                                                       17
     1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,            18
     2T21   ,P21   ,H21   ,S21   ,T3    ,P3    ,H3    ,S3    ,            19
     3T4    ,P4    ,H4    ,S4    ,T5    ,P5    ,H5    ,S5    ,            20
     4T55   ,P55   ,H55   ,S55   ,BLF   ,BLC   ,BLDU  ,BLOB  ,            21
     5CNF   ,PRF   ,ETAF  ,WAFC  ,WAF   ,WA3   ,WG4   ,FAR4  ,            22
     6CNC   ,PRC   ,ETAC  ,WACC  ,WAC   ,ETAB  ,DPCOM ,DUMF  ,            23
     7CNHP  ,ETATHP,DHTCHP,DHTC  ,BLHP  ,WG5   ,FAR5  ,CS    ,            24
     8CNLP  ,ETATLP,DHTCLP,DHTF  ,BLLP  ,WG55  ,FAR55 ,HPEXT ,            25
     9AM    ,ALTP  ,ETAR  ,ZF    ,PCNF  ,ZC    ,PCNC  ,WFB   ,            26
     $TFFHP ,TFFLP ,PCBLF ,PCBLC ,PCBLDU,PCBLOB,PCBLHP,PCBLLP              27
      COMMON/SIDE/QXQ(48)/BACK/QWQ(72)                                      28
      COMMON/DUMMYS/DUMMY(100)                                              29
      COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI     30
     1,ETAI,WACI,TFFIP,CNIP,ETATIP,DHTCIP,DHTI,BLIP,PCBLIP,PCNIGU,ZIDS,     31
     2PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS,    32
     3TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI ,T22DS,WA21          33
      COMMON/TERBMD/DHMDSV,TFMDSV,CNMDSV,ETMDSV,DHMDDS                      34
      COMMON/ITURB/TFFX(15),CNX(15,15),DHTCX(15,15),ETATX(15,15),           35
     1NTFFS,NPTTFF(15)                                                      36
      EQUIVALENCE (FXFN2M,DUMMY(50)),(FXM2CP,DUMMY(51))                     37
      LOGICAL FXFN2M,FXM2CP                                                 38
      EQUIVALENCE (AFTFAN,DUMMY(58))                                        39
      LOGICAL AFTFAN                                                        40
      COMMON/HTURB/TFFY(15),CNY(15,15),DHTCY(15,15),ETATY(15,15),NTFYS,     41
     1NPTTSF(15)                                                            42
      DIMENSION ERR(9)                                                      43
      EQUIVALENCE (ERR,DUMMY(11)),(WG50,DUMMY(20)),(FAR50,DUMMY(21))        44
      EQUIVALENCE(TFFACT,DUMMY(63)),(CNACT,DUMMY(66)),(DHCACT,DUMMY(70))    45
     1,(DHTACT,DUMMY(71)),(ETAACT,DUMMY(75))                                46
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      DATA AWORD,WLO,WHI/6HCOIPTB,6H (LO) ,6H (HI) /                    47
      H22SAV=H22                                                        48
      IF (AFTFAN) H22=H2                                                49
      WORD=AWORD                                                        50
      IF (IDES.EQ.0) GO TO 1                                            51
      CNIPCF=CNIPDS*SQRT(T50)/PCNI                                      52
      IF (FXM2CP) CNIPCF=CNHPDS*SQRT(T50)/PCNI                          53
1     CNIP=CNIPCF*PCNI/SQRT(T50)                                        54
      CNIPS=CNIP                                                        55
      TFFIPS=TFFIP                                                      56
      IF (FXM2CP) GO TO 2                                               57
      CALL SEARCH (-1.,TFFIP,CNIP,DHTCIP,ETATIP,TFFX(1),NTFFS,CNX(1,1),D 58
     1HTCX(1,1),ETATX(1,1),NPTTFF(1),15,15,IGO)                         59
2     IF (FXM2CP) CALL SEARCH (-1.,TFFIP,CNIP,DHTCIP,ETATIP,TFFY(1),NTFY 60
     1S,CNY(1,1),DHTCY(1,1),ETATY(1,1),NPTTSF(1),15,15,IGO)             61
      IF (IGO.EQ.1.OR.IGO.EQ.11.OR.IGO.EQ.21) WRITE (8,9) TFFIPS,WLO    62
      IF (IGO.EQ.2.OR.IGO.EQ.12.OR.IGO.EQ.22) WRITE (8,9) TFFIPS,WHI    63
      IF (IGO.EQ.10.OR.IGO.EQ.11.OR.IGO.EQ.12) WRITE (8,9) CNIPS,WLO    64
      IF (IGO.EQ.20.OR.IGO.EQ.21.OR.IGO.EQ.22) WRITE (8,10) CNIPS,WHI   65
      IF (IGO.NE.7) GO TO 3                                             66
      CALL ERROR                                                        67
      RETURN                                                            68
3     MAPGO=0                                                           69
      IF (ABS(TFFIPS-TFFIP).LE.0.001*TFFIPS) GO TO 4                    70
      MAPGO=1                                                           71
      IF (ABS(CNIPS-CNIP).GT.0.001*CNIPS) MAPGO=3                       72
      GO TO 5                                                           73
4     IF (ABS(CNIPS-CNIP).GT.0.001*CNIPS) MAPGO=2                       74
5     IF (MAPGO.GT.0) CALL MAPBAC (3,MAPGO,TFFIPS,TFFIP,CNIPS,CNIP,PCNI, 75
     1T4,MODE,NOMAP,NUMMAP)                                             76
      IF (NOMAP.GT.0) RETURN                                            77
      TFICAL=WG50*SQRT(T50)/(14.696*P50)                                78
      DHTIC=(WAI*(H21-H22))/(WG50*T50)                                  79
      IF (FXM2CP) DHTIC=(.706705*HPEXT+WAC*(H3-H21)+WAI*(H21-H22))/(WG50 80
     1*T50)                                                             81
      IF (IDES.EQ.0) GO TO 6                                            82
      TFIPCF=TFIPDS/TFICAL                                              83
      DHIPCF=DHTIC/DHTCIP                                               84
      ETIPCF=ETIPDS/ETATIP                                              85
      IF (FXM2CP) TFIPCF=TFHPDS/TFICAL                                  86
      IF (FXM2CP) ETIPCF=ETHPDS/ETATIP                                  87
      WRITE (6,11) CNIPCF,TFIPCF,ETIPCF,DHIPCF                          88
6     TFICAL=TFIPCF*TFICAL                                              89
      DHTCIP=DHIPCF*DHTCIP                                              90
      ETATIP=ETIPCF*ETATIP                                              91
      DHTI=DHTIC*T50                                                    92
      TFFACT=TFICAL/TFIPCF                                              93
      CNACT=CNIP/CNIPCF                                                 94
      DHCACT=DHTCIP/DHIPCF                                              95
      DHTACT=DHTI                                                       96
      ETAACT=ETATIP                                                     97
      N1=8                                                              98
      N2=9                                                              99
      IF (FXM2CP) N1=1                                                 100
      IF (FXM2CP) N2=2                                                 101
      ERR(N1)=(TFICAL-TFFIP)/TFICAL                                    102
      ERR(N2)=(DHTIC-DHTCIP)/DHTIC                                     103
      CALL THTURB (DHTI,ETATIP,FAR50,H50,S50,P50,T5,H5,S5,P5)          104
      IF (BLIP.LE.0.) GO TO 7                                          105
      FAR5=WFB/(WA3+BLHP+BLIP)                                         106
      WG5=WG50+BLIP                                                    107
      H5=(BLIP*H3+WG50*H5)/WG5                                         108
```

```
      CALL THERMO (P5,H5,T5,S5,XX2,1,FAR5,1)                                109
      GO TO 8                                                               110
7     FAR5=FAR50                                                            111
      WG5=WG50                                                              112
      H22=H22SAV                                                            113
8     CALL COLPTB                                                           114
      RETURN                                                                115
C                                                                           116
C                                                                           117
C                                                                           118
9     FORMAT (19HO*****TFFIP OFF MAP,F10.4,2XA6,11H*****$$$$$$)            119
10    FORMAT (19HO***** CNIP OFF MAP,F10.4,2XA6,11H*****$$$$$$)            120
11    FORMAT (20HOI.P. TURBINE DESIGN,5X7HCNIPCF=,E15.8,8H TFIPCF=,E15.8    121
     1,8H ETIPCF=,E15.8,8H DHIPCF=,E15.8)                                   122
      END                                                                   123
```

```
$IBFTC COLPTB  DECK
      SUBROUTINE COLPTB                                                      1
      COMMON /   ALL/                                                        2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,              3
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,              4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                      5
      COMMON /DESIGN/                                                        6
     1PCNFGU,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,              7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,              8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,              9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,             10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,             11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,             12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,             13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,             14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,             15
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV             16
      COMMON / FRONT/                                                       17
     1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,             18
     2T21   ,P21   ,H21   ,S21   ,T3    ,P3    ,H3    ,S3    ,             19
     3T4    ,P4    ,H4    ,S4    ,T5    ,P5    ,H5    ,S5    ,             20
     4T55   ,P55   ,H55   ,S55   ,BLF   ,BLC   ,BLDU  ,BLOB  ,             21
     5CNF   ,PRF   ,ETAF  ,WAFC  ,WAF   ,WA3   ,WG4   ,FAR4  ,             22
     6CNC   ,PRC   ,ETAC  ,WACC  ,WAC   ,ETAB  ,DPCOM ,DUMF  ,             23
     7CNHP  ,ETATHP,DHTCHP,DHTC  ,BLHP  ,WG5   ,FAR5  ,CS    ,             24
     8CNLP  ,ETATLP,DHTCLP,DHTF  ,BLLP  ,WG55  ,FAR55 ,HPEXT ,             25
     9AM    ,ALTP  ,ETAR  ,ZF    ,PCNF  ,ZC    ,PCNC  ,WFB   ,             26
     $TFFHP ,TFFLP ,PCBLF ,PCBLC ,PCBLDU,PCBLOB,PCBLHP,PCBLLP              27
      COMMON/SIDE/QXQ(48)/BACK/QWQ(72)                                      28
      COMMON/DUMMYS/DUMMY(100)                                              29
      EQUIVALENCE (FXFN2M,DUMMY(50)),(FXM2CP,DUMMY(51))                     30
      LOGICAL FXFN2M,FXM2CP                                                 31
      EQUIVALENCE (AFTFAN,DUMMY(58))                                        32
      EQUIVALENCE(TFFACT,DUMMY(64)),(CNACT,DUMMY(67)),(DHCACT,DUMMY(72))    33
     1,(DHTACT,DUMMY(73)),(ETAACT,DUMMY(76))                                34
      LOGICAL AFTFAN                                                        35
      COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI     36
     1,ETAI,WACI,TFFIP,CNIP,ETATIP,DHTCIP,DHTI,BLIP,PCBLIP,PCNIGU,ZIDS,     37
     2PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS,    38
     3TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI ,T22DS,WA21          39
      COMMON /LTURB/TFFX(15),CNX(15,15),DHTCX(15,15),ETATX(15,15),          40
     1NTFFS,NPTTFF(15)                                                      41
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      DIMENSION ERR(9)                                                  42
      EQUIVALENCE (ERR,DUMMY(11))                                       43
      DATA AWORD,WLO,WHI/6HCOLPTB,6H (LO) ,6H (HI) /                    44
      WORD=AWORD                                                        45
      IF (IDES.EQ.0) GO TO 1                                            46
      CNLPCF=CNLPDS*SQRT(T5)/PCNF                                       47
1     CNLP=CNLPCF*PCNF/SQRT(T5)                                         48
      CNLPS=CNLP                                                        49
      TFFLPS=TFFLP                                                      50
      CALL SEARCH (-1.,TFFLP,CNLP,DHTCLP,ETATLP,TFFX(1),NTFFS,CNX(1,1),D 51
     1HTCX(1,1),ETATX(1,1),NPTTFF(1),15,15,IGO)                         52
      IF (IGO.EQ.1.OR.IGO.EQ.11.OR.IGO.EQ.21) WRITE (8,8) TFFLPS,WLO    53
      IF (IGO.EQ.2.OR.IGO.EQ.12.OR.IGO.EQ.22) WRITE (8,8) TFFLPS,WHI    54
      IF (IGO.EQ.10.OR.IGO.EQ.11.OR.IGO.EQ.12) WRITE (8,9) CNLPS,WLO    55
      IF (IGO.EQ.20.OR.IGO.EQ.21.OR.IGO.EQ.22) WRITE (8,9) CNLPS,WHI    56
      IF (IGO.NE.7) GO TO 2                                             57
      CALL ERROR                                                        58
      RETURN                                                            59
2     MAPGO=0                                                           60
      IF (ABS(TFFLPS-TFFLP).LE.0.001*TFFLPS) GO TO 3                    61
      MAPGO=1                                                           62
      IF (ABS(CNLPS-CNLP).GT.0.001*CNLPS) MAPGO=3                       63
      GO TO 4                                                           64
3     IF (ABS(CNLPS-CNLP).GT.0.001*CNLPS) MAPGO=2                       65
4     IF (MAPGO.GT.0) CALL MAPBAC (2,MAPGO,TFFLPS,TFFLP,CNLPS,CNLP,PCNF, 65
     1T4,MODE,NOMAP,NUMMAP)                                             67
      IF (NOMAP.GT.0) RETURN                                            68
      TFLCAL=WG5*SQRT(T5)/(14.696*P5)                                   69
      DHTCF=WAF*(H22-H2)/(WG5*T5)                                       70
      IF (FXFN2M) DHTCF=(WAF*(H22-H2)+WAI*(H21-H22))/(WG5*T5)           71
      IF (FXFN2M.AND.AFTFAN) DHTCF=(WAF*(H22-H2)+WAI*(H21-H2))/(WG5*T5) 72
      IF (IDES.EQ.0) GO TO 5                                            73
      TFLPCF=TFLPDS/TFLCAL                                              74
      DHLPCF=DHTCF/DHTCLP                                               75
      ETLPCF=ETLPDS/ETATLP                                              76
      WRITE (6,10) CNLPCF,TFLPCF,ETLPCF,DHLPCF                          77
5     TFLCAL=TFLPCF*TFLCAL                                              78
      DHTCLP=DHLPCF*DHTCLP                                              79
      ETATLP=ETLPCF*ETATLP                                              80
      DHTF=DHTCF*T5                                                     81
      TFFACT=TFLCAL/TFLPCF                                              82
      CNACT=CNLP/CNLPCF                                                 83
      DHCACT=DHTCLP/DHLPCF                                              84
      DHTACT=DHTF                                                       85
      ETAACT=ETATLP                                                     86
      ERR(3)=(TFLCAL-TFFLP)/TFLCAL                                      87
      ERR(4)=(DHTCF-DHTCLP)/DHTCF                                       88
      CALL TURB (DHTF,ETATLP,FAR5,H5,S5,P5,T55,H55,S55,P55)             89
      IF (BLLP.LE.0.) GO TO 6                                           90
      FAR55=WFB/(WA3+BLHP+BLLP)                                         91
      WG55=WG5+BLLP                                                     92
      H55=(BLLP*H3+WG5*H55)/WG55                                        93
      CALL THERMO (P55,H55,T55,S55,XX2,1,FAR55,1)                       94
      GO TO 7                                                           95
6     FAR55=FAR5                                                        96
      WG55=WG5                                                          97
7     CALL FRTOSD                                                       98
      RETURN                                                            99
C                                                                      100
C                                                                      101
8     FORMAT (19H0*****TFFLP OFF MAP,F10.4,2XA6,11H*****$$$$$$)       102
9     FORMAT (19H0***** CNLP OFF MAP,F10.4,2XA6,11H*****$$$$$$)       103
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10    FORMAT (20HOL.P. TURBINE DESIGN,5X7HCNLPCF=,E15.8,8H TFLPCF=,E15.8      104
     1,8H ETLPCF=,E15.8,8H DHLPCF=,E15.8)                                     105
      END                                                                     106



$IBFTC CODUCT  DECK
      SUBROUTINE CODUCT                                                        1
      COMMON /   ALL/                                                          2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,                3
     2IGASMK,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,                4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                        5
      COMMON /DESIGN/                                                          6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,                7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,                8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,                9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,               10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,               11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,               12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,               13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,               14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,               15
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV               16
      COMMON/FRONT/XX(80)                                                     17
      COMMON /  SIDE/                                                         18
     1P1    ,WAF   ,WAC   ,BLF   ,BLDU  ,H3    ,DUMS1 ,DUMS2 ,               19
     2T21   ,P21   ,H21   ,S21   ,T23   ,P23   ,H23   ,S23   ,               20
     3T24   ,P24   ,H24   ,S24   ,T25   ,P25   ,H25   ,S25   ,               21
     4T28   ,P28   ,H28   ,S28   ,T29   ,P29   ,H29   ,S29   ,               22
     5WAD   ,WFD   ,WG24  ,FAR24 ,ETAD  ,DPDUC ,BYPASS,DUMS3 ,               23
     6TS28  ,PS28  ,V28   ,AM28  ,TS29  ,PS29  ,V29   ,AM29                  24
      COMMON/BACK/ZZ(72)                                                      25
      COMMON/DUMMYS/DUMMY(100)                                                26
      COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI       27
     1,ETAI,WACI,TFFIP,CNIP,ETATIP,DHTCIP,DHTI,BLIP,PCBLIP,PCNIGU,ZIDS,       28
     2PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS,      29
     3TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI ,T22DS,WA21            30
      DIMENSION ERR(9)                                                        31
      EQUIVALENCE (ERR,DUMMY(11))                                             32
      EQUIVALENCE(A24,DUMMY(4)),(AM23,DUMMY(5))                               33
      EQUIVALENCE (AFTFAN,DUMMY(58)),(PCBLID,DUMMY(61))                       34
      LOGICAL AFTFAN                                                          35
      DIMENSION Q(9)                                                          36
      DATA AWORD1,AWORD2/6HCODUCT,6HDNOZZL/                                   37
      WORD=AWORD1                                                             38
      Q(2)=0.                                                                 39
      Q(3)=0.                                                                 40
      AJ=778.26                                                               41
      CAPSF=2116.2170                                                         42
      GOGO=0.0                                                                43
      G=32.174049                                                             44
      WAX=WAF-WAI-BLF                                                         45
      IF (PCBLID.EQ.0.) WAX=WAF-WAC-BLF                                       46
      IF (AFTFAN) WAX=WAF-BLF                                                 47
      WAD=WAX+BLDU                                                            48
      P23=P22                                                                 49
C***  DRY LOSS                                                                50
      H23=(BLDU*H3+WAX*H22)/WAD                                               51
      CALL THERMO (P23,H23,T23,S23,XX2,1,0.0,1)                               52
      WA23C=WAD*SQRT(T23)/P23                                                 53
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      IF (IDES.EQ.1) WA23DS=WA23C                                          54
      BYPASS=(WAF-WAI)/WAI                                                 55
      IF (AFTFAN) BYPASS=WAF/WAI                                           56
      DPDUC=DPDUDS*(WA23C/WA23DS)                                          57
      IF (DPDUC.GT.1.) DPDUC=1.0                                           58
      P24=P23*(1.-DPDUC)                                                   59
      CALL PROCOM (0.,T23,XX1,XX2,XX3,XX4,PHI23,XX6)                       60
      IF (IGASMX.GT.0) IDBURN=0                                            61
      IF (SJBFAN.GT.0.) GO TO 7                                            62
      AM24=AM23                                                            63
      TS24=T23*0.875                                                       64
1     DO 2 I=1,15                                                          65
      CALL PROCOM (0.,TS24,CS24,AK24,CP24,REX24,PHIS24,HS24)               66
      V24=AM24*CS24                                                        67
      HSCAL=H23-V24**2/(2.*G*AJ)                                           68
      DELHS=HSCAL-HS24                                                     69
      IF (ABS(DELHS).LE.0.001*HSCAL) GO TO 3                               70
2     TS24=TS24+DELHS/CP24                                                 71
      GO TO 11                                                             72
3     C1=P24*SQRT(G/(T23*AJ))*CAPSF                                        73
      IF (IDES.NE.1) GO TO 4                                               74
      IF (GOGO.GT.0.) GO TO 4                                              75
      ASTOA=((AK24+1.)/2.)**((AK24+1.)/(2.*(AK24-1.)))*AM24*(1.+(((AK24-   76
     11.)/2.)*AM24**2))**((AK24+1.)/(2.*(AK24-1.)))                        77
      EQWCR=SQRT(G*AK24/REX24/AJ)/(SQRT(518.69)/2116.2)*(2.0/(AK24+1.))*   78
     1*((AK24+1.)/2./(AK24-1.))                                            79
      WA23CC=WA23C/SQRT(518.69)                                            80
      A24=1./ASTOA*WA23CC/EQWCR                                            81
      GOGO=1.0                                                             82
4     WQA=WAD/A24                                                          83
      WQAT=C1*SQRT(AK24/REX24)*AM24/(1.+(AK24-1.)*AM24**2/2.)**((AK24+1.   84
     1)/(2.*(AK24-1.)))                                                    85
      DIR=WQA/WQAT                                                         86
      EW=(WQA-WQAT)/WQA                                                    87
      CALL AFQUIR (Q(1),AM24,EW,0.,30.,0.001,DIR,AM24T,IGO)                88
      GO TO (5,6,11),IGO                                                   89
5     AM24=AM24T                                                           90
      IF (AM24.GT.1.0) AM24=0.5                                            91
      GO TO 1                                                              92
6     PS24=P24/EXP((PHI23-PHIS24)/REX24)                                   93
7     IF (IDBURN.GT.0) GO TO 8                                             94
C***  NON-DUCT BURNING                                                     95
      T24=T23                                                              96
      WFD=0.                                                               97
      FAR24=0                                                              98
      GO TO 17                                                             99
8     IF (IDBURN.EQ.2) T24=T23+2000.                                      100
9     IF (T24.GT.4000.) T24=4000.                                         101
      IF (T24.LT.T23) T24=T23                                             102
C***  DUCT BURNING                                                        103
      RHO42=CAPSF*PS24/(AJ*REX24*TS24)                                    104
      PS42=PS24                                                           105
      V42=V24                                                             106
      Q(2)=0.                                                             107
      Q(3)=0.                                                             108
C *** IF DESIRED, ENTER CALCULATIONS FOR ETAD HERE                        109
      HV=((((((-.4594317E-19*T24)-.2034116E-15)*T24+.2783643E-11)*T24+.2  110
     1051501E-07)*T24-.2453116E-03)*T24-.9433296E-01)*T24+.1845537E+05    111
      CALL THERMO (P24,HA,T24,XX1,XX2,0,0.0,0)                            112
      FAR24=(HA-H23)/(HV*ETAD)                                            113
      IF (FAR24.LT.0.) FAR24=0.                                           114
      WFDX=FAR24*WAD                                                      115
      IF (IDBURN.NE.2) GO TO 12                                           116
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      ERRW=(WFD-WFDX)/WFD                                                117
      DIR=SQRT(WFD/WFDX)                                                 118
      CALL AFQUIR (Q(1),T24,ERRW,0.,20.,0.0001,DIR,T24T,IGO)             119
      GO TO (10,13,11),IGO                                               120
10    T24=T24T                                                           121
      GO TO 9                                                            122
11    CALL ERROR                                                         123
12    WFD=WFDX                                                           124
13    CONTINUE                                                           125
C***  MOMENTUM LOSS                                                      126
      WG24=WFD+WAD                                                       127
      CALL PROCOM (FAR24,T24,XX1,XX2,XX3,REX24,PHI24,H24)                128
      RHO24=CAPSF*P24/(AJ*REX24*T24)                                     129
      V24=WG24/(RHO24*A24)                                               130
      Q(2)=0.                                                            131
      Q(3)=0.                                                            132
      PS24=PS42-0.01                                                     133
14    RHO24=WG24/(V24*A24)                                               134
      HS24=H24-V24**2/(2.*G*AJ)                                          135
      CALL THERMO (1.0,HS24,TS24,PHIS24,XX2,1,FAR24,1)                   136
      IF (TS24.GE.301.) GO TO 15                                         137
      CALL THERMO (1.0,HS24,400.,PHIS24,XX2,1,FAR24,1)                   138
      V24=SQRT(2.*G*AJ*(H24-HS24))                                       139
      GO TO 14                                                           140
15    PS24=RHO24*AJ*REX24*TS24/CAPSF                                     141
      PS24A=PS42+(RHO42*V42**2-RHO24*V24**2)/(G*CAPSF)                   142
      DIR=SQRT(ABS(PS24/PS24A))                                          143
      EP=(PS24-PS24A)/PS24                                               144
      CALL AFQUIR (Q(1),V24,EP,0.,50.,0.001,DIR,V24T,IGO)                145
      V24=V24T                                                           146
      IF (V24.LT.25.) V24=25.                                            147
      GO TO (14,16,11),IGO                                               148
16    P24=PS24*EXP((PHI24-PHIS24)/REX24)                                 149
      CALL PROCOM (FAR24,TS24,CS24,XX2,XX3,XX4,XX5,XX6)                  150
      AM24=V24*CS24                                                      151
17    CALL THERMO (P24,H24,T24,S24,XXI,1,FAR24,0)                        152
      WG24=WFD+WAD                                                       153
      T25=T24                                                            154
      P25=P24                                                            155
      H25=H24                                                            156
      S25=S24                                                            157
      IF (IGASMX.GT.0) GO TO 21                                          158
      WORD=AWORD2                                                        159
      A28SAV=A28                                                         160
      A29SAV=A29                                                         161
      NOZD=0                                                             162
      IDNOZ=0                                                            163
      IF (NOZFLT.EQ.2.OR.NOZFLT.EQ.3) NOZD=1                             164
      IF (IDES.EQ.1.OR.IDBURN.GT.0.OR.NOZD.EQ.1) IDNOZ=1                 165
      IF (IDCD.EQ.1) GO TO 18                                            166
      CALL CONVRG (T25,H25,P25,S25,FAR24,WG24,P1,IDNOZ,A28,P25R,T28,H28,  167
     1P28,S28,TS28,PS28,V28,AM28,ICON)                                   168
      GO TO (19,19,19,11),ICON                                           169
18    CALL CONDIV (T25,H25,P25,S25,FAR24,WG24,P1,IDNOZ,A28,A29,P25R,T28, 170
     1H28,P28,S28,T29,H29,P29,S29,TS28,TS29,PS28,PS29,V28,V29,AM28,AM29, 171
     2ICON)                                                              172
      IDSHOC=ICON                                                        173
      GO TO (20,20,20,11),ICON                                           174
19    T29=T28                                                            175
      H29=H28                                                            176
      P29=P28                                                            177
      S29=S28                                                            178
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      TS29=TS28                                                          179
      PS29=PS28                                                          180
      V29=V28                                                            181
      AM29=AM28                                                          182
      A29=A28                                                            183
      IDSHOC=ICON+3                                                      184
20    ERR(5)=(P25R-P25)/P25R                                             185
      IF (IDNOZ.EQ.1) WRITE (6,22) A28,AM28,A29,AM29                     186
21    CALL FASTBK                                                        187
      RETURN                                                             188
C                                                                        189
C                                                                        190
22    FORMAT (19HODUCT NOZZLE DESIGN,5X8H    A28=,E15.8,8H   AM28=,E15.8 191
     1,8H    A29=,E15.8,8H   AM29=,E15.8)                               192
      END                                                                193
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$IBFTC COMIX   DECK
      SUBROUTINE COMIX                                                    1
      COMMON /   ALL/                                                     2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,           3
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,           4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                   5
      COMMON /DESIGN/                                                     6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,           7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,           8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,           9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,          10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,          11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,          12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,          13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,          14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,          15
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV           16
      COMMON/FRONT/QZQ(80)/SIDE/QWQ(48)                                  17
      COMMON /  BACK/                                                    18
     1T55   ,P55   ,H55   ,S55   ,T25   ,P25   ,H25   ,S25   ,          19
     2WFB   ,WG55  ,FAR55 ,WFD   ,WG24  ,FAR24 ,P1    ,DUMB  ,          20
     3T6    ,P6    ,H6    ,S6    ,T7    ,P7    ,H7    ,S7    ,          21
     4T8    ,P8    ,H8    ,S8    ,T9    ,P9    ,H9    ,S9    ,          22
     5WG6   ,WFA   ,WG7   ,FAR7  ,ETAA  ,DPAFT ,V55   ,V25   ,          23
     6PS6   ,V6    ,AM6   ,TS7   ,PS7   ,V7    ,AM7   ,AM25  ,          24
     7TS8   ,PS8   ,V8    ,AM8   ,TS9   ,PS9   ,V9    ,AM9   ,          25
     8VA    ,FRD   ,VJD   ,FGMD  ,VJM   ,FGMM  ,FGPD  ,FGPM  ,          26
     9FGM   ,FGP   ,WFT   ,WGT   ,FART  ,FG    ,FN    ,SFC             27
      COMMON/DUMMYS/DUMMY(100)                                           28
      COMMON/SPOOL2/TWOSPL(44)                                           29
      EQUIVALENCE (ERR,DUMMY(11))                                        30
      EQUIVALENCE (ZF,QZQ(68)),(PCNF,QZQ(69))                            31
      DIMENSION ERR(9)                                                   32
      COMMON/LOOPPR/KKGO,PRFNEW,PRCNEW                                   33
      DATA AWORD/6H COMIX/                                               34
      DIMENSION QQ(9)                                                    35
      WORD=AWORD                                                         36
      AJ=778.26                                                          37
      CAPSF=2116.2170                                                    38
      G=32.174049                                                        39
      CALL PROCOM (FAR55,T55,XX1,XX2,XX3,XX4,PHI55,XX5)                  40
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```
      CALL PROCOM (FAR24,T25,XX1,XX2,XX3,XX4,PHI25,XX5)                  41
      IF (IDES.EQ.0) GO TO 12                                            42
C *** CALCULATE A55 AND A25 WITH PS25=PS55                               43
      IF (PS55.EQ.0.) GO TO 3                                            44
      TS55=T55*(PS55/P55)**0.286                                         45
      DO 1 I=1,15                                                        46
      CALL PROCOM (FAR55,TS55,CS55,AK55,CP55,REX55,PHIS55,HS55)          47
      PHIS=PHI55-REX55*ALOG(P55/PS55)                                    48
      DELPHI=PHIS-PHIS55                                                 49
      IF (ABS(DELPHI).LE.0.0001*PHIS) GO TO 6                            50
1     TS55=TS55*EXP(4.0*DELPHI)                                          51
2     CALL ERROR                                                         52
      RETURN                                                             53
3     TS55=0.875*T55                                                     54
      DO 4 I=1,15                                                        55
      CALL PROCOM (FAR55,TS55,CS55,AK55,CP55,REX55,PHIS55,HS55)          56
      V55=AM55*CS55                                                      57
      HSCAL=H55-V55**2/(2.*G*AJ)                                         58
      DELHS=HSCAL-HS55                                                   59
      IF (ABS(DELHS).LE.0.0005*HSCAL) GO TO 5                            60
4     TS55=TS55+DELHS/CP55                                               61
      GO TO 2                                                            62
5     PS55=P55/EXP((PHI55-PHIS55)/REX55)                                 63
      IF (PS55.GT.P25.AND.IDES.EQ.1.AND.IGASMX.GT.0) GO TO 45            64
6     IF (H55.GT.HS55) GO TO 7                                           65
      WRITE (8,46) P55,PS55,T55,TS55,H55,HS55                            66
      CALL ERROR                                                         67
7     V55=SQRT(2.*G*AJ*(H55-HS55))                                       68
      RHO=CAPSF*PS55/(AJ*REX55*TS55)                                     69
      A55=WG55/(RHO*V55)                                                 70
      AM55=V55/CS55                                                      71
      IF (IGASMX.GT.0) GO TO 8                                           72
      WRITE (6,47) A55,AM55                                              73
      GO TO 41                                                           74
8     PS25=PS55                                                          75
      TS25=T25*(PS25/P25)**0.286                                         76
      DO 9 I=1,15                                                        77
      CALL PROCOM (FAR24,TS25,CS25,AK25,CP25,REX25,PHIS25,HS25)          78
      PHIS=PHI25-REX25*ALOG(P25/PS25)                                    79
      DELPHI=PHIS-PHIS25                                                 80
      IF (ABS(DELPHI).LE.0.0001*PHIS) GO TO 10                           81
9     TS25=TS25*EXP(4.0*DELPHI)                                          82
      GO TO 2                                                            83
10    IF (H25.GT.HS25) GO TO 11                                          84
      WRITE (8,48) P25,PS25,T25,TS25,H25,HS25                            85
      CALL ERROR                                                         86
11    V25=SQRT(2.*G*AJ*(H25-HS25))                                       87
      RHO=CAPSF*PS25/(AJ*REX25*TS25)                                     88
      A25=WG24/(RHO*V25)                                                 89
      AM25=V25/CS25                                                      90
      WRITE (6,49) A55,AM55,A25,AM25                                     91
      GO TO 27                                                           92
C *** CALCULATE PS55 AND PS25                                            93
12    WQA=WG55/A55                                                       94
      C1=P55*SQRT(G/(T55*AJ))*CAPSF                                      95
      MCON=0                                                             96
      QQ(2)=0.                                                           97
      QQ(3)=0.                                                           98
      AM55=0.50                                                          99
      TS55=0.875*T55                                                    100
13    DO 14 I=1,15                                                      101
      CALL PROCOM (FAR55,TS55,CS55,AK55,CP55,REX55,PHIS55,HS55)         102
      V55=AM55*CS55                                                     103
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```
      HSCAL=H55-V55**2/(2.*G*AJ)                                        104
      DELHS=HSCAL-HS55                                                  105
      IF (ABS(DELHS).LE.0.0005*HSCAL) GO TO 15                          106
14    TS55=TS55+DELHS/CP55                                              107
      GO TO 2                                                           108
15    WQAT=C1*SQRT(AK55/REX55)*AM55/(1.+(AK55-1.)*AM55**2/2.)**((AK55+1.  109
     1)/(2.*(AK55-1.)))                                                 110
      AMX=AM55                                                          111
      IGOGO=0                                                           112
16    DIR=WQA/WQAT                                                      113
      EW=(WQA-WQAT)/WQA                                                 114
      CALL AFQUIR (QQ(1),AMX,EW,0.,30.,0.0005,DIR,AMXT,ICON)            115
      GO TO (17,22,2),ICON                                              116
17    IF (AMXT.LE.1.0) GO TO 20                                         117
      AMXT=0.7                                                          118
      MCON=MCON+1                                                       119
      IF (MCON.LE.1) GO TO 20                                           120
      IF (MODE.EQ.3) GO TO 19                                           121
      PCNF=DUMD1                                                        122
      WRITE (8,50) PCNF,AMX,P55,PS55,P25,PS25                           123
      PCNF=1.01*PCNF                                                    124
      DUMD1=PCNF                                                        125
18    NOMAP=7                                                           126
      RETURN                                                            127
19    WRITE (8,51) ZF,AMX,P55,PS55,P25,PS25                             128
      ZF=0.99*ZF                                                        129
      GO TO 18                                                          130
20    IF (IGOGO.EQ.1) GO TO 21                                          131
      AM55=AMXT                                                         132
      GO TO 13                                                          133
21    AM25=AMXT                                                         134
      GO TO 23                                                          135
22    IF (IGOGO.EQ.1) GO TO 26                                          136
      PS55=P55/EXP((PHI55-PHIS55)/REX55)                                137
      IF (IGASMX.LE.0) GO TO 41                                         138
      WQA=WG24/A25                                                      139
      C1=P25*SQRT(G/(T25*AJ))*CAPSF                                     140
      MCON=0                                                            141
      QQ(2)=0.                                                          142
      QQ(3)=0.                                                          143
      AM25=0.25                                                         144
      TS25=0.875*T25                                                    145
23    DO 24 I=1,15                                                      146
      CALL PROCOM (FAR24,TS25,CS25,AK25,CP25,REX25,PHIS25,HS25)         147
      V25=AM25*CS25                                                     148
      HSCAL=H25-V25**2/(2.*G*AJ)                                        149
      DELHS=HSCAL-HS25                                                  150
      IF (ABS(DELHS).LE.0.0005*HSCAL) GO TO 25                          151
24    TS25=TS25+DELHS/CP25                                              152
      GO TO 2                                                           153
25    WQAT=C1*SQRT(AK25/REX25)*AM25/(1.+(AK25-1.)*AM25**2/2.)**((AK25+1.  154
     1)/(2.*(AK25-1.)))                                                 155
      AMX=AM25                                                          156
      IGOGO=1                                                           157
      GO TO 16                                                          158
26    PS25=P25/EXP((PHI25-PHIS25)/REX25)                                159
27    WG6=WG24+WG55                                                     160
      ERR(5)=(PS25-PS55)/PS25                                           161
      WF6=WFD+WFB                                                       162
      FAR6=WF6/(WG6-WF6)                                                163
      H6=(WG24*H25+WG55*H55)/WG6                                        164
      CALL THERMO (1.,H6,T6,PHI6,AMX,1,FAR6,1)                          165
      C1=PS55*A55*(1.+AK55*AM55**2)+PS25*A25*(1.+AK25*AM25**2)          166
```

```
      TS6=0.833*T6                                                          167
      DO 32 I=1,15                                                          168
      CALL PROCOM (FAR6,TS6,CS6,AK6,CP6,REX6,PHIS6,HS6)                     169
      C2=WG6*SQRT(AJ*REX6*T6/(AK6*G))                                       170
      C3=C2/(CAPSF*C1)                                                      171
      C4=(AK6-1.)/2.-(C3*AK6)**2                                            172
      C5=1.-2.*AK6*C3**2                                                    173
      C6=C5**2+4.*C4*C3**2                                                  174
      IF (C6) 28,29,30                                                      175
28    CALL ERROR                                                            176
      RETURN                                                                177
29    AM62G=-C5/(2.*C4)                                                     178
      GO TO 31                                                              179
30    AM62G=(SQRT(C6)-C5)/(2.*C4)                                           180
31    IF (AM62G.LE.0.) GO TO 28                                             181
      AM6G=SQRT(AM62G)                                                      182
      V6=AM6G*CS6                                                           183
      HSCAL=H6-V6**2/(2.*G*AJ)                                              184
      DELHS=HSCAL-HS6                                                       185
      IF (ABS(DELHS).LE.0.0005*HSCAL) GO TO 33                              186
32    TS6=TS6+DELHS/CP6                                                     187
      GO TO 28                                                              188
33    IF (IGASMX.GT.0) GO TO 34                                             189
34    A6G=A25+A55                                                           190
      C7=SQRT(1.+(AK6-1.)*AM62G/2.)                                         191
      PS6=C2/(CAPSF*A6G*AM6G*C7)                                            192
      P6=PS6*EXP((PHI6-PHIS6)/REX6)                                         193
      CALL THERMO (P6,H6,T6,S6,XX1,1,FAR6,0)                                194
      S6AVE=(WG24*S25+WG55*S55)/WG6                                         195
      IF (S6.GE.S6AVE) GO TO 35                                             196
      S6=S6AVE                                                              197
      P6=EXP(AMX*(PHI6-S6)/1.986375)                                        198
35    IF (IGASMX.EQ.1) GO TO 43                                             199
      IF (IDES.EQ.0) GO TO 38                                               200
C***  CALCULATES A6 AS A FUNCTION OF INPUT AM6                              201
      TS6=T6/(1.0+(((AK6-1.0)/2.0)*AM6**2))                                 202
      DO 36 JJ=1,15                                                         203
      AK6P=AK6                                                              204
      CALL PROCOM (FAR6,TS6,CS6,AK6,CP6,REX6,PHIS6,HS6)                     205
      V6=AM6*CS6                                                            206
      DELAK6=AK6P-AK6                                                       207
      IF (ABS(DELAK6).LE.0.0005*AK6) GO TO 37                               208
36    TS6=T6/(1.0+(((AK6-1.0)/2.0)*AM6**2))                                 209
      GO TO 28                                                              210
37    PS6=P6/(((1.0+(((AK6-1.0)/2.0)*AM6**2))**(AK6/(AK6-1.0)))             211
      AM6ABD=AM6                                                            212
      RHO=CAPSF*PS6/(AJ*REX6*TS6)                                           213
      A6=WG6/(RHO*V6)                                                       214
      WRITE (6,52) A6                                                       215
      GO TO 44                                                              216
C     CALCULATES M6=F(A6DESIGN)                                             217
38    TS6P=T6/(1.0+(((AK6-1.0)/2.0)*AM6ABD**2))                             218
      DO 39 I=1,15                                                          219
      CALL PROCOM (FAR6,TS6P,CS6,AK6,CP6,REX6,PHIS6,HS6)                    220
      PS6P=PS6*(TS6P/TS6)**(AK6/(AK6-1.0))                                  221
      RHO6=CAPSF*PS6P/(AJ*REX6*TS6P)                                        222
      V6=SQRT(2.*G*AJ*(H6-HS6))                                             223
      IF ((H6-HS6).LT.0.0) GO TO 42                                         224
      A6P=WG6/(RHO6*V6)                                                     225
      DELA6=A6P-A6                                                          226
      V6=WG6/(RHO6*A6)                                                      227
      AM6=V6/CS6                                                            228
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      AM62=AM6**2                                                       229
      IF (ABS(DELA6).LE.00.002*A6) GO TO 40                             230
39    TS6P=T6/(1.0+(((AK6-1.0)/2.0)*AM62))                              231
      GO TO 28                                                          232
40    TS6=TS5P                                                          233
      PS6=PS5P                                                          234
      GO TO 44                                                          235
41    T6=T55                                                            236
      P6=P55                                                            237
      H6=H55                                                            238
      S6=S55                                                            239
      WG6=WG55                                                          240
      PS6=PS55                                                          241
      V6=V55                                                            242
      AM6=AM55                                                          243
      IF (IGASMX.EQ.0) A6=A55                                           244
      GO TO 44                                                          245
42    WRITE (6,53) H6,HS6                                               246
      GO TO 28                                                          247
43    AM62=AM62G                                                        248
      AM6=AM6G                                                          249
      A6=A25+A55                                                        250
44    CALL COAFBN                                                       251
      RETURN                                                            252
45    KKGO=1                                                            253
      OPRDS=PRFDS*PRCDS                                                 254
      PRFNEW=PRFDS*PS55/P25*1.02                                        255
      PRCNEW=OPRDS/PRFNEW                                               256
      CALL ENGBAL                                                       257
      RETURN                                                            258
C                                                                       259
C                                                                       260
46    FORMAT (22HOSQRT OF H55-HS55 NEG ,6E15.6,6H$$$$$$)                261
47    FORMAT (20HOTURBINE AREA DESIGN,6X6H  A55=,E15.8,8H   AM55=,E15.8)  262
48    FORMAT (22HOSQRT OF H25-HS25 NEG ,6E15.6,6H$$$$$$)                263
49    FORMAT (25HOTURBINE/DUCT AREA DESIGN,7H   A55=,E15.8,8H   AM55=,E1  264
     15.8,8H    A25=,E15.8,8H   AM25=,E15.8)                           265
50    FORMAT (12HOCOMIX PCNF=,F7.4,4H AM=,F8.6,5H P55=,F9.5,6H PS55=,F9.  266
     15,5H P25=,F9.5,6H PS25=,F9.5,6H$$$$$$)                           267
51    FORMAT (10HOCOMIX ZF=,F8.5,4H AM=,F8.6,5H P55=,F9.5,6H PS55=,F9.5,  268
     15H P25=,F9.5,6H PS25=,F9.5,6H$$$$$$)                             269
52    FORMAT (3X,27HAFTERBURNER DESIGN AREA A6 F8.3)                    270
53    FORMAT (3X,18HNEG.HS6 FACTOR H6 F9.4,3X,4HHS6 F9.4)               271
      END                                                               272
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```
$IBFTC COAFBN  DECK
      SUBROUTINE COAFBN                                                  1
      COMMON /   ALL/                                                    2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,          3
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,          4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                  5
      COMMON /DESIGN/                                                    6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,          7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,          8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,          9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,         10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,         11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,         12
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```
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV
      COMMON/FRONT/QXQ(80)/SIDE/QYQ(48)
      COMMON /  BACK/
     1T55   ,P55   ,H55   ,S55   ,T25   ,P25   ,H25   ,S25   ,
     2WFB   ,WG55  ,FAR55 ,WFD   ,WG24  ,FAR24 ,P1    ,DUMB  ,
     3T6    ,P6    ,H6    ,S6    ,T7    ,P7    ,H7    ,S7    ,
     4T8    ,P8    ,H8    ,S8    ,T9    ,P9    ,H9    ,S9    ,
     5WG6   ,WFA   ,WG7   ,FAR7  ,ETAA  ,DPAFT ,V55   ,V25   ,
     6PS6   ,V6    ,AM6   ,TS7   ,PS7   ,V7    ,AM7   ,AM25  ,
     7TS8   ,PS8   ,V8    ,AM8   ,TS9   ,PS9   ,V9    ,AM9   ,
     8VA    ,FRD   ,VJD   ,FGMD  ,VJM   ,FGMM  ,FGPD  ,FGPM  ,
     9FGM   ,FGP   ,WFT   ,WGT   ,FART  ,FG    ,FN    ,SFC
      COMMON/DUMMYS/DUMMY(100)
      COMMON/SPOOL2/TWOSPL(44)
      EQUIVALENCE (ERR,DUMMY(11))
      DIMENSION ERR(9)
      EQUIVALENCE (P6DSAV,DUMMY(7)),(AM6DSV,DUMMY(8)),(ETAASV,DUMMY(9)),
     1(FAR7SV,DUMMY(10))
      DIMENSION Q(9)
      DATA AWORD/6HCOAFBN/
      WORD=AWORD
      Q(2)=0.
      Q(3)=0.
      AJ=778.26
      CAPSF=2116.2170
      G=32.174049
C***  P6DS AND AM6DS ARE SET FOR GENERALIZATION OF AFTERBURNER
C***  EFFICIENCY MAP GENERALIZATION
      IF (IDES.EQ.1) P6DS=P6*14.696
      IF (IDES.EQ.1) AM6DS=AM6
      WF6=WFB
      IF (IGASMX.GT.0) WF6=WF6+WFD
      WA6=WG6-WF6
C *** DRY LOSS
      WG6C=WG6*SQRT(T6)/P6
      IF (IDES.EQ.1) WG6CDS=WG6C
      DPAFT=DPAFDS*(WG6C/WG6CDS)
      IF (DPAFT.GT.1.) DPAFT=1.
      P7=P6*(1.-DPAFT)
      A7=A6
      FAR6=WF6/WA6
      CALL PROCOM (FAR6,T6,XX1,XX2,XX3,XX4,PHI6,XX6)
      WQA=WG6/A7
      C1=P7*SQRT(G/(T6*AJ))*CAPSF
      AM7=AM6
      TS7=0.875*T6
1     DO 2 I=1,15
      CALL PROCOM (FAR6,TS7,CS7,AK7,CP7,REX7,PHIS7,HS7)
      V7=AM7*CS7
      HSCAL=H6-V7**2/(2.*G*AJ)
      DELHS=HSCAL-HS7
      IF (ABS(DELHS).LE.0.0005*HSCAL) GO TO 3
2     TS7=TS7+DELHS/CP7
      GO TO 14
3     WQAT=C1*SQRT(AK7/REX7)*AM7/(1.+(AK7-1.)*AM7**2/2.)**((AK7+1.)/(2.*
     1(AK7-1.)))
      DIR=WQA/WQAT
      EW=(WQA-WQAT)/WQA
      CALL AFQUIR (Q(1),AM7,EW,0.,40.,.001,DIR,AM7T,IGO)
      GO TO (4,5,14),IGO
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4       AM7=AM7T                                                          76
        IF (AM7.GE.1.0) AM7=0.9                                           77
        GO TO 1                                                           78
5       PS7=P7/EXP((PHI6-PHIS7)/REX7)                                     79
        IF (IAFTBN.GT.0) GO TO 7                                          80
C *** NON-AFTERBURNING                                                    81
6       T7=T6                                                             82
        WFA=0.0                                                           83
        FAR7=FAR6                                                         84
        WG7=WG6                                                           85
        IF (IDES.EQ.1.AND.T7DS.NE.0.) GO TO 7                             86
        GO TO 20                                                          87
C *** AFTERBURNING                                                        88
7       IF (IAFTBN.EQ.2) T7=T6+2000.                                      89
        IF (IDES.EQ.1) T7=T7DS                                            90
        IF (T7.LE.T6) GO TO 6                                             91
        RHO65=GAPSF*PS7/(AJ*REX7*TS7)                                     92
        PS65=PS7                                                          93
        V65=V7                                                            94
        Q(2)=0.                                                           95
        Q(3)=0.                                                           96
8       IF (T7.GT.4000.) T7=4000.                                         97
        HV=((((((-.4594317E-19*T7)-.2034116E-15)*T7+.2783643E-11)*T7+.2051 98
      1501E-07)*T7-.2453115E-03)*T7-.9433296E-01)*T7+.1845537E+05         99
        CALL THERMO (P7,HA,T7,XX1,XX2,1,FAR6,0)                          100
C***    TO ALTER DESIGN ABETAA MAP FROM GENERAL TO SPECIFIC MAP           101
        IF (IDES.NE.1) GO TO 9                                            102
        FAR7DS=(HA-H6)/(HV*ETAADS)                                        103
        CALL ETAAB (0.,0.,0.,0.,ETAADS,ETAASV,P6DS,P6DSAV,AM6DS,AM6DSV,IDE 104
      1S,FAR7DS,FAR7SV)                                                   105
        T7=T6                                                             106
        GO TO 20                                                          107
9       P6GS=P6*14.696                                                    108
        FAR7DS=(HA-H6)/(HV*ETAADS)                                        109
        DO 10 II=1,15                                                     110
        CALL ETAAB (FAR7GS,AM6,P6GS,ETAA,ETAADS,ETAASV,P6DS,P6DSAV,AM6DS,A 111
      1M6DSV,IDES,FAR7DS,FAR7SV)                                          112
        FAR7=(HA-H6)/(HV*ETAA)                                            113
        DELFA7=ABS(FAR7-FAR7GS)                                           114
        IF (DELFA7.LE.0.01*FAR7) GO TO 11                                 115
10      FAR7GS=FAR7                                                       116
11      CONTINUE                                                          117
        IF (FAR7.GT.0.) GO TO 12                                          118
        CALL ERROR                                                        119
12      WFAX=FAR7*WG6                                                     120
        IF (IAFTBN.EQ.1) GO TO 15                                         121
        ERRW=(WFA-WFAX)/WFA                                               122
        DIR=SQRT(WFA/WFAX)                                                123
        CALL AFQUIR (Q(1),T7,ERRW,0.,30.,.0005,DIR,T7T,IGO)               124
        GO TO (13,16,14),IGO                                              125
13      T7=T7T                                                            126
        GO TO 8                                                           127
14      CALL ERROR                                                        128
15      WFA=WFAX                                                          129
16      FAR7=(WF6+WFA)/WA6                                                130
        WG7=WG6+WFA                                                       131
C *** MOMENTUM LOSS                                                       132
        CALL PROCOM (FAR7,T7,XX1,XX2,XX3,REX7,PHI7,H7)                    133
        RHO7=GAPSF*P7/(AJ*REX7*T7)                                        134
        V7=WG7/(RHO7*A7)                                                  135
        Q(2)=0.                                                           136
        Q(3)=0.                                                           137
        PS7=PS65-0.01                                                     138
```

```
17    RHO7=WG7/(V7*A7)                                                    139
      HS7=H7-V7**2/(2.*G*AJ)                                              140
      CALL THERMO (1.0,HS7,TS7,PHIS7,XX2,1,FAR7,1)                        141
      IF (TS7.GE.301.) GO TO 18                                           142
      CALL THERMO (1.0,HS7,400.,PHIS7,XX2,1,FAR7,0)                       143
      V7=SQRT(2.*G*AJ*(H7-HS7))                                           144
      GO TO 17                                                            145
18    PS7=RHO7*AJ*REX7*TS7/CAPSF                                          146
      PS7A=PS65+(RHO65*V65**2-RHO7*V7**2)/(G*CAPSF)                       147
      DIR=SQRT(ABS(PS7/PS7A))                                             148
      EP=(PS7-PS7A)/PS7                                                   149
      CALL ACQUIR (Q(1),V7,EP,0.,50.,.001,DIR,V7T,IGO)                    150
      V7=V7T                                                              151
      IF (V7.LT.100.) V7=100.                                             152
      GO TO (17,19,14),IGO                                                153
19    P7=PS7*EXP((PHI7-PHIS7)/REX7)                                       154
      CALL PROCOM (FAR7,TS7,CS7,XX2,XX3,XX4,XX5,XX6)                      155
      AM7=V7/CS7                                                          156
20    CALL THERMO (P7,H7,T7,S7,XX2,1,FAR7,0)                              157
      CALL COMNOZ                                                         158
      RETURN                                                              159
C                                                                         160
C                                                                         161
      END                                                                 162
```

```
$IBFTC FRTOSD  DECK
      SUBROUTINE FRTOSD                                                    1
      COMMON/ALL/XX(28)/DESIGN/YY(80)                                      2
      COMMON / FRONT/                                                      3
     1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,           4
     2T21   ,P21   ,H21   ,S21   ,T3    ,P3    ,H3    ,S3    ,           5
     3T4    ,P4    ,H4    ,S4    ,T5    ,P5    ,H5    ,S5    ,           6
     4T55   ,P55   ,H55   ,S55   ,BLF   ,BLC   ,BLDU  ,BLOB  ,           7
     5CNF   ,PRF   ,ETAF  ,WAFC  ,WAF   ,WA3   ,WG4   ,FAR4  ,           8
     6CNC   ,PRC   ,ETAC  ,WACC  ,WAC   ,ETAB  ,DPCOM ,DUMF  ,           9
     7CNHP  ,ETATHP,DHTCHP,DHTC  ,BLHP  ,WG5   ,FAR5  ,CS    ,          10
     8CNLP  ,ETATLP,DHTCLP,DHTF  ,BLLP  ,WG55  ,FAR55 ,HPEXT ,          11
     9AM    ,ALTP  ,ETAR  ,ZF    ,PCNF  ,ZC    ,PCNC  ,WFB   ,          12
     $TFFHP ,TFFLP ,PCBLF ,PCBLC ,PCBLDU,PCBLOB,PCBLHP,PCBLLP            13
      COMMON /  SIDE/                                                     14
     1XP1   ,XWAF  ,XWAC  ,XBLF  ,XBLDU ,XH3   ,DUMS1 ,DUMS2 ,          15
     2XT21  ,XP21  ,XH21  ,XS21  ,T23   ,P23   ,H23   ,S23   ,          16
     3T24   ,P24   ,H24   ,S24   ,T25   ,P25   ,H25   ,S25   ,          17
     4T28   ,P28   ,H28   ,S28   ,T29   ,P29   ,H29   ,S29   ,          18
     5WAD   ,WFD   ,WG24  ,FAR24 ,ETAD  ,DPDUC ,BYPASS,DUMS3 ,          19
     6TS28  ,PS28  ,V28   ,AM28  ,TS29  ,PS29  ,V29   ,AM29             20
      COMMON/BACK/ZZ(72)                                                  21
      COMMON/DUMMYS/DUMMY(100)                                            22
      COMMON/SPOOL2/TWOSPL(44)                                            23
      XP1=P1                                                              24
      XWAF=WAF                                                            25
      XWAC=WAC                                                            26
      XBLF=BLF                                                            27
      XBLDU=BLDU                                                          28
      XH3=H3                                                              29
      XT21=T21                                                            30
      XP21=P21                                                            31
```

```
      XH21=H21                                                          32
      XS21=S21                                                          33
      CALL CODUCT                                                       34
      RETURN                                                            35
      END                                                               36



$IBFTC FASTBC  DECK
      SUBROUTINE FASTBK                                                  1
      COMMON/ALL/XX(28)/DESIGN/YY(80)                                    2
      COMMON / FRONT/                                                    3
     1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,         4
     2T21   ,P21   ,H21   ,S21   ,T3    ,P3    ,H3    ,S3    ,         5
     3T4    ,P4    ,H4    ,S4    ,T5    ,P5    ,H5    ,S5    ,         6
     4T55   ,P55   ,H55   ,S55   ,BLF   ,BLC   ,BLDU  ,BLOB  ,         7
     5CNF   ,PRF   ,ETAF  ,WAFC  ,WAF   ,WA3   ,WG4   ,FAR4  ,         8
     6CNC   ,PRC   ,ETAC  ,WACC  ,WAC   ,ETAB  ,DPCOM ,DUMF  ,         9
     7CNHP  ,ETATHP,DHTCHP,DHTC  ,BLHP  ,WG5   ,FAR5  ,CS    ,        10
     8CNLP  ,ETATLP,DHTCLP,DHTF  ,BLLP  ,WG55  ,FAR55 ,HPEXT ,        11
     9AM    ,ALTP  ,ETAR  ,ZF    ,PCNF  ,ZC    ,PCNC  ,WFB   ,        12
     $TFFHP ,TFFLP ,PCBLF ,PCBLC ,PCBLDU,PCBLDB,PCBLHP,PCBLLP          13
      COMMON /  SIDE/                                                   14
     1XP1   ,XWAF  ,XWAC  ,XBLF  ,XBLDU ,XH3   ,DUMS1 ,DUMS2 ,        15
     2XT21  ,XP21  ,XH21  ,XS21  ,T23   ,P23   ,H23   ,S23   ,        16
     3T24   ,P24   ,H24   ,S24   ,T25   ,P25   ,H25   ,S25   ,        17
     4T28   ,P28   ,H28   ,S28   ,T29   ,P29   ,H29   ,S29   ,        18
     5WAD   ,WFD   ,WG24  ,FAR24 ,ETAD  ,DPDUC ,BYPASS,DUMS3 ,        19
     6TS28  ,PS28  ,V28   ,AM28  ,TS29  ,PS29  ,V29   ,AM29           20
      COMMON /  BACK/                                                   21
     1XT55  ,XP55  ,XH55  ,XS55  ,XT25  ,XP25  ,XH25  ,XS25  ,        22
     2XWFB  ,XWG55 ,XFAR55,XWFD  ,XWG24 ,XFAR24,XXP1  ,DUMB  ,        23
     3T6    ,P6    ,H6    ,S6    ,T7    ,P7    ,H7    ,S7    ,        24
     4T8    ,P8    ,H8    ,S8    ,T9    ,P9    ,H9    ,S9    ,        25
     5WG6   ,WFA   ,WG7   ,FAR7  ,ETAA  ,DPAFT ,V55   ,V25   ,        26
     6PS6   ,V6    ,AM6   ,TS7   ,PS7   ,V7    ,AM7   ,AM25  ,        27
     7TS8   ,PS8   ,V8    ,AM8   ,TS9   ,PS9   ,V9    ,AM9   ,        28
     8VA    ,FRD   ,VJD   ,FGMD  ,VJM   ,FGMM  ,FGPD  ,FGPM  ,        29
     9FGM   ,FGP   ,WFT   ,WGT   ,FART  ,FG    ,FN    ,SFC           30
      COMMON/DUMMYS/DUMMY(100)                                          31
      COMMON/SPOOL2/TWOSPL(44)                                          32
      XT55=T55                                                          33
      XP55=P55                                                          34
      XH55=H55                                                          35
      XS55=S55                                                          36
      XT25=T25                                                          37
      XP25=P25                                                          38
      XH25=H25                                                          39
      XS25=S25                                                          40
      XWFB=WFB                                                          41
      XWG55=WG55                                                        42
      XFAR55=FAR55                                                      43
      XWFD=WFD                                                          44
      XWG24=WG24                                                        45
      XFAR24=FAR24                                                      46
      XXP1=P1                                                           47
      CALL COMIX                                                        48
      RETURN                                                            49
      END                                                               50
```

```
$IBFTC COMNOZ  DECK
      SUBROUTINE COMNOZ                                                      1
      COMMON /   ALL/                                                        2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,              3
     2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,              4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                      5
      COMMON /DESIGN/                                                        6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,              7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,              8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,              9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,             10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,             11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,             12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,             13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,             14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,             15
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV              16
      COMMON/FRONT/QXQ(80)/SIDE/QYQ(48)                                     17
      COMMON /  BACK/                                                       18
     1T55   ,P55   ,H55   ,S55   ,T25   ,P25   ,H25   ,S25   ,             19
     2WFB   ,WG55  ,FAR55 ,WFD   ,WG24  ,FAR24 ,P1    ,DUMB  ,             20
     3T6    ,P6    ,H6    ,S6    ,T7    ,P7    ,H7    ,S7    ,             21
     4T8    ,P8    ,H8    ,S8    ,T9    ,P9    ,H9    ,S9    ,             22
     5WG6   ,WFA   ,WG7   ,FAR7  ,ETAA  ,DPAFT ,V55   ,V25   ,             23
     6PS6   ,V6    ,AM6   ,TS7   ,PS7   ,V7    ,AM7   ,AM25  ,             24
     7TS8   ,PS8   ,V8    ,AM8   ,TS9   ,PS9   ,V9    ,AM9   ,             25
     8VA    ,FRD   ,VJD   ,FGMD  ,VJM   ,FGMM  ,FGPD  ,FGPM  ,             26
     9FGM   ,FGP   ,WFT   ,WGT   ,FART  ,FG    ,FN    ,SFC                 27
      COMMON/DUMMYS/DUMMY(100)                                              28
      COMMON/SPOOL2/TWOSPL(44)                                              29
      EQUIVALENCE (ERR,DUMMY(11))                                           30
      DIMENSION ERR(9)                                                      31
      DATA AWORD/6HMNOZZL/                                                  32
      WORD=AWORD                                                            33
      A8SAV=A8                                                              34
      A9SAV=A9                                                              35
      NOZM=0                                                                36
      IMNOZ=0                                                               37
      IF (NOZFLT.EQ.1.OR.NOZFLT.EQ.3) NOZM=1                                38
      IF (IDES.EQ.1.OR.IAFTBN.GT.0.OR.NOZM.EQ.1) IMNOZ=1                    39
      IF (IMCD.EQ.1) GO TO 1                                                40
      CALL CONVRG (T7,H7,P7,S7,FAR7,WG7,P1,IMNOZ,A8,P7R,T8,H8,P8,S8,TS8,    41
     1PS8,V8,AM8,ICON)                                                      42
      GO TO (3,3,3,2),ICON                                                  43
1     CALL CONDIV (T7,H7,P7,S7,FAR7,WG7,P1,IMNOZ,A8,A9,P7R,T8,H8,P8,S8,T    44
     19,H9,P9,S9,TS8,TS9,PS8,PS9,V8,V9,AM8,AM9,ICON)                        45
      IMSHOC=ICON                                                           46
      GO TO (4,4,4,2),ICON                                                  47
2     CALL ERROR                                                            48
3     T9=T8                                                                 49
      H9=H8                                                                 50
      P9=P8                                                                 51
      S9=S8                                                                 52
      TS9=TS8                                                               53
      PS9=PS8                                                               54
      V9=V8                                                                 55
      AM9=AM8                                                               56
      A9=A8                                                                 57
      IMSHOC=ICON+3                                                         58
4     ERR(6)=(P7R-P7)/P7R                                                   59
      IF (IMNOZ.EQ.1) WRITE (6,5) A8,AM8,A9,AM9                             60
      RETURN                                                                61
```

```
C                                                                       62
C                                                                       63
5     FORMAT (14HONOZZLE DESIGN,10X8H     A8=,E15.8,8H    AM8=,E15.8,8H     64
     1    A9=,E15.8,8H    AM9=,E15.8)                                   65
      END                                                               66



$IBFTC ERROR   DECK
      SUBROUTINE ERROR                                                   1
      COMMON /   ALL/                                                    2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,          3
     2IGASMK,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,          4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                  5
      COMMON /DESIGN/                                                    6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,          7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,          8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,          9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,         10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,         11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,         12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,         13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,         14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,         15
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV          16
      COMMON / FRONT/                                                   17
     1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,         18
     2T21   ,P21   ,H21   ,S21   ,T3    ,P3    ,H3    ,S3    ,         19
     3T4    ,P4    ,H4    ,S4    ,T5    ,P5    ,H5    ,S5    ,         20
     4T55   ,P55   ,H55   ,S55   ,BLF   ,BLC   ,BLDU  ,BLOB  ,         21
     5CNF   ,PRF   ,ETAF  ,WAFC  ,WAF   ,WA3   ,WG4   ,FAR4  ,         22
     6CNC   ,PRC   ,ETAC  ,WACC  ,WAC   ,ETAB  ,DPCOM ,DUMF  ,         23
     7CNHP  ,ETATHP,DHTCHP,DHTC  ,BLHP  ,WG5   ,FAR5  ,CS    ,         24
     8CNLP  ,ETATLP,DHTCLP,DHTF  ,BLLP  ,WG55  ,FAR55 ,HPEXT ,         25
     9AM    ,ALTP  ,ETAR  ,ZF    ,PCNF  ,ZC    ,PCNC  ,WFB   ,         26
     $TFFHP ,TFFLP ,PCBLF ,PCBLC ,PCBLDU,PCBLOB,PCBLHP,PCBLLP           27
      COMMON /  SIDE/                                                   28
     1XP1   ,XWAF  ,XWAC  ,XBLF  ,XBLDU ,XH3   ,DUMS1 ,DUMS2 ,         29
     2XT21  ,XP21  ,XH21  ,XS21  ,T23   ,P23   ,H23   ,S23   ,         30
     3T24   ,P24   ,H24   ,S24   ,T25   ,P25   ,H25   ,S25   ,         31
     4T28   ,P28   ,H28   ,S28   ,T29   ,P29   ,H29   ,S29   ,         32
     5WAD   ,WFD   ,WG24  ,FAR24 ,ETAD  ,DPDUC ,BYPASS,DUMS3 ,         33
     6TS28  ,PS28  ,V28   ,AM28  ,TS29  ,PS29  ,V29   ,AM29            34
      COMMON /  BACK/                                                   35
     1XT55  ,XP55  ,XH55  ,XS55  ,XT25  ,XP25  ,XH25  ,XS25  ,         36
     2XWF8  ,XWG55 ,XFAR55,XWFD  ,XWG24 ,XFAR24,XXP1  ,DUMB  ,         37
     3T6    ,P6    ,H6    ,S6    ,T7    ,P7    ,H7    ,S7    ,         38
     4T8    ,P8    ,H8    ,S8    ,T9    ,P9    ,H9    ,S9    ,         39
     5WG6   ,WFA   ,WG7   ,FAR7  ,ETAA  ,DPAFT ,V55   ,V25   ,         40
     6PS6   ,V6    ,AM6   ,TS7   ,PS7   ,V7    ,AM7   ,AM25  ,         41
     7TS8   ,PS8   ,V8    ,AM8   ,TS9   ,PS9   ,V9    ,AM9   ,         42
     8VA    ,FRD   ,VJD   ,FGMD  ,VJM   ,FGMM  ,FGPD  ,FGPM  ,         43
     9FGM   ,FGP   ,WFT   ,WGT   ,FART  ,FG    ,FN    ,SFC             44
      COMMON/DUMMYS/DUMMY(100)                                          45
      COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI 46
     1,ETAI,WACI,TFFIP,CNIP,ETATIP,DHTCIP,DHTI,BLIP,PCBLIP,PCNIGU,ZIDS, 47
     2PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS, 48
     3TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI ,T22DS,WA21      49
      LOGICAL ERRER                                                     50
      COMMON/ERER/ERRER                                                 51
```

```
      DIMENSION TRASH1(80),TRASH2(80),TRASH3(48),TRASH4(72)                  52
      DIMENSION TRASH5(44),TRASH6(48)                                        53
      EQUIVALENCE (TRASH5,T22),(TRASH6,DUMMY(22))                            54
      EQUIVALENCE (TRASH1,PCNFGU),(TRASH2,T1),(TRASH3,XP1),(TRASH4,XT55)     55
      DATA AWORD/6HCOMMON/                                                   56
      ERRER=.TRUE.                                                           57
      WRITE (6,2) WORD                                                       58
      WORD=AWORD                                                             59
      WRITE (6,3) WORD,ZF,PCNF,ZI,PCNI,ZC,PCNC,T4,MODE                       60
      WRITE (6,4)                                                            61
      WRITE (6,5) (TRASH1(I),I=1,80)                                         62
      WRITE (6,6)                                                            63
      WRITE (6,5) (TRASH2(I),I=1,80)                                         64
      WRITE (6,4)                                                            65
      WRITE (6,5) (TRASH3(I),I=1,48)                                         66
      WRITE (6,4)                                                            67
      WRITE (6,5) (TRASH4(I),I=1,72)                                         68
      WRITE (6,4)                                                            69
      WRITE (6,5) (TRASH5(I),I=1,44)                                         70
      WRITE (6,4)                                                            71
      WRITE (6,5) (TRASH6(I),I=1,48)                                         72
      WRITE (6,4)                                                            73
      WRITE (6,7) LOOPER                                                     74
      IF (IDUMP.EQ.0) GO TO 1                                                75
      WRITE (6,6)                                                            76
      CALL SYG (2)                                                           77
1     CALL ENGBAL                                                            78
      RETURN                                                                 79
C                                                                            80
C                                                                            81
2     FORMAT (28H0AN ERROR HAS BEEN FOUND IN ,A6)                            82
3     FORMAT (1H0,A6,9X,7E15.6,I4)                                           83
4     FORMAT (2H0 )                                                          84
5     FORMAT (1H ,8E15.6)                                                    85
6     FORMAT (1H1)                                                           86
7     FORMAT (25H0FAILED TO CONVERGE AFTER,I4,6H LOOPS)                      87
      END                                                                    88
```

```
$IBFTC SYGS    DECK
      SUBROUTINE SYG (ICON)                                                   1
      DIMENSION WORD(132)                                                     2
      DATA ONEDOL/6H$     /                                                   3
      GO TO (1,2),ICON                                                        4
1     END FILE 8                                                              5
      REWIND 8                                                                6
      RETURN                                                                  7
C        TERMINATE THE FILE                                                   8
2     WRITE (8,10)                                                            9
      END FILE 8                                                             10
      REWIND 8                                                               11
C        READ RECORD                                                         12
3     READ (8,11) (WORD(I),I=1,132)                                          13
C        CHECK FOR 12 LEADING DOLLAR SIGNS                                   14
      DO 4 I=1,12                                                            15
      IF (WORD(I)-ONEDOL) 5,4,5                                              16
4     CONTINUE                                                               17
      RETURN                                                                 18
C        CHECK FOR 6 TRAILING DOLLAR SIGNS                                   19
```

```
5       DO 8 I=1,132                                                    20
        I=I                                                             21
        IF (WORD(I)-ONEDOL) 8,6,8                                       22
6       K=I+5                                                           23
        DO 7 J=I,K                                                      24
        IF (WORD(J)-ONEDOL) 8,7,8                                       25
7       CONTINUE                                                        26
        GO TO 9                                                         27
8       CONTINUE                                                        28
        WRITE (6,12)                                                    29
        RETURN                                                          30
C          PRINT LINE                                                   31
9       I=I-1                                                           32
        WRITE (6,11) (WORD(M),M=1,I)                                    33
        GO TO 3                                                         34
C                                                                       35
C                                                                       36
10      FORMAT (12H$$$$$$$$$$$$)                                        37
11      FORMAT (132A1)                                                  38
12      FORMAT (1H0,12HERROR IN SYG)                                    39
        END                                                             40
```

```
$IBFTC PERFOR  DECK
       SUBROUTINE PERF                                                   1
       COMMON /   ALL/                                                   2
      1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,         3
      2IGASMX,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,         4
      3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                 5
       COMMON /DESIGN/                                                  6
      1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,         7
      2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,         8
      3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,         9
      4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,        10
      5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,        11
      6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,        12
      7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,        13
      8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,        14
      9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,        15
      $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV        16
       COMMON / FRONT/                                                  17
      1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,       18
      2T21   ,P21   ,H21   ,S21   ,T3    ,P3    ,H3    ,S3    ,       19
      3T4    ,P4    ,H4    ,S4    ,T5    ,P5    ,H5    ,S5    ,       20
      4T55   ,P55   ,H55   ,S55   ,BLF   ,BLC   ,BLDU  ,BLOB  ,       21
      5CNF   ,PRF   ,ETAF  ,WAFC  ,WAF   ,WA3   ,WG4   ,FAR4  ,       22
      6CNC   ,PRC   ,ETAC  ,WACC  ,WAC   ,ETAB  ,DPCOM ,DUMF  ,       23
      7CNHP  ,ETATHP,DHTCHP,DHTC  ,BLHP  ,WG5   ,FAR5  ,CS    ,       24
      8CNLP  ,ETATLP,DHTCLP,DHTF  ,BLLP  ,WG55  ,FAR55 ,HPEXT ,       25
      9AM    ,ALTP  ,ETAR  ,ZF    ,PCNF  ,ZC    ,PCNC  ,WFB   ,       26
      $TFFHP ,TFFLP ,PCBLF ,PCBLC ,PCBLDU,PCBLOB,PCBLHP,PCBLLP         27
       COMMON /  SIDE/                                                  28
      1XP1   ,XWAF  ,XWAC  ,XBLF  ,XBLDU ,XH3   ,DUMS1 ,DUMS2 ,       29
      2XT21  ,XP21  ,XH21  ,XS21  ,T23   ,P23   ,H23   ,S23   ,       30
      3T24   ,P24   ,H24   ,S24   ,T25   ,P25   ,H25   ,S25   ,       31
      4T28   ,P28   ,H28   ,S28   ,T29   ,P29   ,H29   ,S29   ,       32
      5WAD   ,WFD   ,WG24  ,FAR24 ,ETAD  ,DPDUC ,BYPASS,DUMS3 ,       33
      6TS28  ,PS28  ,V28   ,AM28  ,TS29  ,PS29  ,V29   ,AM29          34
       COMMON /  BACK/                                                  35
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     1XT55   ,XP55   ,XH55   ,XS55   ,XT25   ,XP25   ,XH25   ,XS25   ,                36
     2XWFB   ,XWG55  ,XFAR55,XWFD   ,XWG24  ,XFAR24,XXP1   ,DUMB   ,                37
     3T6     ,P6     ,H6     ,S6     ,T7     ,P7     ,H7     ,S7     ,                38
     4T8     ,P8     ,H8     ,S8     ,T9     ,P9     ,H9     ,S9     ,                39
     5WG6    ,WFA    ,WG7    ,FAR7   ,ETAA   ,DPAFT  ,V55    ,V25    ,                40
     6PS6    ,V6     ,AM6    ,TS7    ,PS7    ,V7     ,AM7    ,AM25   ,                41
     7TS8    ,PS8    ,V8     ,AM8    ,TS9    ,PS9    ,V9     ,AM9    ,                42
     8VA     ,FRD    ,VJD    ,FGMD   ,VJM    ,FGMM   ,FGPD   ,FGPM   ,                43
     9FGM    ,FGP    ,WFT    ,WGT    ,FART   ,FG     ,FN     ,SFC                     44
      COMMON/DUMMYS/DUMMY(21),WA32,DPWGDS,DPWING,WA32DS,A38,AM38,V38,                 45
     1T38,H38,P38,TS38,PS38,T39,H39,P39,TS39,V39,AM39,A39,BPRINT,WG37,                45
     2CVDWNG,FGMWNG,FGPWNG,FNWING,FNMAIN,FWOVFN,PS39,DIMMY(51)                       47
      COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI              48
     1,ETAI,WACI,TFFIP,CNIP,ETATIP,DHTCIP,DHTI,BLIP,PCBLIP,PCNIGU,ZIDS,              49
     2PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS,             50
     3TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI ,T22DS,WA21                   51
      DIMENSION ERR(9)                                                               52
      EQUIVALENCE (AFTFAN,DUMMY(58)),(DUMSPL,DUMMY(59))                              53
      LOGICAL DUMSPL                                                                 54
      LOGICAL AFTFAN                                                                 55
      EQUIVALENCE (ERR,DUMMY(11)),(FDES,DUMMY(60)),(PCBLID,DUMMY(61))                56
     1,(VJWING,DUMMY(77))                                                            57
      EQUIVALENCE    (FFOVFN,DUMMY(54))   ,   (FCOVFN,DUMMY(55)),                   58
     1               (FMNOFN,DUMMY(56))   ,   (FNOVFD,DUMMY(57))                    59
      DATA AWORD/6H  PERF/                                                           60
      WORD=AWORD                                                                     61
      G=32.174049.                                                                   62
      CAPSF=2116.2170                                                                63
      WFT=WFB+WFD+WFA                                                                64
      WAT=WAF-BLOB                                                                   65
      IF (AFTFAN) WAT=WAT+WAI                                                        66
      WGT=WAT+WFT                                                                    67
      FART=WFT/WAT                                                                   68
      VA=AM*CS                                                                       69
      FRD=VA*WAF/G                                                                   70
      VJM=CVMNOZ*V9                                                                  71
      FGMM=VJM*WG7/G                                                                 72
      FGPM=CAPSF*(PS9-P1)*A9                                                         73
      IF (IGASMX.GT.0) GO TO 1                                                       74
      VJD=CVDNOZ*V29                                                                 75
      FGMD=VJD*WG24/G                                                                76
      FGPD=CAPSF*(PS29-P1)*A29                                                       77
1     VJWING=0.                                                                      78
      FGMWNG=0.                                                                      79
      FGPWNG=0.                                                                      80
      FGWING=0.                                                                      81
      FNWING=0.                                                                      82
      IF (PCBLID.EQ.0.) GO TO 2                                                      83
      VJWING=CVDWNG*V39                                                              84
      FGMWNG=VJWING*WG37/G                                                           85
      FGPWNG=CAPSF*(PS39-P1)*A39                                                     86
      FGWING=FGMWNG+FGPWNG                                                           87
      FNWING=FGWING-VA*WA32/G                                                        88
2     FGM=FGMM+FGMD+FGMWNG                                                           89
      FGP=FGPM+FGPD+FGPWNG                                                           90
      FNMAIN=(FGMM+FGMD+FGPM+FGPD)-VA*(WAF-WA32)/G                                   91
      FG=FGM+FGP                                                                     92
      FN=FG-FRD                                                                      93
      SFC=3600.*WFT/FN                                                               94
      FG=DELFG*FG                                                                    95
      FN=DELFN*FN                                                                    96
      SFC=DELSFC*SFC                                                                 97
      FFAN=FGMD+FGPD-VA*WAD/G                                                        98
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      FCORE=FNMAIN-FFAN                                                  99
      FFOVFN=FFAN/FN                                                     100
      FCOVFN=FCORE/FN                                                    101
      FWOVFN=FNWING/FN                                                   102
      FMNOFN=FNMAIN/FN                                                   103
      IF (IDES.EQ.1) FDES=FN                                             104
      FNOVFD=FN/FDES                                                     105
      IF (.NOT.DUMSPL) GO TO 3                                           106
      PCNI=1.0                                                           107
      CNI=0.                                                             108
3     CALL OUTPUT                                                        109
      CALL ERROR                                                         110
      RETURN                                                             111
      END                                                                112
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$IBFTC PUTOUT  DECK
      SUBROUTINE OUTPUT                                                   1
      COMMON /   ALL/                                                     2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,           3
     2IGASMK,IDBURN,IAFTBV,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,           4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                   5
      COMMON /DESIGN/                                                     6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,           7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,           8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,           9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,          10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,          11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,          12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,          13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,          14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,          15
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV          16
      COMMON / FRONT/                                                    17
     1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,          18
     2T21   ,P21   ,H21   ,S21   ,T3    ,P3    ,H3    ,S3    ,          19
     3T4    ,P4    ,H4    ,S4    ,T5    ,P5    ,H5    ,S5    ,          20
     4T55   ,P55   ,H55   ,S55   ,BLF   ,BLC   ,BLDU  ,BLOB  ,          21
     5CNF   ,PRF   ,ETAF  ,WAFC  ,WAF   ,WA3   ,WG4   ,FAR4  ,          22
     6CNC   ,PRC   ,ETAC  ,WACC  ,WAC   ,ETAB  ,DPCOM ,DUMF  ,          23
     7CNHP  ,ETATHP,DHTCHP,DHTC  ,BLHP  ,WG5   ,FAR5  ,CS    ,          24
     8CNLP  ,ETATLP,DHTCLP,DHTF  ,BLLP  ,WG55  ,FAR55 ,HPEXT ,          25
     9AM    ,ALTP  ,ETAR  ,ZF    ,PCNF  ,ZC    ,PCNC  ,WFB   ,          26
     $TFFHP ,TFFLP ,PCBLF ,PCBLC ,PCBLDU,PCBLOB,PCBLHP,PCBLLP           27
      COMMON /  SIDE/                                                    28
     1XP1   ,XWAF  ,XWAC  ,XBLF  ,XBLDU ,XH3   ,DUMS1 ,DUMS2 ,          29
     2XT21  ,XP21  ,XH21  ,XS21  ,T23   ,P23   ,H23   ,S23   ,          30
     3T24   ,P24   ,H24   ,S24   ,T25   ,P25   ,H25   ,S25   ,          31
     4T28   ,P28   ,H28   ,S28   ,T29   ,P29   ,H29   ,S29   ,          32
     5WAD   ,WFD   ,WG24  ,FAR24 ,ETAD  ,DPDUC ,BYPASS,DUMS3 ,          33
     6TS28  ,PS28  ,V28   ,AM28  ,TS29  ,PS29  ,V29   ,AM29             34
      COMMON /  BACK/                                                    35
     1XT55  ,XP55  ,XH55  ,XS55  ,XT25  ,XP25  ,XH25  ,XS25  ,          36
     2XWFB  ,XWG55 ,XFAR55,XWFD  ,XWG24 ,XFAR24,XXP1  ,DUMB  ,          37
     3T6    ,P6    ,H6    ,S6    ,T7    ,P7    ,H7    ,S7    ,          38
     4T8    ,P8    ,H8    ,S8    ,T9    ,P9    ,H9    ,S9    ,          39
     5WG6   ,WFA   ,WG7   ,FAR7  ,ETAA  ,DPAFT ,V55   ,V25   ,          40
     6PS6   ,V6    ,AM6   ,TS7   ,PS7   ,V7    ,AM7   ,AM25  ,          41
     7TS8   ,PS8   ,V8    ,AM8   ,TS9   ,PS9   ,V9    ,AM9   ,          42
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     8VA    ,FRD   ,VJD   ,FGMD  ,VJM   ,FGMM  ,FGPD  ,FGPM  ,                  43
     9FGM   ,FGP   ,WFT   ,WGT   ,FART  ,FG    ,FN    ,SFC                     44
      COMMON/DUMMYS/DUMMY(21),WA32,DPWGDS,DPWING,WA32DS,A38,AM38,V38,          45
     1T38,H38,P38,TS38,PS38,T39,H39,P39,TS39,V39,AM39,A39,BPRINT,WG37,          46
     2CVDWNG,FGMWNG,FGPWNG,FNWING,FNMAIN,FWDVFN,DIMMY(52)                      47
      COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI        48
     1,ETAI,WACI,TFFIP,CNIP,ETATIP,DHTCIP,DHTI,BLIP,PCBLIP,PCNIGU,ZIDS,        49
     2PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS,       50
     3TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI ,T22DS,WA21             51
      EQUIVALENCE (T4PBL,DUMMY(2)),(T41,DUMMY(3))                             52
      DIMENSION W(5,4),ANS1(80),ANS2(80),ANS3(48),ANS4(72)                    53
      EQUIVALENCE (ANS1,PCNFGU),(ANS2,T1),(ANS3,XP1),(ANS4,XT55)              54
      EQUIVALENCE (ANS5,T22)                                                  55
      DIMENSION ANS5(44)                                                      56
      DIMENSION ANS6(48)                                                      57
      EQUIVALENCE (ANS6,WA32)                                                 58
      EQUIVALENCE (FXFN2M,DUMMY(50)),(FXM2CP,DUMMY(51)),                      59
     1            (AFTFAN,DUMMY(58)),(DUMSPL,DUMMY(59))                       60
      EQUIVALENCE (PCBLID,DUMMY(61))                                          61
      LOGICAL FXFN2M,FXM2CP,AFTFAN,DUMSPL                                     62
      DATA &WORD1,&WORD2/6HOUTPUT,6HCOMMON/                                   63
      DATA (W(1,I),I=1,4)/6HSUBSON,6HIC C-D,6H NOZZL,6HE     /                64
      DATA (W(2,I),I=1,4)/6HSHOCK ,6HINSIDE,6H C-D N,6HOZZLE /                65
      DATA (W(3,I),I=1,4)/6HSHOCK ,6HOUTSID,6HE C-D ,6HNOZZLE/                66
      DATA (W(4,I),I=1,4)/6HSUBSON,6HIC CON,6HVERG. ,6HNOZZLE/                67
      DATA (W(5,I),I=1,4)/6HSONIC ,6HCONVER,6HGENT N,6HOZZLE /                68
      WORD=&WORD1                                                             69
      IF (IDBURN.GT.0) GO TO 2                                                70
      IF (IAFTBN.GT.0) GO TO 1                                                71
      WRITE (6,7) WORD,AM,ALTP,T4,ETAR                                        72
      GO TO 3                                                                 73
1     WRITE (6,8) WORD,AM,ALTP,T4,T7,ETAR                                     74
      GO TO 3                                                                 75
2     WRITE (6,9) WORD,AM,ALTP,T4,T24,ETAR                                    76
3     IF (FXFN2M) WRITE (6,17)                                                77
      IF (FXM2CP) WRITE (6,18)                                                78
      IF (.NOT.FXFN2M.AND.(.NOT.FXM2CP).AND.(.NOT.DUMSPL)) WRITE (6,19)       79
      IF (DUMSPL) WRITE (6,23)                                                80
      IF (PCBLID.EQ.0.) WRITE (6,20)                                          81
      IF (PCBLID.EQ.0..AND.AFTFAN) WRITE (6,21)                               82
      IF (PCBLID.NE.0..AND.AFTFAN) WRITE (6,22)                               83
      CALL CONOUT (2)                                                         84
      WRITE (6,10) (W(IMSHOC,I),I=1,4),FG,FN,SFC                              85
      IF (IBASMX.GT.0) GO TO 4                                                86
      WRITE (6,11) (W(IDSHOC,I),I=1,4)                                        87
4     WRITE (6,12) LOOPER                                                     88
      IF (IDES.NE.1) GO TO 5                                                  89
      WORD=&WORD2                                                             90
      WRITE (6,13) WORD,ZF,PCNF,ZI,PCNI,ZC,PCNC,T4,MODE                       91
      WRITE (6,14)                                                            92
      WRITE (6,15) (ANS1(I),I=1,80)                                           93
      WRITE (6,14)                                                            94
      WRITE (6,15) (ANS2(I),I=1,80)                                           95
      WRITE (6,14)                                                            96
      WRITE (6,15) (ANS3(I),I=1,48)                                           97
      WRITE (6,14)                                                            98
      WRITE (6,15) (ANS4(I),I=1,72)                                           99
      WRITE (6,14)                                                           100
      WRITE (6,15) (ANS5(I),I=1,44)                                          101
      WRITE (6,14)                                                           102
      WRITE (6,15) (ANS6(I),I=1,48)                                          103
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      WRITE (6,16)                                                          104
      IF (IDES.EQ.1) GO TO 6                                                105
5     CONTINUE                                                              105
      A8=A8SAV                                                              107
      A9=A9SAV                                                              108
      A28=A28SAV                                                            109
      A29=A29SAV                                                            110
      IF (IDUMP.NE.2) GO TO 6                                               111
      WRITE (6,16)                                                          112
      CALL SYG (2)                                                          113
6     CALL ENGBAL                                                           114
      RETURN                                                                115
C                                                                           116
C                                                                           117
C                                                                           118
7     FORMAT (1HB,A6,14X7H     AM=,F7.3,6X7H  ALTP=,F7.0,6X7H     T4=,F8.2   119
     1,25X7H  ETAR=,F7.4)                                                   120
8     FORMAT (1HB,A6,14X7H     AM=,F7.3,6X7H  ALTP=,F7.0,6X7H     T4=,F8.2   121
     1,5X7H    T7=,F8.2,5X7H  ETAR=,F7.4)                                  122
9     FORMAT (1HB,A6,14X7H     AM=,F7.3,6X7H  ALTP=,F7.0,6X7H     T4=,F8.2   123
     1,5X7H   T24=,F8.2,5X7H  ETAR=,F7.4)                                  124
10    FORMAT (6HOMAIN ,4A6,9X3HFG=,F9.2,18X3HFN=,F9.2,18X4HSFC=,F8.5)       125
11    FORMAT (6H DUCT ,4A6)                                                 126
12    FORMAT (16HOCONVERGED AFTER,I4,6H LOOPS,/,1H1)                        127
13    FORMAT (1H ,A6,9X,7E15.6,I4)                                          128
14    FORMAT (1H )                                                          129
15    FORMAT (1H ,8E15.6)                                                   130
16    FORMAT (1H1)                                                          131
17    FORMAT (65HOFAN AND MIDDLE SPOOL ARE ATTACHED , USE INNER AND OUTE    132
     1R TURBINES)                                                           133
18    FORMAT (74HOMIDDLE AND COMPRESSOR SPOOLS ARE ATTACHED , USE MIDDLE    134
     1 AND OUTER TURBINES)                                                  135
19    FORMAT (19HOTHREE SPOOL ENGINE)                                       136
20    FORMAT (21HONO AIRFLOW INTO WING)                                     137
21    FORMAT (1H+22X,14H, AFT-TURBOFAN)                                     138
22    FORMAT (14HO AFT-TURBOFAN)                                            139
23    FORMAT (22HOMIDDLE SPOOL IS DUMMY)                                    140
      END                                                                   141
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$IBFTC CONOUT  DECK
      SUBROUTINE CONOUT (ICON)                                               1
      COMMON /   ALL/                                                        2
     1WORD  ,IDES  ,JDES  ,KDES  ,MODE  ,INIT  ,IDUMP ,IAMTP ,              3
     2IGASMK,IDBURN,IAFTBN,IDCD  ,IMCD  ,IDSHOC,IMSHOC,NOZFLT,              4
     3ITRYS ,LOOPER,NOMAP ,NUMMAP,MAPEDG,TOLALL,ARR(6)                      5
      COMMON /DESIGN/                                                        6
     1PCNFGJ,PCNCGU,T4GU  ,DUMD1 ,DUMD2 ,DELFG ,DELFN ,DELSFC,              7
     2ZFDS  ,PCNFDS,PRFDS ,ETAFDS,WAFDS ,PRFCF ,ETAFCF,WAFCF ,              8
     3ZCDS  ,PCNCDS,PRCDS ,ETACDS,WACDS ,PRCCF ,ETACCF,WACCF ,              9
     4T4DS  ,WFBDS ,DTCODS,ETABDS,WA3CDS,DPCODS,DTCOCF,ETABCF,             10
     5TFHPDS,CNHPDS,ETHPDS,TFHPCF,CNHPCF,ETHPCF,DHHPCF,T2DS  ,             11
     6TFLPDS,CNLPDS,ETLPDS,TFLPCF,CNLPCF,ETLPCF,DHLPCF,T21DS ,             12
     7T24DS ,WFDDS ,DTDUDS,ETADDS,WA23DS,DPDUDS,DTDUCF,ETADCF,             13
     8T7DS  ,WFADS ,DTAFDS,ETAADS,WG6CDS,DPAFDS,DTAFCF,ETAACF,             14
     9A55   ,A25   ,A6    ,A7    ,A8    ,A9    ,A28   ,A29   ,             15
     $PS55  ,AM55  ,CVDNOZ,CVMNOZ,A8SAV ,A9SAV ,A28SAV,A29SAV              16
      COMMON / FRONT/                                                       17
     1T1    ,P1    ,H1    ,S1    ,T2    ,P2    ,H2    ,S2    ,             18
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2T21    ,P21    ,H21    ,S21    ,T3     ,P3     ,H3     ,S3     ,                19
3T4     ,P4     ,H4     ,S4     ,T5     ,P5     ,H5     ,S5     ,                20
4T55    ,P55    ,H55    ,S55    ,BLF    ,BLC    ,BLDU   ,BLOB   ,                21
5CNF    ,PRF    ,ETAF   ,WAFC   ,WAF    ,WA3    ,WG4    ,FAR4   ,                22
6CNC    ,PRC    ,ETAC   ,WACC   ,WAC    ,ETAB   ,DPCOM  ,DUMF   ,                23
7CNHPM  ,ETATHM,DHTCHM,DHTCM  ,BLHP   ,WG5    ,FAR5   ,CS     ,                24
8CNLPM  ,ETATLM,DHTCLM,DHTFM  ,BLLP   ,WG55   ,FAR55  ,HPEXT  ,                25
9AM     ,ALTP   ,ETAR   ,ZF     ,PCNF   ,ZC     ,PCNC   ,WFB    ,                26
$TFFHPM,TFFLPM,PCBLF  ,PCBLC  ,PCBLDU,PCBLOB,PCBLHP,PCBLLP                       27
 COMMON /  SIDE/                                                                 28
1XP1    ,XWAF   ,XWAC   ,XBLF   ,XBLDU  ,XH3    ,DUMS1  ,DUMS2  ,                29
2XT21   ,XP21   ,XH21   ,XS21   ,T23    ,P23    ,H23    ,S23    ,                30
3T24    ,P24    ,H24    ,S24    ,T25    ,P25    ,H25    ,S25    ,                31
4T28    ,P28    ,H28    ,S28    ,T29    ,P29    ,H29    ,S29    ,                32
5WAD    ,WFD    ,WG24   ,FAR24  ,ETAD   ,DPDUC  ,BYPASS,DUMS3  ,                33
6TS28   ,PS28   ,V28    ,AM28   ,TS29   ,PS29   ,V29    ,AM29                    34
 COMMON /  BACK/                                                                 35
1XT55   ,XP55   ,XH55   ,XS55   ,XT25   ,XP25   ,XH25   ,XS25   ,                35
2XWFB   ,XWG55  ,XFAR55,XWFD   ,XWG24  ,XFAR24,XXP1   ,DUMB   ,                37
3T6     ,P6     ,H6     ,S6     ,T7     ,P7     ,H7     ,S7     ,                38
4T8     ,P8     ,H8     ,S8     ,T9     ,P9     ,H9     ,S9     ,                39
5WG6    ,WFA    ,WG7    ,FAR7   ,ETAA   ,DPAFT  ,V55    ,V25    ,                40
6PS6    ,V6     ,AM6    ,TS7    ,PS7    ,V7     ,AM7    ,AM25   ,                41
7TS8    ,PS8    ,V8     ,AM8    ,TS9    ,PS9    ,V9     ,AM9    ,                42
8VA     ,FRD    ,VJD    ,FGMD   ,VJM    ,FGMM   ,FGPD   ,FGPM   ,                43
9FGM    ,FGP    ,WFT    ,WGT    ,FART   ,FG     ,FN     ,SFC                     44
 COMMON/DUMMYS/DUMMY(21),WA32,DPWGDS,DPWING,WA32DS,A38,AM38,V38,                  45
1T38,H38,P38,TS38,PS38,T39,H39,P39,TS39,V39,AM39,A39,BPRINT,WG37,                 46
2CVDWNG,FGMWNG,FGPWNG,FNWING,FNMAIN,FWDVFN,DIMMY(52)                             47
 COMMON/SPOOL2/T22,P22,H22,S22,T50,P50,H50,S50,WA22,ZI,PCNI,CNI,PRI               48
1,ETAI,WACI,TFFIPM,CNIPM,ETATIM,DHTCIM,DHTIM,BLIP,PCBLIP,PCNIGU,                  49
2ZIDS,                                                                           50
3PCNIDS,PRIDS,ETAIDS,WAIDS,PRICF,ETAICF,WAICF,TFIPDS,CNIPDS,ETIPDS,              51
4TFIPCF,CNIPCF,ETAPCF,DHIPCF,WAICDS,WAI,PCBLI,BLI  ,T22DS,WA21                   52
 DIMENSION PARAM(424),WORDY(424),IOUT(150),AOUT(6),WOUT(6)                       53
 EQUIVALENCE    (FFOVFN,DUMMY(54))    ,    (FCOVFN,DUMMY(55)),                  54
1               (FMNOFN,DUMMY(56))    ,    (FNOVFD,DUMMY(57))                   55
 EQUIVALENCE (PARAM,PCNFGU)                                                      56
 DATA (WORDY(I),I=1,98)/                                                         57
16HPCNFGU,6HPCNCGU,6HT4GU  ,6HDUMD1 ,6HDUMD2 ,6HDELFG ,6HDELFN ,                 58
26HDELSFC,6HZFDS  ,6HPCNFDS,6HPRFDS ,6HETAFDS,6HWAFDS ,6HPRFCF ,                 59
36HETAFCF,6HWAFCF ,6HZCDS  ,6HPCNCDS,6HPRCDS ,6HETACDS,6HWACDS ,                 60
46HPRCCF ,6HETACCF,6HWACCF ,6HT4DS  ,6HWFBDS ,6HDTCODS,6HETABDS,                 61
56HWA3CDS,6HDPCODS,6HDTCOCF,6HETABCF,6HTFHPDS,6HCNHPDS,6HETHPDS,                 62
66HTFHPCF,6HCNHPCF,6HETHPCF,6HDHHPCF,6HT2DS  ,6HTFLPDS,6HCNLPDS,                 63
76HETLPDS,6HTFLPCF,6HCNLPCF,6HETLPCF,6HDHLPCF,6HT21DS ,6HT24DS ,                 64
86HWFDDS ,6HDTDUDS,6HETADDS,6HWA23DS,6HDPDUDS,6HDTDUCF,6HETADCF,                 65
96HT7DS  ,6HWFADS ,6HDTAFDS,6HETAADS,6HWG6CDS,6HDPAFDS,6HDTAFCF,                 66
$6HETAACF,6HA55    ,6HA25    ,6HA6     ,6HA7     ,6HA8     ,6HA9     ,          67
$6HA28   ,6HA29    ,6HPS55   ,6HAM55   ,6HCVDNOZ,6HCVMNOZ,6HA8SAV ,              68
$6HA9SAV ,6HA28SAV,6HA29SAV,6HT1     ,6HP1     ,6HH1     ,6HS1     ,          69
$6HT2    ,6HP2     ,6HH2     ,6HS2     ,6HT21    ,6HP21    ,6HH21    ,          70
$6HS21   ,6HT3     ,6HP3     ,6HH3     ,6HS3     ,6HT4     ,6HP4     /          71
 DATA (WORDY(I),I=99,189)/                                                       72
16HH4    ,6HS4     ,6HT5     ,6HP5     ,6HH5     ,6HS5     ,6HT55    ,          73
26HP55   ,6HH55    ,6HS55    ,6HBLF    ,6HBLC    ,6HBLDU   ,6HBLOB   ,          74
36HCNF   ,6HPRF    ,6HETAF   ,6HWAFC   ,6HWAF    ,6HWA3    ,6HWG4    ,          75
46HFAR4  ,6HCNC    ,6HPRC    ,6HETAC   ,6HWACC   ,6HWAC    ,6HETAB   ,          76
56HDPCOM ,6HDUMP   ,6HCNHPM ,6HETATHM,6HDHTCHM,6HDHTCM ,6HBLHP   ,          77
66HWG5   ,6HFAR5   ,6HCS     ,6HCNLPM ,6HETALM ,6HDHTCLM,6HDHTFM ,          78
76HBLLP  ,6HWG55   ,6HFAR55 ,6HHPEXT ,6HAM     ,6HALTP  ,6HETAR  ,          79
86HZF    ,6HPCNF   ,6HZC     ,6HPCNC   ,6HWFB    ,6HTFFHPM,6HTFFLPM,          80
96HPCBLF ,6HPCBLC  ,6HPCBLDU,6HPCBLOB,6HPCBLHP,6HPCBLLP,6HXP1    ,          81
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     $6HXWAF   ,6HXWAC   ,6HXBLF   ,6HXBLDU ,6HXH3    ,6HDUMS1 ,6HDUMS2 ,          82
     $6HXT21   ,6HXP21   ,6HXH21   ,6HXS21  ,6HT23    ,6HP23   ,6HH23   ,          83
     $6HS23    ,6HT24    ,6HP24    ,6HH24   ,6HS24    ,6HT25   ,6HP25   ,          84
     $6HH25    ,6HS25    ,6HT28    ,6HP28   ,6HH28    ,6HS28   ,6HT29   /          85
      DATA (WORDY(I),I=190,280)/                                                   86
     16HP29    ,6HH29    ,6HS29    ,6HWAD   ,6HWFD    ,6HWG24  ,6HFAR24 ,          87
     26HETAD   ,6HDPDUC  ,6HBYPASS,6HDUMS3  ,6HTS28   ,6HPS28  ,6HV28   ,          88
     36HAM28   ,6HTS29   ,6HPS29   ,6HV29   ,6HAM29   ,6HXT55  ,6HXP55  ,          89
     46HXH55   ,6HXS55   ,6HXT25   ,6HXP25  ,6HXH25   ,6HXS25  ,6HXWFB  ,          90
     56HXWG55  ,6HXFAR55,6HXWFD   ,6HXWG24 ,6HXFAR24,6HXXP1  ,6HDUMB  ,          91
     66HT6     ,6HP6     ,6HH6     ,6HS6    ,6HT7     ,6HP7    ,6HH7    ,          92
     76HS7     ,6HT8     ,6HP8     ,6HH8    ,6HS8     ,6HT9    ,6HP9    ,          93
     86HH9     ,6HS9     ,6HWG6    ,6HWFA   ,6HWG7    ,6HFAR7  ,6HETAA  ,          94
     96HDPAFT  ,6HV55    ,6HV25    ,6HPS6   ,6HV6     ,6HAM6   ,6HTS7   ,          95
     $6HPS7    ,6HV7     ,6HAM7    ,6HAM25  ,6HTS8    ,6HPS8   ,6HV8    ,          96
     $6HAM8    ,6HTS9    ,6HPS9    ,6HV9    ,6HAM9    ,6HVA    ,6HFRD   ,          97
     $6HVJD    ,6HFGMD   ,6HVJM    ,6HFGMM  ,6HFGPD   ,6HFGPM  ,6HFGM   ,          98
     $6HFGP    ,6HWFT    ,6HWGT    ,6HFART  ,6HFG     ,6HFN    ,6HSFC   /          99
      DATA (WORDY(I),I=281,424)/                                                  100
     121*0.    ,6HWA32   ,6HDPWGDS,6HDPWING,6HWA32DS,6HA38   ,6HAM38  ,          101
     26HV38    ,6HT38    ,6HH38    ,6HP38   ,6HTS38   ,6HPS38  ,6HT39   ,          102
     36HH39    ,6HP39    ,6HTS39   ,6HV39   ,6HAM39   ,6HA39   ,6HBPRINT,          103
     46HWG37   ,6HCVDWNG,6HFGMWNG,6HFGPWNG,6HFNWING,6HFNMAIN,6HFWDVFN,          104
     56HPS39   ,4*0.     ,6HFFOVFN,6HFCDVFN,6HFMNDFN,6HFNDVFD,4*0.     ,          105
     66HTFFHP  ,6HTFFIP  ,6HTFFLP  ,6HCNHP   ,6HCNIP   ,6HCNLP   ,               106
     76HDHTCHP,6HDHTC    ,6HDHTCIP,6HDHTI    ,6HDHTCLP,6HDHTF   ,               107
     86HETATHP,6HETATIP,6HETATLP,6HVJW    ,23*0.,                              108
     96HT22    ,6HP22    ,6HH22    ,6HS22   ,6HT50    ,6HP50   ,6HH50   ,          109
     $6HS50    ,6HWA22   ,6HZI     ,6HPCNI  ,6HCNI    ,6HPRI   ,6HETAI  ,          110
     $6HWACI   ,6HTFFIPM,6HCNIPM ,6HETATIM,6HDHTCIM,6HDHTIM ,6HBLIP  ,          111
     $6HPCBLIP,6HPCNIGU,6HZIDS  ,6HPCNIDS,6HPRIDS ,6HETAIDS,6HWAIDS ,          112
     $6HPRICF ,6HETAICF,6HWAICF ,6HTFIPDS,6HCNIPDS,6HETIPDS,6HTFIPCF,          113
     $6HCNIPCF,6HETAPCF,6HDHIPCF,6HWAICDS,6HWAI    ,6HPCBLI ,6HBLI   ,          114
     $6HT22DS ,6HWA21  /                                                       115
      DATA THEEND,BLANK,LIMIT/6HTHEEND,6H      ,424/                           116
      GO TO (1,6),ICON                                                         117
C *** INPUT SECTION                                                            118
1     DO 4 N=1,150                                                             119
      NUM=N                                                                    120
      READ (5,11) AIN,CHANGE                                                   121
      IF (AIN.EQ.THEEND) GO TO 5                                               122
      DO 2 J=1,LIMIT                                                           123
      JJ=J                                                                     124
      IF (AIN.EQ.WORDY(J)) GO TO 3                                             125
2     CONTINUE                                                                 126
      WRITE (6,12) AIN                                                         127
      GO TO 4                                                                  128
3     IOUT(NUM)=JJ                                                             129
      IF (CHANGE.NE.BLANK) WORDY(JJ)=CHANGE                                    130
4     CONTINUE                                                                 131
      WRITE (6,13)                                                             132
5     NUM=NUM-1                                                                133
      RETURN                                                                   134
C *** OUTPUT SECTION                                                           135
6     IF (NUM.EQ.1) GO TO 10                                                   136
      N=NUM                                                                    137
      J=6                                                                      138
      DO 9 I=1,NUM,6                                                           139
      IF (N.GT.6) GO TO 7                                                      140
      J=N                                                                      141
7     N=N-6                                                                    142
      DO 8 K=1,J                                                               143
      L=I+K-1                                                                  144
```

```
      M=IOUT(L)                                                          145
      WOUT(K)=WORDY(M)                                                   146
8     AOUT(K)=PARAM(M)                                                   147
      WRITE (6,14) (WOUT(K),K=1,J)                                       148
      WRITE (6,15) (AOUT(K),K=1,J)                                       149
      IF (N.LE.0) GO TO 10                                               150
9     CONTINUE                                                           151
10    RETURN                                                             152
C                                                                        153
C                                                                        154
C                                                                        155
11    FORMAT (A6,6X,A6)                                                  156
12    FORMAT (10HOTHE WORD ,A6,26H NOT FOUND IN COMMON ARRAY)            157
13    FORMAT (22HOERROR IN CONOUT INPUT)                                 158
14    FORMAT (26X,A6,5(9XA6))                                            159
15    FORMAT (1H ,20X6E15.6)                                             160
      END                                                                161
```

```
$IBFTC THCOMP  DECK
      SUBROUTINE THCOMP (PR,ETA,T,H,S,P,TO,HO,SO,PO)                      1
      PO=P*PR                                                             2
      TP=T*PR**0.28572                                                    3
      DO 1 I=1,25                                                         4
      CALL THERMO (PO,HP,TP,SP,X1,0,X2,0)                                 5
      DELS=SP-S                                                           6
      IF (ABS(DELS).LE.0.00005*S) GO TO 2                                 7
1     TP=TP/EXP(4.*DELS)                                                  8
      CALL ERROR                                                          9
2     HO=H+((HP-H)/ETA)                                                  10
      CALL THERMO (PO,HO,TO,SO,X1,0,X2,1)                                11
      RETURN                                                             12
      END                                                                13
```

```
$IBFTC PROCOM  DECK
      SUBROUTINE PROCOM (FARX,TEX,CSEX,AKEX,CPEX,REX,PHI,HEX)             1
      IF (FARX.LE.0.067623) GO TO 1                                       2
      FARX=0.067623                                                       3
1     IF (TEX.GE.300.) GO TO 2                                            4
      TEX=300.                                                            5
2     IF (TEX.LE.4000.) GO TO 3                                           6
      TEX=4000.                                                           7
3     IF (FARX.GE.0.0) GO TO 4                                            8
      FARX=0.0                                                            9
C     AIR PATH                                                           10
4     CPA=((((((1.0115540E-25*TEX-1.4526770E-21)*TEX+7.6215767E-18)*TEX-  11
     11.5128259E-14)*TEX-6.7178376E-12)*TEX+6.5519486E-08)*TEX-5.1535879  12
     2E-05)*TEX+2.5020051E-01                                            13
      HEA=(((((((1.2644425E-26*TEX-2.0752522E-22)*TEX+1.2702630E-18)*TEX  14
     1-3.0255518E-15)*TEX-1.6794594E-12)*TEX+2.1839826E-08)*TEX-2.576844  15
     20E-05)*TEX+2.5020051E-01)*TEX-1.7558886E+00                        15
      SEA=+2.5020051E-01*ALOG(TEX)+((((((1.4450767E-26*TEX-2.4211288E-22  17
     1)*TEX+1.5243153E-18)*TEX-3.7820648E-15)*TEX-2.2392790E-12)*TEX+3.2  18
     2759743E-08)*TEX-5.1576879E-05)*TEX+4.5432300E-02                   19
```

```
      IF (FARX.LE.0.0) GO TO 5                                          20
C     FUEL/AIR PATH                                                     21
      CPF=((((((7.2678710E-25*TEX-1.3335668E-20)*TEX+1.0212913E-16)*TEX-  22
     14.2051104E-13)*TEX+9.9686793E-10)*TEX-1.3771901E-06)*TEX+1.2258630  23
     2E-03)*TEX+7.3816638E-02                                           24
      HEF=((((((9.0848388E-26*TEX-1.9050949E-21)*TEX+1.7021525E-17)*TEX  25
     1-8.4102208E-14)*TEX+2.4921698E-10)*TEX-4.5906332E-07)*TEX+6.129315  26
     20E-04)*TEX+7.3816638E-02)*TEX+3.0581530E+01                       27
      SEF=+7.3816638E-02*ALOG(TEX)+((((((1.0382670E-25*TEX-2.2226118E-21  28
     1)*TEX+2.0425826E-17)*TEX-1.0512776E-13)*TEX+3.3228928E-10)*TEX-6.8  29
     2859505E-07)*TEX+1.2258630E-03)*TEX+6.483398E-01                   30
5     CPEX=(CPA+FARX*CPF)/(1.+FARX)                                     31
      HEX=(HEA+FARX*HEF)/(1.+FARX)                                      32
      PHI=(SEA+FARX*SEF)/(1.+FARX)                                      33
      AMW=28.97-.946186*FARX                                            34
      REX=1.986375/AMW                                                  35
      AKEX=CPEX/(CPEX-REX)                                              36
      CSEX=SQRT(AKEX*REX*TEX*25031.37)                                  37
      RETURN                                                            38
      END                                                               39
```

```
$IBFTC SURCH   DECK
      SUBROUTINE SEARCH (P,A,B,C,D,AX,NA,BX,CX,DX,NO,NAM,NOM,NCODE)      1
      DIMENSION AX(NAM),BX(NAM,NOM),CX(NAM,NOM),DX(NAM,NOM),NO(NAM),Q(9)  2
C *** NEEDS SUBROUTINE AFQUIR                                            3
C *** AX AND BX MUST BE STORED LO TO HI                                  4
C *** P=INPJT PROPORTION BETWEEN 0.0 AND 1.0                             5
C     IF NOT INPUT, P MUST EQUAL -1.                                     6
C *** NCODE=00   OK                                                      7
C     NCODE=01   A LO                                                    8
C     NCODE=02   A HI                                                    9
C     NCODE=07   ERROR                                                  10
C     NCODE=10   B LO                                                   11
C     NCODE=20   B HI                                                   12
      NCODE=0                                                           13
      C=0.                                                              14
      D=0.                                                              15
C *** FIND A                                                            16
      DO 1 I=1,NA                                                       17
      IH=I                                                              18
      IF (A.LT.AX(I)) GO TO 2                                           19
1     CONTINJE                                                          20
      IF (A.GT.AX(IH)) NCODE=2                                          21
      A=AX(IH)                                                          22
      GO TO 3                                                           23
2     IF (IH.GT.1) GO TO 3                                              24
      NCODE=1                                                           25
      IH=2                                                              26
      A=AX(1)                                                           27
3     IL=IH-1                                                           28
      LIMH=NO(IH)                                                       29
      LIML=NO(IL)                                                       30
C *** FIND B                                                            31
      PRM=(A-AX(IL))/(AX(IH)-AX(IL))                                    32
      PP=P                                                              33
      IF (P.GE.0.) GO TO 6                                              34
      BL=BX(IL,1)+PRM*(BX(IH,1)-BX(IL,1))                               35
      BH=BX(IL,LIML)+PRM*(BX(IH,LIMH)-BX(IL,LIML))                      36
```

```
      IF (B.GE.BL) GO TO 4                                                37
      NCODE=NCODE+10                                                      38
      B=BL                                                                39
      GO TO 5                                                             40
4     IF (B.LE.BH) GO TO 5                                                41
      NCODE=NCODE+20                                                      42
      B=BH                                                                43
5     PP=0.5                                                              44
      Q(2)=0.                                                             45
      Q(3)=0.                                                             46
6     BH=PP*(BX(IH,LIMH)-BX(IH,1))+BX(IH,1)                               47
      BL=PP*(BX(IL,LIML)-BX(IL,1))+BX(IL,1)                               48
      DO 7 J=2,LIMH                                                       49
      JH=J                                                                50
      IF (B.LT.BX(IH,J)) GO TO 8                                          51
7     CONTINUE                                                            52
8     JL=JH-1                                                             53
      DO 9 K=2,LIML                                                       54
      KH=K                                                                55
      IF (B.LT.BX(IL,K)) GO TO 10                                         56
9     CONTINUE                                                            57
10    KL=KH-1                                                             58
      PR=(BX(IH,JL)-BH)/(BX(IH,JH)-BX(IH,JL))                             59
      CH=CX(IH,JL)-PR*(CX(IH,JH)-CX(IH,JL))                               60
      DH=DX(IH,JL)-PR*(DX(IH,JH)-DX(IH,JL))                               61
      PR=(BX(IL,KL)-BL)/(BX(IL,KH)-BX(IL,KL))                             62
      CL=CX(IL,KL)-PR*(CX(IL,KH)-CX(IL,KL))                               63
      DL=DX(IL,KL)-PR*(DX(IL,KH)-DX(IL,KL))                               64
      BT=BL+PRM*(BH-BL)                                                   65
      CT=CL+PRM*(CH-CL)                                                   66
      DT=DL+PRM*(DH-DL)                                                   67
      IF (P.GE.0.) GO TO 13                                               68
      DIR=SQRT(B/BT)                                                      69
      ERR=(B-BT)/B                                                        70
      CALL AFQUIR (Q(1),PP,ERR,0.,25.,0.001,DIR,PT,ICON)                  71
      GO TO (11,13,12),ICON                                               72
11    PP=PT                                                               73
      IF (PP.LT.0.) PP=0.                                                 74
      IF (PP.GT.1.) PP=1.                                                 75
      GO TO 6                                                             76
12    NCODE=7                                                             77
13    B=BT                                                                78
      C=CT                                                                79
      D=DT                                                                80
      RETURN                                                              81
      END                                                                 82
```

```
$IBFTC MAPBAK  DECK
      SUBROUTINE MAPBAC (MAP,MAPGO,TFFS,TFF,CNS,CN,PCN,T,MODE,IGO,NUM)     1
      DATA NH,NL,NT,NS/6H H.P. ,6H L.P. ,6H TFF  ,6HSPEED /                2
      DATA NM/6H I.P.  /                                                   3
      MAPS=MAP                                                             4
      IF (MAP.EQ.3) MAP=2                                                  5
      IF (NUM.GT.0) GO TO 1                                                6
      NUMH=0                                                               7
      NUML=0                                                               8
1     IGO=MAPGO+3*(MAP-1)                                                  9
      GO TO (2,3,5,6,7,9),IGO                                             10
```

```
C *** HIGH PRESSURE TURBINE                                              11
2     TFF=TFF+0.1*(TFF-TFFS)                                             12
      WRITE (8,10) WH,WT,TFFS,TFF                                        13
      RETURN                                                             14
3     CN=CN+0.05*(CN-CNS)                                                15
      IF (MODE.NE.1) PCN=PCN*(CN/CNS)                                    16
      IF (MODE.EQ.1) T=T*(CNS/CN)**2                                     17
      WRITE (8,10) WH,WS,CNS,CN                                          18
      IF (NJMH.GT.2) GO TO 4                                             19
      NUM=1                                                              20
      NUMH=NJMH+1                                                        21
      RETURN                                                             22
4     DELCN=CN-CNS                                                       23
      IF (DELCN.GE.0.) RETURN                                            24
      TFF=TFF*(1.+DELCN/CN)                                              25
      WRITE (8,11) WH,WT,TFFS,TFF                                        26
      RETURN                                                             27
5     TFF=TFF+0.1*(TFF-TFFS)                                             28
      WRITE (8,10) WH,WT,TFFS,TFF                                        29
      GO TO 3                                                            30
C *** LOW PRESSURE TURBINE                                               31
6     TFF=TFF+0.1*(TFF-TFFS)                                             32
      IF (MAPS.EQ.2) WRITE (8,10) WL,WT,TFFS,TFF                         33
      IF (MAPS.EQ.3) WRITE (8,10) WM,WT,TFFS,TFF                         34
      MAP=MAPS                                                           35
      RETURN                                                             36
7     CN=CN+0.05*(CN-CNS)                                                37
      IF (MODE.NE.3) PCN=PCN*(CN/CNS)                                    38
      IF (MODE.EQ.3) T=T*(CNS/CN)                                        39
      IF (MAPS.EQ.2) WRITE (8,10) WL,WS,CNS,CN                           40
      IF (MAPS.EQ.3) WRITE (8,10) WM,WS,CNS,CN                           41
      MAP=MAPS                                                           42
      IF (NJML.GT.2) GO TO 8                                             43
      NUM=1                                                              44
      NUML=NJML+1                                                        45
      RETURN                                                             46
8     DELCN=CN-CNS                                                       47
      IF (DELCN.GE.0.) RETURN                                            48
      TFF=TFF*(1.+DELCN/CN)                                              49
      IF (MAPS.EQ.2) WRITE (8,11) WL,WT,TFFS,TFF                         50
      IF (MAPS.EQ.3) WRITE (8,11) WM,WT,TFFS,TFF                         51
      MAP=MAPS                                                           52
      RETURN                                                             53
9     TFF=TFF+0.1*(TFF-TFFS)                                             54
      IF (MAPS.EQ.2) WRITE (8,10) WL,WT,TFFS,TFF                         55
      IF (MAPS.EQ.3) WRITE (8,10) WM,WT,TFFS,TFF                         56
      MAP=MAPS                                                           57
      GO TO 7                                                            58
C                                                                        59
C                                                                        60
10    FORMAT (1HO,A6,12HTURBINE MAP ,A6,4HWAS=,E13.6,10H  AND NOW=,E13.6 61
     1,6H$$$$$$)                                                         62
11    FORMAT (1HO,A6,A6,22HWAS ALSO CHANGED FROM ,E13.6,5H  TO ,E13.6,5H 63
     1$$$$$$)                                                            64
      END                                                                65
```

```
$IBFTC CONVRG  DECK
      SUBROUTINE CONVRG (TI,HI,PI,SI,FAR,WG,PA,IDES,AO,PR,TO,HO,PO,SO,TS      1
     1O,PSO,VO,AMO,ICON)                                                      2
C     ICON=1      SUBSONIC, COMPARE PI WITH PR                               3
C     ICON=2      SONIC, COMPARE PI WITH PR                                  4
C     ICON=4      ERROR                                                      5
      AJ=778.26                                                              6
      CAPSF=2116.217                                                         7
      G=32.174049                                                            8
      CALL PROCOM (FAR,TI,XX1,XX2,XX3,XX4,PHII,XX6)                          9
C *** SONIC CALCULATIONS                                                     10
      J=0                                                                    11
      TSS=0.833*TI                                                           12
1     J=J+1                                                                  13
      CALL PROCOM (FAR,TSS,CSS,AKS,CP,REXS,PHISS,HSS)                        14
      HSCAL=HI-CSS**2/(2.*G*AJ)                                              15
      DELHS=HSCAL-HSS                                                        16
      IF (ABS(DELHS)-0.0005*HSCAL) 4,4,2                                     17
2     TSS=TSS+DELHS/CP                                                       18
      IF (J-15) 1,1,3                                                        19
3     ICON=4                                                                 20
      RETURN                                                                 21
4     IF (IDES) 12,12,5                                                      22
C *** ISENTROPIC EXPANSION CALCULATIONS                                      23
5     J=0                                                                    24
      TSI=TI*(PA/PI)**0.286                                                  25
6     J=J+1                                                                  26
      CALL THERMO (PA,HSI,TSI,SSI,XX1,1,FAR,0)                               27
      IF (ABS(SSI-SI)-0.0001*SI) 8,8,7                                       28
7     TSI=TSI/EXP(4.*(SSI-SI))                                               29
      IF (J-30) 6,6,3                                                        30
8     VIS=SQRT(2.*G*AJ*(HI-HSI))                                             31
      IF (VIS-CSS) 9,11,11                                                   32
C *** SUBSONIC DESIGN, CALCULATE AO                                          33
9     VO=VIS                                                                 34
      TSO=TSI                                                                35
      PSO=PA                                                                 36
      CALL PROCOM (FAR,TSO,CSO,XX2,XX3,REX,PHISO,HSO)                        37
      RHO=CAPSF*PSO/(AJ*REX*TSO)                                             38
      AO=WG/(RHO*VO)                                                         39
      AMO=VO/CSO                                                             40
      PR=PI                                                                  41
      ICON=1                                                                 42
10    TO=TI                                                                  43
      HO=HI                                                                  44
      PO=PI                                                                  45
      SO=SI                                                                  46
      RETURN                                                                 47
C *** SONIC DESIGN, CALCULATE AO                                             48
11    VO=CSS                                                                 49
      TSO=TSS                                                                50
      PSO=PI*(TSO/TI)**(AKS/(AKS-1.))                                        51
      RHO=CAPSF*PSO/(AJ*REXS*TSO)                                            52
      AO=WG/(RHO*VO)                                                         53
      AMO=1.0                                                                54
      PR=PI                                                                  55
      ICON=2                                                                 56
      GO TO 10                                                               57
C *** NON-DESIGN, CALCULATE CRITICAL CONDITIONS                              58
12    VO=CSS                                                                 59
      TSO=TSS                                                                60
      PSO=PA                                                                 61
      RHO=CAPSF*PSO/(AJ*REXS*TSO)                                            62
```

```
      AOCRIT=WG/(RHO*VO)                                                    63
      AMO=1.0                                                               64
      PR=PSO*(TI/TSO)**(AKS/(AKS-1.))                                       65
      IF (AO-AOCRIT) 13,13,14                                               66
C *** NON-DESIGN, CRITICAL AND SUPERCRITICAL CONDITIONS                     67
13    PSO=PSO*AOCRIT/AO                                                     68
      PR=PR*AOCRIT/AO                                                       69
      ICON=2                                                                70
      GO TO 10                                                              71
C *** NON-DESIGN, SUBSONIC CALCULATIONS                                     72
14    PSO=PA                                                                73
      J=0                                                                   74
      TSO=0.833*TSO                                                         75
15    J=J+1                                                                 76
      CALL PROCOM (FAR,TSO,CSO,AKO,CP,REX,PHISO,HSO)                        77
      RHO=CAPSF*PSO/(AJ*REX*TSO)                                            78
      VO=WG/(RHO*AO)                                                        79
      HSCAL=HI-VO**2/(2.*G*AJ)                                              80
      DELHS=HSCAL-HSO                                                       81
      IF (ABS(DELHS)-0.0005*HSCAL) 17,17,16                                 82
16    TSO=TSO+DELHS/CP                                                      83
      IF (J-15) 15,15,3                                                     84
17    AMO=VO/CSO                                                            85
      PR=PSO*(TI/TSO)**(AKO/(AKO-1.))                                       86
      ICON=1                                                                87
      GO TO 10                                                              88
      END                                                                   89
```

```
$IBFTC CONDIV  DECK
      SUBROUTINE CONDIV (TI,HI,PI,SI,FAR,WG,PA,IDES,AT,AO,PIR,TT,HT,PT,S     1
     1T,TO,HO,PO,SO,TST,TSO,PST,PSO,VT,VO,AMT,AMO,ICON)                      2
C     ICON=1  SUBSONIC, COMPARE PIR WITH PI                                  3
C     ICON=2  SONIC, SHOCK INSIDE NOZZLE, COMPARE PIR WITH PI                4
C     ICON=3  SONIC, SHOCK OUTSIDE NOZZLE, COMPARE PIR WITH PI               5
C     ICON=4  ERROR                                                          6
      DIMENSION Q(9)                                                         7
      Q(2)=0.                                                                8
      Q(3)=0.                                                                9
      AJ=778.26                                                             10
      CAPSF=2116.2170                                                       11
      G=32.174049                                                           12
      CALL PROCOM (FAR,TI,XX1,XX2,XX3,XX4,PHII,XX6)                         13
C *** SONIC CALCULATIONS                                                    14
      J=0                                                                   15
      TSS=0.833*TI                                                          16
1     J=J+1                                                                 17
      CALL PROCOM (FAR,TSS,CSS,AK,CP,REXS,PHISS,HSS)                        18
      HSCAL=HI-CSS**2/(2.*G*AJ)                                             19
      DELHS=HSCAL-HSS                                                       20
      IF (ABS(DELHS)-0.0005*HSCAL) 4,4,2                                    21
2     TSS=TSS+DELHS/CP                                                      22
      IF (J-15) 1,1,3                                                       23
3     ICON=4                                                                24
      RETURN                                                                25
4     IF (IDES) 11,11,5                                                     26
C *** SONIC DESIGN, CALCULATE AT                                            27
5     VT=CSS                                                                28
      TST=TSS                                                               29
```

```
      PST=PI*(TST/TI)**(AK/(AK-1.))                                          30
      RHO=CAPSF*PST/(AJ*REXS*TST)                                            31
      AT=WG/(RHO*VT)                                                         32
      AMT=1.0                                                                33
C *** IDEAL EXPANSION DESIGN, CALCULATE AO                                   34
      PSO=PA                                                                 35
      J=0                                                                    36
      TSO=TI*(PSO/PI)**.286                                                  37
6     J=J+1                                                                  38
      CALL PROCOM (FAR,TSO,CSO,AK,CP,REX,PHISO,HSO)                          39
      PHICAL=PHII-REX*ALOG(PI/PSO)                                           40
      DELPHI=PHICAL-PHISO                                                    41
      IF (ABS(DELPHI)-0.0001*PHICAL) 8,8,7                                   42
7     TSO=TSO*EXP(4.*DELPHI)                                                 43
      IF (J-15) 6,6,3                                                        44
8     VO=SQRT(2.*G*AJ*(HI-HSO))                                              45
      AMO=VO/CSO                                                             46
      AO=(AT/AMO)*(2.*(1.+(AK-1.)*AMO**2/2.)/(AK+1.))**((AK+1.)/(2.*(AK-     47
     11.)))                                                                  48
      PIR=PI                                                                 49
      ICON=3                                                                 50
9     TO=TI                                                                  51
      HO=HI                                                                  52
      PO=PI                                                                  53
      SO=SI                                                                  54
10    TT=TI                                                                  55
      HT=HI                                                                  56
      PT=PI                                                                  57
      ST=SI                                                                  58
      RETURN                                                                 59
C *** ASSUME SONIC THROAT AND ISENTROPIC EXPANSION TO AO                     60
11    VT=CSS                                                                 61
      AMT=1.0                                                                62
      TST=TSS                                                                63
      RHO=WG/(AT*VT)                                                         64
      PST=RHO*AJ*REXS*TST/CAPSF                                              65
      PIR=PST*(TI/TST)**(AK/(AK-1.))                                         66
      IF (PST-PA) 12,27,27                                                   67
12    TSO=0.95*TI                                                            68
      MAM=0                                                                  69
13    CALL PROCOM (FAR,TSO,CSO,AK,CP,REX,PHISO,HSO)                          70
      AMO=SQRT(2.*((TI/TSO)-1.)/(AK-1.))                                     71
      AOCAL=(AT/AMO)*(2.*(1.+(AK-1.)*AMO**2/2.)/(AK+1.))**((AK+1.)/(2.*(     72
     1AK-1.)))                                                               73
      EA=(AO-AOCAL)/AO                                                       74
      DIR=SQRT(AO/AOCAL)                                                     75
      CALL AFQUIR (Q(1),TSO,EA,0.,100.,0.0001,DIR,TSOT,JCON)                 76
      GO TO (14,18,3),JCON                                                   77
14    TSO=TSOT                                                               78
      IF (TSO-TI) 15,13,16                                                   79
15    TSC=2.*TI/(AK+1.)                                                      80
      IF (TSO.GT.TSC) GO TO 17                                               81
16    TSO=0.98*TI                                                            82
      GO TO 13                                                               83
17    IF (Q(2).LT.30.0.OR.AMO.LT.0.95.OR.MAM.EQ.1) GO TO 13                  84
      TSO=2.*TI/(2.+0.98*(AK-1.))                                            85
      MAM=1                                                                  86
      GO TO 13                                                               87
18    PSO=PIR*(TSO/TI)**(AK/(AK-1.))                                         88
      IF (PSO-PA) 20,19,27                                                   89
C *** CRITICAL FLOW, ISENTROPIC EXPANSION TO PA                              90
```

```
19    VO=AMO*CSO                                                        91
      ICON=1                                                            92
      GO TO 9                                                           93
C *** SUBSONIC FLOW                                                     94
20    PSO=PA                                                            95
      Q(2)=0.                                                           96
      Q(3)=0.                                                           97
      J=0                                                               98
      TSO=0.833*TI                                                      99
21    J=J+1                                                            100
      CALL PROCOM (FAR,TSO,CSO,AK,CP,REX,PHISO,HSO)                    101
      RHO=CAPSF*PSO/(AJ*REX*TSO)                                       102
      VO=WG/(RHO*AO)                                                   103
      HSCAL=HI-VO**2/(2.*G*AJ)                                         104
      DELHS=HSCAL-HSO                                                  105
      IF (ABS(DELHS)-0.0005*HSCAL) 23,23,22                            106
22    TSO=TSO+DELHS/CP                                                 107
      IF (J-15) 21,21,3                                                108
23    AMO=VO/CSO                                                       109
      PIR=PSO*(TI/TSO)**(AK/(AK-1.))                                   110
      TST=TSO                                                          111
24    CALL PROCOM (FAR,TST,CST,AK,CP,REX,PHIST,HST)                    112
      PST=PIR*(TST/TI)**(AK/(AK-1.))                                   113
      RHO=PST*CAPSF/(AJ*REX*TST)                                       114
      VT=WG/(RHO*AT)                                                   115
      HSCAL=HI-VT**2/(2.*G*AJ)                                         116
      EH=(HSCAL-HST)/HSCAL                                             117
      DIR=1.+(HSCAL-HST)/(CP*TST)                                      118
      CALL AFQUIR (Q(1),TST,EH,0.,20.,0.0005,DIR,TSTT,JCON)            119
      GO TO (25,26,3),JCON                                             120
25    TST=TSTT                                                         121
      GO TO 24                                                         122
26    AMT=VT/CST                                                       123
      ICON=1                                                           124
      GO TO 9                                                          125
C *** SUPERCRITICAL FLOW, ISENTROPIC EXPANSION TO PA                   126
27    PSO=PA                                                           127
      J=0                                                              128
      TSO=TI*(PSO/PIR)**.286                                           129
28    J=J+1                                                            130
      CALL PROCOM (FAR,TSO,CSO,AK,CP,REX,PHISO,HSO)                    131
      PHICAL=PHII-REX*ALOG(PIR/PSO)                                    132
      DELPHI=PHICAL-PHISO                                              133
      IF (ABS(DELPHI)-0.0001*PHICAL) 30,30,29                          134
29    TSO=TSO*EXP(4.0*DELPHI)                                          135
      IF (J-15) 28,28,3                                                136
30    VO=SQRT(2.*G*AJ*(HI-HSO))                                        137
      AMO=VO/CSO                                                       138
      AOID=(AT/AMO)*(2.*(1.+(AK-1.)*AMO**2/2.)/(AK+1.))**((AK+1.)/(2.*(A 139
     1K-1.)))                                                          140
      ICON=3                                                           141
      N=0                                                              142
      IF (AO-AOID) 31,9,32                                             143
C *** SUPERCRITICAL FLOW, ISENTROPIC EXPANSION TO AO                   144
31    N=1                                                              145
32    TSO=0.833*TI                                                     146
      J=0                                                              147
33    J=J+1                                                            148
      CALL PROCOM (FAR,TSO,CSO,AK,CP,REX,PHISO,HSO)                    149
      AMO=SQRT(2.*((TI/TSO)-1.)/(AK-1.))                               150
      AOCAL=(AT/AMO)*(2.*(1.+(AK-1.)*AMO**2/2.)/(AK+1.))**((AK+1.)/(2.*( 151
     1AK-1.)))                                                         152
```

```
      DELA=AJ-AOCAL                                                     153
      IF (ABS(DELA)-0.0001*AO) 35,35,34                                 154
34    TSO=TSJ*SQRT(AOCAL/AO)                                            155
      IF (J-50) 33,33,3                                                 156
35    IF (N) 37,37,36                                                   157
C *** UNDEREXPANDED, SHOCK OUTSIDE NOZZLE                               158
36    PSO=PIR*(TSO/TI)**(AK/(AK-1.))                                    159
      VO=AMJ*CSO                                                        160
      GO TO 9                                                           161
C *** OVEREXPANDED, FIND SHOCK POSITION                                 162
37    PSX=PIR*(TSO/TI)**(AK/(AK-1.))                                    163
      PSY=PSX*(2.*AK*AMO**2/(AK+1.)-(AK-1.)/(AK+1.))                    164
      IF (PA-PSY) 38,39,39                                              165
C *** OVEREXPANDED, SHOCK OUTSIDE NOZZLE                                166
38    PSO=PSX                                                           167
      VO=AMJ*CSO                                                        168
      GO TO 9                                                           169
C *** OVEREXPANDED, SHOCK INSIDE NOZZLE                                 170
39    PSO=PA                                                            171
      J=0                                                               172
      TSO=0.833*TI                                                      173
40    J=J+1                                                             174
      CALL PROCOM (FAR,TSO,CSO,AK,CP,REX,PHISO,HSO)                     175
      RHO=CAPSF*PSO/(AJ*REX*TSO)                                        176
      VO=WG/(RHO*AO)                                                    177
      HSCAL=HI-VO**2/(2.*G*AJ)                                          178
      DELHS=HSCAL-HSO                                                   179
      IF (ABS(DELHS)-0.0005*HSCAL) 42,42,41                             180
41    TSO=TSJ+DELHS/CP                                                  181
      IF (J-15) 40,40,3                                                 182
42    AMO=VJ/CSO                                                        183
      TO=TI                                                             184
      HO=HI                                                             185
      PO=PSJ*(TO/TSO)**(AK/(AK-1.))                                     186
      SO=PHII-REX*ALOG(PO)                                              187
      ICON=2                                                            188
      GO TO 10                                                          189
      END                                                               190
```

```
$IBFTC THTRB   DECK
      SUBROJTINE THTURB (DH,ETA,FAR,H,S,P,TO,HO,SO,PO)                   1
      HO=H-JH                                                            2
      HOP=H-DH/ETA                                                       3
      PT=P/2.                                                            4
      DO 1 I=1,25                                                        5
      CALL THERMO (PT,HOP,TT,ST,AMWT,1,FAR,1)                            6
      DELS=ST-S                                                          7
      IF (ABS(DELS).LE.0.00005*S) GO TO 2                                8
1     PT=P*EXP(DELS*AMWT/1.986375+ALOG(PT/P))                            9
      CALL ERROR                                                        10
2     PO=PT                                                             11
      CALL THERMO (PO,HO,TO,SO,X1,1,FAR,1)                              12
      RETURN                                                            13
      END                                                               14
```

```
$IBFTC THERMO  DECK
      SUBROUTINE THERMO (PX,HX,TX,SX,AMX,L,FAR,K)                          1
      FX=0.                                                                2
      IF (L.EQ.1) FX=FAR                                                   3
      IF (K.EQ.1) GO TO 1                                                  4
      CALL PROCOM (FX,TX,CS,AK,CP,R,PHI,HX)                                5
      GO TO 3                                                              6
1     TX=4.*HX                                                             7
      DO 2 I=1,15                                                          8
      CALL PROCOM (FX,TX,CS,AK,CP,R,PHI,H)                                 9
      DELH=HX-H                                                           10
      IF (ABS(DELH).LE.0.00001*HX) GO TO 3                                11
2     TX=TX+4.*DELH                                                       12
      WRITE (8,4)                                                         13
3     SX=PHI-R*ALOG(PX)                                                   14
      AMX=1.986375/R                                                      15
      RETURN                                                              16
C                                                                         17
C                                                                         18
4     FORMAT (31HONO CONVERGENCE IN THERMO$$$$$$)                         19
      END                                                                 20
```

```
$IBFTC SERCH   DECK
      SUBROUTINE SEARCH (P,A,B,C,D,AX,NA,BX,CX,DX,NO,NAM,NOM,NCODE)        1
      DIMENSION AX(NAM),BX(NAM,NOM),CX(NAM,NOM),DX(NAM,NOM),NO(NAM),Q(9)   2
C *** NEEDS SUBROUTINE AFQUIR                                              3
C *** AX AND BX MUST BE STORED LO TO HI                                    4
C *** P=INPUT PROPORTION BETWEEN 0.0 AND 1.0                               5
C     IF NOT INPUT, P MUST EQUAL -1.                                       6
C *** NCODE=00   OK                                                        7
C     NCODE=01   A LO                                                      8
C     NCODE=02   A HI                                                      9
C     NCODE=07   ERROR                                                    10
C     NCODE=10   B LO                                                     11
C     NCODE=20   B HI                                                     12
      NCODE=0                                                             13
      C=0.                                                                14
      D=0.                                                                15
C *** FIND A                                                              16
      DO 1 I=1,NA                                                         17
      IH=I                                                                18
      IF (A.LT.AX(I)) GO TO 2                                             19
1     CONTINUE                                                            20
      IF (A.GT.AX(IH)) NCODE=2                                            21
      A=AX(IH)                                                            22
      GO TO 3                                                             23
2     IF (IH.GT.1) GO TO 3                                                24
      NCODE=1                                                             25
      IH=2                                                                26
      A=AX(1)                                                             27
3     IL=IH-1                                                             28
      LIMH=NO(IH)                                                         29
      LIML=NO(IL)                                                         30
C *** FIND B                                                              31
      PRM=(A-AX(IL))/(AX(IH)-AX(IL))                                      32
      PP=P                                                                33
      IF (P.GE.0.) GO TO 6                                                34
      BL=BX(IL,1)+PRM*(BX(IH,1)-BX(IL,1))                                 35
```

```
      BH=BX(IL,LIML)+PRM*(BX(IH,LIMH)-BX(IL,LIML))                        36
      IF (B.GE.BL) GO TO 4                                                37
      NCODE=NCODE+10                                                      38
      B=BL                                                                39
      GO TO 5                                                             40
4     IF (B.LE.BH) GO TO 5                                                41
      NCODE=NCODE+20                                                      42
      B=BH                                                                43
5     PP=0.5                                                              44
      Q(2)=0.                                                             45
      Q(3)=0.                                                             46
6     BH=PP*(BX(IH,LIMH)-BX(IH,1))+BX(IH,1)                               47
      BL=PP*(BX(IL,LIML)-BX(IL,1))+BX(IL,1)                               48
      DO 7 J=2,LIMH                                                       49
      JH=J                                                                50
      IF (B.LT.BX(IH,J)) GO TO 8                                          51
7     CONTINUE                                                            52
8     JL=JH-1                                                             53
      DO 9 K=2,LIML                                                       54
      KH=K                                                                55
      IF (BL.LT.BX(IL,K)) GO TO 10                                        56
9     CONTINUE                                                            57
10    KL=KH-1                                                             58
      PR=(BX(IH,JL)-BH)/(BX(IH,JH)-BX(IH,JL))                             59
      CH=CX(IH,JL)-PR*(CX(IH,JH)-CX(IH,JL))                               60
      DH=DX(IH,JL)-PR*(DX(IH,JH)-DX(IH,JL))                               61
      PR=(BX(IL,KL)-BL)/(BX(IL,KH)-BX(IL,KL))                             62
      CL=CX(IL,KL)-PR*(CX(IL,KH)-CX(IL,KL))                               63
      DL=DX(IL,KL)-PR*(DX(IL,KH)-DX(IL,KL))                               64
      BT=BL+PRM*(BH-BL)                                                   65
      CT=CL+PRM*(CH-CL)                                                   66
      DT=DL+PRM*(DH-DL)                                                   67
      IF (P.GE.0.) GO TO 13                                               68
      DIR=SQRT(B/BT)                                                      69
      ERR=(B-BT)/B                                                        70
      CALL AFQUIR (Q(1),PP,ERR,0.,25.,0.001,DIR,PT,ICON)                  71
      GO TO (11,13,12),ICON                                               72
11    PP=PT                                                               73
      IF (P).LT.0.) PP=0.                                                 74
      IF (P).GT.1.) PP=1.                                                 75
      GO TO 6                                                             76
12    NCODE=7                                                             77
13    B=BT                                                                78
      C=CT                                                                79
      D=DT                                                                80
      RETURN                                                              81
      END                                                                 82
```

```
$IBFTC AFQUER  DECK
      SUBROUTINE AFQUIR (X,AIND,DEPEND,ANS,AJ,TOL,DIR,ANEW,ICON)           1
      DIMENSION X(9)                                                       2
C X(1)=NAME OF ARRAY TO USE                                                3
C AIND=INDEPENDANT VARIABLE                                                4
C DEPEND= DEPENDANT VARIABLE                                               5
C ANS=ANSWER UPON WHICH TO CONVERGE                                        6
C AJ=MAX NUMBER OF TRYS                                                    7
C TOL=PERCENT TOLERANCE FOR CONVERGENCE                                    8
C DIR=DIRECTION AND PERCENTAGE FOR FIRST GUESS                             9
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C ANEW=CALCULATED VALUE OF NEXT TRY AT INDEPENDANT VARIABLE                    10
C ICON=CONTROL  =1 GO THRU LOOP AGAIN                                          11
C               =2 YOU HAVE REACHED THE ANSWER                                 12
C               =3 COUNTER HAS HIT LIMITS                                      13
C X(2)=COUNTER STORAGE                                                         14
C X(3)=CHOOSES METHOD OF CONVERGENCE                                           15
C X(4)=THIRD DEPEND VAR                                                        16
C X(5)=THIRD IND VAR                                                           17
C X(6)=SECOND DEPEND VAR                                                       18
C X(7)=SECOND IND VAR                                                          19
C X(8)=FIRST DEPEND VAR                                                        20
C X(9)=FIRST IND VAR                                                           21
C X(3) MUST BE ZERO UPON FIRST ENTRY TO ROUTINE                                22
      Y=0.                                                                     23
      IF (ANS) 1,2,1                                                           24
1     DEP=DEPEND-ANS                                                           25
      TOLANS=TOL*ANS                                                           26
      GO TO 3                                                                  27
2     DEP=DEPEND                                                               28
      TOLANS=TOL                                                               29
3     IF (ABS(DEP)-TOLANS) 5,5,4                                               30
4     IF (X(2)-AJ) 8,8,7                                                       31
5     ANEW=AIND                                                                32
      X(2)=0.                                                                  33
      ICON=2                                                                   34
      RETURN                                                                   35
6     ANEW=Y                                                                   36
      X(2)=X(2)+1.                                                             37
      ICON=1                                                                   38
      RETURN                                                                   39
7     ANEW=Y                                                                   40
      X(2)=0.                                                                  41
      ICON=3                                                                   42
      RETURN                                                                   43
8     IF (X(3)) 9,9,12                                                         44
C *** FIRST GUESS USING DIR                                                    45
9     X(3)=1.                                                                  46
      X(8)=DEP                                                                 47
      X(9)=AIND                                                                48
      IF (AIND) 10,11,10                                                       49
10    Y=DIR*AIND                                                               50
      GO TO 6                                                                  51
11    Y=DIR                                                                    52
      GO TO 6                                                                  53
12    IF (X(3)-1.) 13,13,16                                                    54
C *** LINEAR GUESS                                                             55
13    X(3)=2.                                                                  56
      X(6)=DEP                                                                 57
      X(7)=AIND                                                                58
      IF (X(8)-X(6)) 14,9,14                                                   59
14    IF (X(9)-X(7)) 15,9,15                                                   60
15    A=(X(9)-X(7))/(X(8)-X(6))                                                61
      Y=X(9)-A*X(8)                                                            62
      IF (ABS(10.*X(9))-ABS(Y)) 9,9,6                                          63
C *** QUADRATIC GUESS                                                          64
16    X(4)=DEP                                                                 65
      X(5)=AIND                                                                66
      IF (X(7)-X(5)) 18,17,18                                                  67
17    IF (X(6)-X(4)) 13,9,13                                                   68
18    IF (X(6)-X(4)) 19,13,19                                                  69
19    IF (X(9)-X(5)) 23,20,23                                                  70
20    IF (X(8)-X(4)) 21,22,21                                                  71
```

```
21    X(9)=X(7)                                                                  72
      X(8)=X(6)                                                                  73
      GO TO 13                                                                   74
22    X(9)=X(7)                                                                  75
      X(8)=X(6)                                                                  76
      X(3)=1.                                                                    77
      IF (X(9)) 10,11,10                                                         78
23    IF (X(8)-X(4)) 24,21,24                                                    79
24    F=(X(5)-X(4))/(X(7)-X(5))                                                  80
      A=(X(8)-X(4)-F*(X(9)-X(5)))/((X(9)-X(7))*(X(9)-X(5)))                      81
      B=F-A*(X(5)+X(7))                                                          82
      C=X(4)+X(5)*(A*X(7)-F)                                                     83
      IF (A) 27,25,27                                                            84
25    IF (B) 26,7,26                                                             85
26    Y=-C/B                                                                     86
      GO TO 47                                                                   87
27    IF (B) 32,28,32                                                            88
28    IF (C) 30,29,30                                                            89
29    Y=0.                                                                       90
      GO TO 47                                                                   91
30    G=-C/A                                                                     92
      IF (G) 7,7,31                                                              93
31    Y=SQRT(G)                                                                  94
      YY=-SQRT(G)                                                                95
      GO TO 37                                                                   96
32    IF (C) 34,33,34                                                            97
33    Y=-B/A                                                                     98
      YY=0.                                                                      99
      GO TO 37                                                                  100
34    D=4.*A*C/B**2                                                             101
      IF (1.-D) 13,35,36                                                        102
35    Y=-B/(2.*A)                                                               103
      GO TO 47                                                                  104
36    E=SQRT(1.-D)                                                              105
      Y=(-B/(2.*A))*(1.+E)                                                      106
      YY=(-B/(2.*A))*(1.-E)                                                     107
37    J=4                                                                       108
      DEPMIN=ABS(X(4))                                                          109
      DO 39 I=6,8,2                                                             110
      IF (DEPMIN-ABS(X(I))) 39,39,38                                            111
38    J=I                                                                       112
      DEPMIN=ABS(X(I))                                                          113
39    CONTINUE                                                                  114
      K=J+1                                                                     115
      IF ((X(K)-Y)*(X(K)-YY)) 42,42,40                                          116
40    IF (ABS(X(K)-Y)-ABS(X(K)-YY)) 47,47,41                                    117
41    Y=YY                                                                      118
      GO TO 47                                                                  119
42    IF (J-6) 43,44,44                                                         120
43    JJ=J+2                                                                    121
      KK=K+2                                                                    122
      GO TO 45                                                                  123
44    JJ=J-2                                                                    124
      KK=K-2                                                                    125
45    SLOPE=(X(KK)-X(K))/(X(JJ)-X(J))                                           126
      IF (SLOPE*X(J)*(X(K)-Y)) 46,46,47                                         127
46    Y=YY                                                                      128
47    X(9)=X(7)                                                                 129
      X(8)=X(6)                                                                 130
      X(7)=X(5)                                                                 131
      X(6)=X(4)                                                                 132
      GO TO 6                                                                   133
      END                                                                       134
```

```
$IBFTC PARABO  DECK
      SUBROJTINE PARABO (X,Y,XD,YANS)                                          1
      DIMENSION X(3),Y(3)                                                      2
      A=((X(1)-X(2))*(Y(1)-Y(3))-(X(1)-X(3))*(Y(1)-Y(2)))/((X(1)-X(2))*(       3
     1X(1)-X(3))*(X(3)-X(2)))                                                  4
      B=((X(1)**2-X(2)**2)*(Y(1)-Y(3))-(X(1)**2-X(3)**2)*(Y(1)-Y(2)))/((       5
     1X(1)-X(2))*(X(1)-X(3))*(X(2)-X(3)))                                      6
      D=(Y(1)*X(2)**2-Y(2)*X(1)**2-B*X(2)*X(1)*(X(2)-X(1)))/(X(2)**2-X(1       7
     1)**2)                                                                    8
      YANS=(A*XD+B)*XD+D                                                       9
      RETURN                                                                  10
      END                                                                     11

$IBFTC OVELAY  DECK
C     DUMMY ROUTINE TO RESTORE ALL OF WORKING PROGRAM TO CORE AT 1 TIME        1
      SUBROJTINE OVLAY                                                        2
      X=X                                                                     3
      RETURN                                                                  4
      END                                                                     5

$IBFTC BLKFAN  DECK
C     THIS IS A GENERALIZED FAN MAP FOR UNREALISTIC SUPERSONIC ENGINE          1
      BLOCK DATA                                                              2
      COMMON /  FAN/CN(15),PR(15,15),WAC(15,15),ETA(15,15),N,NP(15)           3
      DATA N,NP/10,6,3*7,5*10,8,5*0/                                          4
      DATA CN/0.3,0.4,0.5,0.6,0.7,0.8,0.9,1.0,1.1,1.2,5*0./                   5
      DATA (PR( 1,J),WAC( 1,J),ETA( 1,J),J=1, 6)/                             6
     1  1.00000,  243.600,  0.75592,  1.01200,  229.800,  0.76120,            7
     2  1.02800,  199.800,  0.76648,  1.03840,  166.800,  0.75592,            8
     3  1.04480,  133.200,  0.72512,  1.04800,   86.400,  0.64152/            9
      DATA (PR( 2,J),WAC( 2,J),ETA( 2,J),J=1, 7)/                            10
     1  1.00000,  286.800,  0.75592,  1.02000,  270.000,  0.77616,            11
     2  1.04000,  253.200,  0.79200,  1.05840,  233.400,  0.79728,            12
     3  1.07520,  209.400,  0.80256,  1.09200,  183.600,  0.77616,            13
     4  1.10000,  156.600,  0.74008/                                          14
      DATA (PR( 3,J),WAC( 3,J),ETA( 3,J),J=1, 7)/                            15
     1  1.00000,  333.600,  0.75064,  1.02560,  322.800,  0.77616,            16
     2  1.05120,  310.200,  0.80256,  1.08000,  291.600,  0.82808,            17
     3  1.11600,  259.800,  0.84392,  1.13200,  240.000,  0.82808,            18
     4  1.14800,  213.600,  0.77616/                                          19
      DATA (PR( 4,J),WAC( 4,J),ETA( 4,J),J=1, 7)/                            20
     1  1.00000,  383.400,  0.74536,  1.03680,  376.200,  0.77616,            21
     2  1.03800,  358.200,  0.82808,  1.12400,  340.200,  0.85448,            22
     3  1.15000,  313.200,  0.88000,  1.18960,  276.600,  0.82808,            23
     4  1.19520,  266.400,  0.80784/                                          24
      DATA (PR( 5,J),WAC( 5,J),ETA( 5,J),J=1,10)/                            25
     1  1.00000,  439.800,  0.72512,  1.06400,  436.800,  0.77616,            26
     2  1.11840,  428.400,  0.82808,  1.14800,  420.600,  0.85448,            27
     3  1.13400,  406.800,  0.88000,  1.20960,  393.600,  0.90112,            28
     4  1.21760,  388.200,  0.90376,  1.22400,  383.400,  0.90112,            29
     5  1.24400,  368.400,  0.88000,  1.26720,  342.600,  0.82808/            30
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```
      DATA (PR( 6,J),WAC( 6,J),ETA( 6,J),J=1,10)/                          31
     1  1.00000,   499.800,   0.68816,   1.10000,   499.800,   0.77616,     32
     2  1.15000,   493.200,   0.82808,   1.20000,   485.400,   0.85448,     33
     3  1.22800,   476.400,   0.88000,   1.25520,   466.800,   0.90112,     34
     4  1.27200,   456.600,   0.91080,   1.28640,   448.200,   0.90112,     35
     5  1.30240,   433.200,   0.88000,   1.33200,   406.800,   0.82720/     36
      DATA (PR( 7,J),WAC( 7,J),ETA( 7,J),J=1,10)/                          37
     1  1.00000,   566.400,   0.64152,   1.07600,   566.400,   0.72512,     38
     2  1.15200,   566.400,   0.77616,   1.21920,   559.800,   0.82808,     39
     3  1.25000,   553.200,   0.85888,   1.28960,   544.800,   0.88000,     40
     4  1.33120,   528.600,   0.90112,   1.36160,   509.400,   0.88000,     41
     5  1.39120,   483.600,   0.82808,   1.40000,   474.000,   0.81752/     42
      DATA (PR( 8,J),WAC( 8,J),ETA( 8,J),J=1,10)/                          43
     1  1.00000,   633.600,   0.60016,   1.04400,   633.600,   0.64152,     44
     2  1.13520,   633.600,   0.72512,   1.22080,   633.000,   0.77616,     45
     3  1.29440,   625.800,   0.82808,   1.34000,   616.800,   0.85888,     46
     4  1.40000,   600.000,   0.88000,   1.42800,   586.800,   0.85888,     47
     5  1.44800,   576.600,   0.82808,   1.48000,   553.200,   0.78672/     48
      DATA (PR( 9,J),WAC( 9,J),ETA( 9,J),J=1,10)/                          49
     1  1.00000,   700.200,   0.56936,   1.10400,   700.200,   0.64152,     50
     2  1.22000,   700.200,   0.72512,   1.32400,   700.200,   0.77616,     51
     3  1.40000,   700.200,   0.80256,   1.44800,   698.400,   0.80784,     52
     4  1.50000,   693.600,   0.80256,   1.53360,   683.400,   0.77616,     53
     5  1.55800,   666.600,   0.74536,   1.58400,   656.400,   0.72512/     54
      DATA (PR(10,J),WAC(10,J),ETA(10,J),J=1, 8)/                          55
     1  1.00000,   750.000,   0.51744,   1.16320,   750.000,   0.64152,     56
     2  1.31200,   750.000,   0.72512,   1.40000,   750.000,   0.75592,     57
     3  1.43000,   750.000,   0.76120,   1.54000,   750.000,   0.75064,     58
     4  1.58000,   749.400,   0.72512,   1.66000,   736.800,   0.64152/     59
      END                                                                  60
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$IBFTC BLKINT  DECK
C     THIS IS A GENERALIZED FAN MAP FOR UNREALISTIC SUPERSONIC ENGINE        1
      BLOCK DATA                                                            2
      COMMON / INT / CN(15),PR(15,15),WAC(15,15),ETA(15,15),N,NP(15)        3
      DATA N,NP/10,6,3*7,5*10,8,5*0/                                        4
      DATA CN/0.3,0.4,0.5,0.6,0.7,0.8,0.9,1.0,1.1,1.2,5*0./                 5
      DATA (PR( 1,J),WAC( 1,J),ETA( 1,J),J=1, 6)/                           6
     1  1.00000,   121.800,   0.75592,   1.01800,   114.900,   0.76120,     7
     2  1.04200,    99.900,   0.76648,   1.05760,    83.400,   0.75592,     8
     3  1.05720,    66.600,   0.72512,   1.07200,    43.200,   0.64152/     9
      DATA (PR( 2,J),WAC( 2,J),ETA( 2,J),J=1, 7)/                           10
     1  1.00000,   143.400,   0.75592,   1.03000,   135.000,   0.77616,     11
     2  1.05000,   126.600,   0.79200,   1.08760,   116.700,   0.79728,     12
     3  1.11280,   104.700,   0.80256,   1.13800,    91.800,   0.77616,     13
     4  1.15000,    78.300,   0.74008/                                       14
      DATA (PR( 3,J),WAC( 3,J),ETA( 3,J),J=1, 7)/                           15
     1  1.00000,   166.800,   0.75064,   1.03840,   161.400,   0.77616,     16
     2  1.07680,   155.100,   0.80256,   1.12000,   145.800,   0.82808,     17
     3  1.17400,   129.900,   0.84392,   1.19800,   120.000,   0.82808,     18
     4  1.22200,   106.800,   0.77616/                                       19
      DATA (PR( 4,J),WAC( 4,J),ETA( 4,J),J=1, 7)/                           20
     1  1.00000,   191.700,   0.74536,   1.05520,   188.100,   0.77616,     21
     2  1.13200,   179.100,   0.82808,   1.18600,   170.100,   0.85448,     22
     3  1.24000,   156.600,   0.88000,   1.28440,   138.300,   0.82808,     23
     4  1.29280,   133.200,   0.80784/                                       24
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```
      DATA (PR( 5,J),WAC( 5,J),ETA( 5,J),J=1,10)/                                25
     1  1.00000,   219.900,   0.72512,   1.09600,   218.400,   0.77616,          26
     2  1.17760,   214.200,   0.82808,   1.22200,   210.300,   0.85448,          27
     3  1.27600,   203.400,   0.88000,   1.31440,   196.800,   0.90112,          28
     4  1.32640,   194.100,   0.90376,   1.33600,   191.700,   0.90112,          29
     5  1.35500,   184.200,   0.88000,   1.40080,   171.300,   0.82808/          30
      DATA (PR( 6,J),WAC( 6,J),ETA( 6,J),J=1,10)/                                31
     1  1.00000,   249.900,   0.68816,   1.15000,   249.900,   0.77616,          32
     2  1.24000,   246.600,   0.82808,   1.30000,   242.700,   0.85448,          33
     3  1.34200,   238.200,   0.88000,   1.38280,   233.400,   0.90112,          34
     4  1.40800,   228.300,   0.91080,   1.42960,   224.100,   0.90112,          35
     5  1.45360,   216.600,   0.88000,   1.49800,   203.400,   0.82720/          36
      DATA (PR( 7,J),WAC( 7,J),ETA( 7,J),J=1,10)/                                37
     1  1.00000,   283.200,   0.64152,   1.11400,   283.200,   0.72512,          38
     2  1.22800,   283.200,   0.77616,   1.32880,   279.900,   0.82808,          39
     3  1.39000,   276.600,   0.85888,   1.43440,   272.400,   0.88000,          40
     4  1.49680,   264.300,   0.90112,   1.54240,   254.700,   0.88000,          41
     5  1.53580,   241.800,   0.82808,   1.60000,   237.000,   0.81752/          42
      DATA (PR( 8,J),WAC( 8,J),ETA( 8,J),J=1,10)/                                43
     1  1.00000,   316.800,   0.60016,   1.06600,   316.800,   0.64152,          44
     2  1.20280,   316.800,   0.72512,   1.33120,   316.500,   0.77616,          45
     3  1.44160,   312.900,   0.82808,   1.51000,   308.400,   0.85888,          46
     4  1.60300,   300.000,   0.88000,   1.64200,   293.400,   0.85888,          47
     5  1.67200,   288.300,   0.82808,   1.72000,   276.600,   0.78672/          48
      DATA (PR( 9,J),WAC( 9,J),ETA( 9,J),J=1,10)/                                49
     1  1.00000,   350.100,   0.56936,   1.15600,   350.100,   0.64152,          50
     2  1.33000,   350.100,   0.72512,   1.48600,   350.100,   0.77616,          51
     3  1.60000,   350.100,   0.80256,   1.67200,   349.200,   0.80784,          52
     4  1.75000,   346.800,   0.80256,   1.80040,   341.700,   0.77616,          53
     5  1.85200,   333.300,   0.74536,   1.87600,   328.200,   0.72512/          54
      DATA (PR(10,J),WAC(10,J),ETA(10,J),J=1, 8)/                                55
     1  1.00000,   375.000,   0.51744,   1.24480,   375.000,   0.64152,          56
     2  1.45800,   375.000,   0.72512,   1.60000,   375.000,   0.75592,          57
     3  1.72000,   375.000,   0.76120,   1.81000,   375.000,   0.75064,          58
     4  1.87000,   374.700,   0.72512,   1.99000,   368.400,   0.64152/          59
      END                                                                        60
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$IBFTC BLKCMP  DECK
C     THIS IS GENERALIZED COMP. MAP FOR UNREALISTIC SUPERSONIC ENGINE            1
      BLOCK DATA                                                                 2
      COMMON / COMP/CN(15),PR(15,15),WAC(15,15),ETA(15,15),N,NP(15)              3
      DATA N,NP/10,2*6,2*8,4*10,2*8,5*0/                                         4
      DATA CN/.562,.674,.787,.899,1.,1.034,1.067,1.124,1.236,1.292,5*0./         5
      DATA (PR( 1,J),WAC( 1,J),ETA( 1,J),J=1, 6)/                                6
     1  1.00000,    51.000,   0.59082,   1.84000,    50.200,   0.62178,          7
     2  2.42800,    49.500,   0.64242,   2.86900,    48.800,   0.65274,          8
     3  3.83500,    46.700,   0.67338,   4.54900,    44.500,   0.64242/          9
      DATA (PR( 2,J),WAC( 2,J),ETA( 2,J),J=1, 6)/                               10
     1  1.00000,    59.300,   0.59082,   1.96600,    59.300,   0.64242,         11
     2  3.09300,    58.800,   0.69402,   3.93300,    57.900,   0.72498,         12
     3  4.68900,    56.700,   0.74562,   5.52900,    55.000,   0.72498/         13
      DATA (PR( 3,J),WAC( 3,J),ETA( 3,J),J=1, 8)/                               14
     1  1.00000,    70.000,   0.58566,   1.84000,    70.000,   0.64242,         15
     2  2.68000,    70.000,   0.68370,   3.40800,    69.500,   0.72498,         16
     3  4.52100,    68.800,   0.77744,   5.44500,    67.900,   0.79292,         17
     4  6.31300,    66.400,   0.77744,   6.52300,    65.700,   0.76970/         18
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      DATA (PR( 4,J),WAC( 4,J),ETA( 4,J),J=1, 8)/                              19
     1  1.00000,   84.800,  0.58050,  2.00800,   84.800,  0.64242,             20
     2  3.42900,   84.800,  0.72498,  4.60500,   84.800,  0.77744,             21
     3  5.69700,   84.000,  0.80840,  6.61400,   83.300,  0.82904,             22
     4  7.53800,   81.700,  0.80840,  7.95800,   80.500,  0.79292/             23
      DATA (PR( 5,J),WAC( 5,J),ETA( 5,J),J=1,10)/                              24
     1  1.00000,  101.700,  0.57190,  2.51900,  101.700,  0.64242,             25
     2  3.93200,  101.700,  0.72498,  5.27700,  101.700,  0.77744,             26
     3  6.48300,  101.200,  0.80840,  7.20200,  101.000,  0.83936,             27
     4  8.00000,  100.000,  0.86000,  8.56700,   99.500,  0.83936,             28
     5  9.38600,   98.100,  0.80840,  9.59600,   97.400,  0.80582/             29
      DATA (PR( 6,J),WAC( 6,J),ETA( 6,J),J=1,10)/                              30
     1  1.00000,  108.100,  0.57018,  2.85500,  108.100,  0.64242,             31
     2  4.29700,  108.100,  0.72498,  5.61300,  108.100,  0.77744,             32
     3  6.93500,  107.600,  0.80840,  7.62200,  107.100,  0.83936,             33
     4  8.54500,  106.700,  0.86000,  9.13400,  106.000,  0.83936,             34
     5  9.92500,  104.500,  0.80840, 10.21900,  104.000,  0.80410/             35
      DATA (PR( 7,J),WAC( 7,J),ETA( 7,J),J=1,10)/                              36
     1  1.00000,  114.500,  0.55986,  3.26100,  114.500,  0.64242,             37
     2  4.75900,  114.500,  0.72498,  6.11700,  114.500,  0.77744,             38
     3  7.45400,  114.500,  0.80840,  8.30800,  114.300,  0.83936,             39
     4  9.21800,  113.600,  0.84968,  9.63800,  113.300,  0.83936,             40
     5 10.51300,  112.600,  0.80840, 10.99600,  112.400,  0.79808/             41
      DATA (PR( 8,J),WAC( 8,J),ETA( 8,J),J=1,10)/                              42
     1  1.00000,  122.900,  0.53922,  1.68600,  122.900,  0.57018,             43
     2  3.84900,  122.900,  0.64242,  5.46600,  122.900,  0.72498,             44
     3  6.85500,  122.900,  0.77744,  8.37100,  122.900,  0.80840,             45
     4  8.95500,  122.600,  0.82388,  9.88300,  122.100,  0.83936,             46
     5 10.91200,  121.700,  0.80840, 11.81500,  120.700,  0.77744/             47
      DATA (PR( 9,J),WAC( 9,J),ETA( 9,J),J=1, 8)/                              48
     1  1.00000,  139.800,  0.47644,  4.35300,  139.800,  0.60114,             49
     2  7.62200,  139.800,  0.72498, 10.21900,  139.800,  0.77744,             50
     3 11.05900,  139.800,  0.78260, 11.89900,  139.500,  0.77744,             51
     4 13.15900,  139.300,  0.72498, 13.65600,  139.000,  0.69918/             52
      DATA (PR(10,J),WAC(10,J),ETA(10,J),J=1, 8)/                              53
     1  1.00000,  146.200,  0.46612,  3.76500,  146.200,  0.57018,             54
     2  6.48100,  146.200,  0.64242,  9.17600,  146.200,  0.72498,             55
     3 10.21900,  146.200,  0.75078, 11.47900,  146.200,  0.75078,             56
     4 12.71100,  146.200,  0.72498, 14.41200,  146.200,  0.64242/             57
      END                                                                      58
```

```
$IBFTC CMBDT   DECK
      BLOCK DATA                                                                1
      COMMON / COMB/PSI(15),DELT(15,15),ETA(15,15),N,NP(15)                     2
      DATA N,NP / 15,15*15 /                                                    3
      DATA PSI/4.9116,9.8232,14.735,19.646,24.558,29.470,34.381,                4
     139.293,44.207,73.674,100.,200.,300.,400.,500./                            5
      DATA DELT/15*200.,15*300.,15*400.,15*500.,15*600.,15*700.,15*800.,        6
     115*900.,15*1000.,15*1100.,15*1200.,15*1300.,15*1400.,15*1500.,            7
     215*1600./                                                                 8
      DATA ETA/                                                                 9
     1.600,.726,.777,.806,.826,.843,.855,.865,7*.870,                          10
     2.758,.825,.858,.875,.888,.898,.906,.912,.914,6*.915,                     11
     3.868,.893,.911,.925,.935,.942,.947,.951,7*.953,                          12
     4.925,.936,.946,.955,.963,.969,.974,.977,.978,6*.979,                     13
     5.960,.966,.972,.977,.982,.985,.990,.992,.993,6*.995,                     14
     6.988,.991,.992,.994,.995,.997,.998,8*.999,                               15
     78*1.00,7*.999,120*1.00/                                                  16
      END                                                                      17
```

```
$IBFTC HPTDAT  DECK
      BLOCK DATA
      COMMON / HTURB/TFF(15),CN(15,15),DH(15,15),ETA(15,15),N,NP(15)
      DATA N,NP/10,9*15,12,5*0/
      DATA TFF /   39.670,   42.990,   47.460,   48.610,   49.175,
     1   49.500,   50.000,   50.425,   50.920,   51.575,    5*0./
      DATA (CN( 1,J),DH( 1,J),ETA( 1,J),J=1,15)/
     1   0.1872,   0.0032,   0.6219,   0.3372,   0.0057,   0.7078,
     2   0.5156,   0.0084,   0.7868,   0.7128,   0.0108,   0.8090,
     3   0.9382,   0.0133,   0.8090,   1.1442,   0.0152,   0.7963,
     4   1.3138,   0.0164,   0.7779,   1.5382,   0.0174,   0.7422,
     5   1.7264,   0.0179,   0.7078,   1.9324,   0.0176,   0.7635,
     6   2.1500,   0.0167,   0.6068,   2.4058,   0.0144,   0.5309,
     7   2.5892,   0.0120,   0.4773,   2.7862,   0.0082,   0.4045,
     8   2.9460,   0.0034,   0.3034/
      DATA (CN( 2,J),DH( 2,J),ETA( 2,J),J=1,15)/
     1   0.1872,   0.0038,   0.6068,   0.3942,   0.0080,   0.7078,
     2   0.5814,   0.0113,   0.8090,   0.7128,   0.0136,   0.8292,
     3   0.9442,   0.0156,   0.8363,   0.9804,   0.0176,   0.8393,
     4   1.1068,   0.0192,   0.8368,   1.2754,   0.0212,   0.8302,
     5   1.4450,   0.0228,   0.8254,   1.7068,   0.0248,   0.8090,
     6   1.9596,   0.0260,   0.7696,   2.2706,   0.0261,   0.7078,
     7   2.5970,   0.0241,   0.6068,   3.0960,   0.0188,   0.5056,
     8   3.3774,   0.0128,   0.4197/
      DATA (CN( 3,J),DH( 3,J),ETA( 3,J),J=1,15)/
     1   0.1872,   0.0046,   0.5764,   0.4362,   0.0100,   0.7078,
     2   0.5568,   0.0144,   0.8090,   0.8726,   0.0184,   0.8494,
     3   1.0696,   0.0216,   0.8543,   1.2382,   0.0240,   0.8515,
     4   1.4638,   0.0268,   0.8494,   1.6882,   0.0292,   0.8409,
     5   1.9596,   0.0316,   0.8262,   2.2138,   0.0331,   0.8090,
     6   2.5520,   0.0344,   0.7579,   2.8050,   0.0346,   0.7078,
     7   3.0392,   0.0340,   0.6652,   3.2648,   0.0324,   0.6068,
     8   3.3774,   0.0312,   0.5865/
      DATA (CN( 4,J),DH( 4,J),ETA( 4,J),J=1,15)/
     1   0.1872,   0.0052,   0.5643,   0.2550,   0.0068,   0.6068,
     2   0.4784,   0.0120,   0.7078,   0.6942,   0.0164,   0.8090,
     3   0.9148,   0.0204,   0.8494,   1.1442,   0.0244,   0.8596,
     4   1.3882,   0.0280,   0.8596,   1.5618,   0.0304,   0.8575,
     5   1.8010,   0.0336,   0.8535,   1.9794,   0.0356,   0.8494,
     6   2.2794,   0.0388,   0.8363,   2.5138,   0.0412,   0.8262,
     7   2.8334,   0.0441,   0.8090,   3.1422,   0.0472,   0.7797,
     8   3.3774,   0.0494,   0.7584/
      DATA (CN( 5,J),DH( 5,J),ETA( 5,J),J=1,15)/
     1   0.1872,   0.0056,   0.5562,   0.3000,   0.0088,   0.6068,
     2   0.5254,   0.0144,   0.7078,   0.7500,   0.0192,   0.8090,
     3   0.9754,   0.0236,   0.8494,   1.2754,   0.0288,   0.8697,
     4   1.4824,   0.0321,   0.8696,   1.7638,   0.0360,   0.8662,
     5   2.0450,   0.0400,   0.8615,   2.3362,   0.0444,   0.8555,
     6   2.5450,   0.0496,   0.8520,   2.8706,   0.0540,   0.8494,
     7   3.0764,   0.0596,   0.8494,   3.1520,   0.0640,   0.8532,
     8   3.1618,   0.0661,   0.8570/
      DATA (CN( 6,J),DH( 6,J),ETA( 6,J),J=1,15)/
     1   0.1872,   0.0068,   0.5309,   0.3568,   0.0120,   0.6068,
     2   0.5196,   0.0192,   0.7078,   0.8628,   0.0252,   0.8090,
     3   1.0932,   0.0300,   0.8494,   1.2852,   0.0340,   0.8697,
     4   1.5010,   0.0384,   0.8819,   1.6882,   0.0421,   0.8899,
     5   1.9138,   0.0472,   0.8940,   2.1246,   0.0524,   0.8969,
     6   2.2706,   0.0564,   0.8975,   2.4226,   0.0612,   0.8976,
     7   2.4950,   0.0640,   0.8968,   2.5372,   0.0668,   0.8937,
     8   2.5558,   0.0698,   0.8896/
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      DATA (CN( 7,J),DH( 7,J),ETA( 7,J),J=1,15)/                                60
     1   0.1872,    0.0080,    0.5062,    0.4314,    0.0164,    0.6068,        61
     2   0.6844,    0.0236,    0.7078,    0.9568,    0.0308,    0.8090,        62
     3   1.2010,    0.0372,    0.8494,    1.3834,    0.0416,    0.8697,        63
     4   1.5108,    0.0448,    0.8797,    1.6186,    0.0476,    0.8899,        64
     5   1.7450,    0.0510,    0.8954,    1.8618,    0.0544,    0.9000,        65
     6   1.9558,    0.0576,    0.9010,    2.0000,    0.0600,    0.9000,        66
     7   2.0450,    0.0624,    0.8980,    2.0824,    0.0660,    0.8925,        67
     8   2.1010,    0.0700,    0.8793/                                         68
      DATA (CN( 8,J),DH( 8,J),ETA( 8,J),J=1,15)/                               69
     1   0.1872,    0.0088,    0.5051,    0.4834,    0.0196,    0.6068,        70
     2   0.7314,    0.0272,    0.7078,    0.8814,    0.0316,    0.7665,        71
     3   1.0226,    0.0356,    0.8090,    1.1442,    0.0392,    0.8292,        72
     4   1.2804,    0.0432,    0.8494,    1.3696,    0.0460,    0.8596,        73
     5   1.4538,    0.0488,    0.8697,    1.5950,    0.0528,    0.8808,        74
     6   1.5746,    0.0560,    0.8848,    1.7450,    0.0596,    0.8848,        75
     7   1.8010,    0.0640,    0.8788,    1.8156,    0.0664,    0.8697,        76
     8   1.8196,    0.0693,    0.8590/                                         77
      DATA (CN( 9,J),DH( 9,J),ETA( 9,J),J=1,15)/                               78
     1   0.1872,    0.0093,    0.4909,    0.3372,    0.0159,    0.5380,        79
     2   0.5344,    0.0232,    0.6068,    0.6754,    0.0284,    0.6573,        80
     3   0.8068,    0.0330,    0.7078,    0.9196,    0.0368,    0.7463,        81
     4   1.0128,    0.0400,    0.7776,    1.1254,    0.0442,    0.8090,        82
     5   1.2196,    0.0480,    0.8191,    1.3138,    0.0524,    0.8302,        83
     6   1.3696,    0.0556,    0.8347,    1.4068,    0.0580,    0.8363,        84
     7   1.4450,    0.0612,    0.8322,    1.4638,    0.0640,    0.8241,        85
     8   1.4576,    0.0668,    0.8090/                                         86
      DATA (CN(10,J),DH(10,J),ETA(10,J),J=1,12)/                               87
     1   0.1872,    0.0132,    0.4257,    0.2814,    0.0180,    0.4747,        88
     2   0.3804,    0.0228,    0.5056,    0.4686,    0.0268,    0.5359,        89
     3   0.5528,    0.0314,    0.5683,    0.6382,    0.0352,    0.5941,        90
     4   0.6892,    0.0380,    0.6068,    0.7362,    0.0412,    0.6178,        91
     5   0.7696,    0.0440,    0.6240,    0.8068,    0.0476,    0.6310,        92
     6   0.8254,    0.0504,    0.6265,    0.8304,    0.0530,    0.6118/        93
      END                                                                      94
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$IBFTC IPTDAT  DECK
      BLOCK DATA                                                                1
      COMMON / ITURB / TFF(15),CN(15,15),DH(15,15),ETA(15,15),N,NP(15)          2
      DATA N,NP/11,9*15,12,9,4*0/                                               3
      DATA TFF /   70.776,   82.236,   93.468,  103.464,  112.836,              4
     1  116.580,  120.000,  122.676,  125.124,  127.824,  130.536,4*0./          5
      DATA (CN( 1,J),DH( 1,J),ETA( 1,J),J=1,15)/                                6
     1   0.3522,    0.0016,    0.7120,    0.5104,    0.0023,    0.7300,        7
     2   0.7044,    0.0031,    0.7472,    0.9330,    0.0038,    0.7300,        8
     3   1.1618,    0.0045,    0.7140,    1.3556,    0.0049,    0.7000,        9
     4   1.5497,    0.0052,    0.6850,    1.6905,    0.0054,    0.6730,       10
     5   1.9367,    0.0055,    0.6452,    2.1835,    0.0054,    0.6200,       11
     6   2.3593,    0.0051,    0.6000,    2.5001,    0.0047,    0.5750,       12
     7   2.5941,    0.0038,    0.5310,    2.8175,    0.0031,    0.5000,       13
     8   3.1698,    0.0001,    0.3850/                                         14
      DATA (CN( 2,J),DH( 2,J),ETA( 2,J),J=1,15)/                               15
     1   0.3522,    0.0023,    0.8000,    0.5278,    0.0035,    0.8100,       16
     2   0.7575,    0.0047,    0.8200,    1.0208,    0.0061,    0.8300,       17
     3   1.2322,    0.0070,    0.8300,    1.3818,    0.0076,    0.8290,       18
     4   1.5201,    0.0084,    0.8100,    1.8130,    0.0089,    0.8000,       19
     5   1.9723,    0.0092,    0.7850,    2.1305,    0.0094,    0.7600,       20
     6   2.2715,    0.0095,    0.7450,    2.5089,    0.0093,    0.7000,       21
     7   2.7471,    0.0089,    0.6800,    2.9227,    0.0083,    0.6450,       22
     8   3.1598,    0.0068,    0.5900/                                         23
```

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 DATA (CN( 3,J),DH( 3,J),ETA( 3,J),J=1,15)/                                    24
1    0.3522,    0.0027,    0.8000,    0.5654,    0.0045,    0.8300,          25
2    0.8279,    0.0063,    0.8600,    1.0296,    0.0076,    0.8630,          26
3    1.1975,    0.0087,    0.8670,    1.3730,    0.0098,    0.8700,          27
4    1.5497,    0.0107,    0.8720,    1.7609,    0.0118,    0.8720,          28
5    1.9367,    0.0126,    0.8700,    2.1479,    0.0134,    0.8670,          29
6    2.3245,    0.0139,    0.8600,    2.4827,    0.0142,    0.8500,          30
7    2.5583,    0.0146,    0.8300,    2.9227,    0.0147,    0.8000,          31
8    3.1598,    0.0145,    0.7600/                                            32
 DATA (CN( 4,J),DH( 4,J),ETA( 4,J),J=1,15)/                                    33
1    0.3522,    0.0029,    0.7995,    0.4052,    0.0034,    0.8000,          34
2    0.6514,    0.0054,    0.8400,    0.8452,    0.0069,    0.8600,          35
3    1.0567,    0.0084,    0.8680,    1.2322,    0.0097,    0.8730,          36
4    1.4434,    0.0111,    0.8800,    1.6722,    0.0124,    0.8830,          37
5    1.9540,    0.0140,    0.8835,    2.1131,    0.0146,    0.8830,          38
6    2.2715,    0.0153,    0.8800,    2.4915,    0.0161,    0.8740,          39
7    2.7471,    0.0168,    0.8600,    2.9931,    0.0172,    0.8350,          40
8    3.1598,    0.0173,    0.8200/                                            41
 DATA (CN( 5,J),DH( 5,J),ETA( 5,J),J=1,15)/                                    42
1    0.3522,    0.0031,    0.7750,    0.4844,    0.0043,    0.8000,          43
2    0.7044,    0.0062,    0.8480,    0.9330,    0.0081,    0.8600,          44
3    1.2322,    0.0105,    0.8750,    1.4967,    0.0124,    0.8900,          45
4    1.5548,    0.0136,    0.8912,    1.8834,    0.0152,    0.8940,          46
5    2.0071,    0.0159,    0.8955,    2.1652,    0.0169,    0.8970,          47
6    2.3274,    0.0178,    0.8961,    2.5531,    0.0189,    0.8900,          48
7    2.8175,    0.0199,    0.8790,    3.0461,    0.0207,    0.8671,          49
8    3.1598,    0.0210,    0.8600/                                            50
 DATA (CN( 6,J),DH( 6,J),ETA( 6,J),J=1,15)/                                    51
1    0.3522,    0.0034,    0.7600,    0.5896,    0.0057,    0.8000,          52
2    0.8008,    0.0076,    0.8450,    1.0567,    0.0100,    0.8600,          53
3    1.2322,    0.0114,    0.8730,    1.4619,    0.0134,    0.8900,          54
4    1.5722,    0.0150,    0.8950,    1.8660,    0.0165,    0.9000,          55
5    2.1171,    0.0184,    0.9005,    2.3245,    0.0199,    0.9010,          56
6    2.5357,    0.0214,    0.9004,    2.7375,    0.0228,    0.9000,          57
7    3.0019,    0.0251,    0.8900,    3.1167,    0.0267,    0.8800,          58
8    3.1598,    0.0280,    0.8735/                                            59
 DATA (CN( 7,J),DH( 7,J),ETA( 7,J),J=1,15)/                                    60
1    0.3522,    0.0038,    0.7310,    0.7392,    0.0078,    0.8000,          61
2    0.9689,    0.0101,    0.8300,    1.2109,    0.0124,    0.8600,          62
3    1.4089,    0.0142,    0.8750,    1.6056,    0.0159,    0.8900,          63
4    1.7609,    0.0173,    0.8930,    1.9367,    0.0190,    0.8975,          64
5    2.0948,    0.0207,    0.8999,    2.2000,    0.0220,    0.9000,          65
6    2.2889,    0.0233,    0.8980,    2.3949,    0.0250,    0.8937,          66
7    2.4471,    0.0261,    0.8900,    2.5001,    0.0276,    0.8799,          67
8    2.5175,    0.0290,    0.8710/                                            68
 DATA (CN( 8,J),DH( 8,J),ETA( 8,J),J=1,15)/                                    69
1    0.3522,    0.0042,    0.7100,    0.5808,    0.0069,    0.7450,          70
2    0.7575,    0.0090,    0.7680,    0.9330,    0.0109,    0.8000,          71
3    1.1801,    0.0135,    0.8380,    1.3915,    0.0156,    0.8600,          72
4    1.5571,    0.0177,    0.8712,    1.7609,    0.0199,    0.8780,          73
5    1.9660,    0.0213,    0.8800,    1.9897,    0.0230,    0.8775,          74
6    2.0501,    0.0241,    0.8760,    2.1131,    0.0251,    0.8722,          75
7    2.1552,    0.0263,    0.8660,    2.2009,    0.0276,    0.8600,          76
8    2.2048,    0.0283,    0.8480/                                            77
 DATA (CN( 9,J),DH( 9,J),ETA( 9,J),J=1,15)/                                    78
1    0.3522,    0.0047,    0.6780,    0.5278,    0.0070,    0.7000,          79
2    0.5340,    0.0084,    0.7125,    0.7922,    0.0104,    0.7350,          80
3    0.9589,    0.0124,    0.7690,    1.1183,    0.0141,    0.8000,          81
4    1.1801,    0.0148,    0.8060,    1.3209,    0.0166,    0.8225,          82
5    1.4519,    0.0184,    0.8395,    1.5497,    0.0196,    0.8450,          83
6    1.5722,    0.0214,    0.8470,    1.7609,    0.0232,    0.8445,          84
7    1.8130,    0.0245,    0.8330,    1.8315,    0.0255,    0.8235,          85
8    1.8401,    0.0267,    0.8080/                                            86
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      DATA (CN(10,J),DH(10,J),ETA(10,J),J=1,12)/                                 87
     1   0.3522,    0.0054,    0.6380,    0.4574,    0.0069,    0.6550,         88
     2   0.5167,    0.0092,    0.6700,    0.7218,    0.0107,    0.6850,         89
     3   0.8279,    0.0123,    0.7000,    0.9330,    0.0138,    0.7110,         90
     4   1.0567,    0.0159,    0.7180,    1.1493,    0.0177,    0.7180,         91
     5   1.2148,    0.0191,    0.7170,    1.2505,    0.0202,    0.7140,         92
     6   1.2784,    0.0214,    0.7000,    1.2824,    0.0221,    0.6890/         93
      DATA (CN(11,J),DH(11,J),ETA(11,J),J=1, 9)/                                 94
     1   0.3522,    0.0061,    0.6000,    0.4226,    0.0075,    0.6000,         95
     2   0.5278,    0.0093,    0.6120,    0.6167,    0.0108,    0.6170,         96
     3   0.7044,    0.0124,    0.6210,    0.7922,    0.0140,    0.6258,         97
     4   0.8452,    0.0151,    0.6250,    0.8983,    0.0164,    0.6230,         98
     5   0.9293,    0.0177,    0.6009/                                           99
      END                                                                       100
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$IBFTC LPTDAT  DECK
      BLOCK DATA                                                                 1
      COMMON / LTURB/TFF(15),CN(15,15),DH(15,15),ETA(15,15),N,NP(15)             2
      DATA N,NP/11,9*15,12,9,4*0/                                                3
      DATA TFF /   88.470,  102.795,  116.835,  129.330,  141.045,               4
     1  145.725,  150.000,  153.345,  156.405,  159.780,  163.170,4*0./           5
      DATA (CN( 1,J),DH( 1,J),ETA( 1,J),J=1,15)/                                 6
     1   0.3582,    0.0018,    0.7120,    0.5336,    0.0026,    0.7300,         7
     2   0.7365,    0.0035,    0.7472,    0.9754,    0.0044,    0.7300,         8
     3   1.2146,    0.0051,    0.7140,    1.4173,    0.0056,    0.7000,         9
     4   1.5201,    0.0059,    0.6850,    1.7673,    0.0061,    0.6730,        10
     5   2.0247,    0.0062,    0.6452,    2.2827,    0.0061,    0.6200,        11
     6   2.4665,    0.0057,    0.6000,    2.6137,    0.0053,    0.5750,        12
     7   2.8166,    0.0044,    0.5310,    2.9456,    0.0035,    0.5000,        13
     8   3.3138,    0.0001,    0.3850/                                          14
      DATA (CN( 2,J),DH( 2,J),ETA( 2,J),J=1,15)/                                 15
     1   0.3582,    0.0026,    0.8000,    0.5518,    0.0039,    0.8100,        16
     2   0.7919,    0.0054,    0.8200,    1.0672,    0.0069,    0.8300,        17
     3   1.2882,    0.0080,    0.8300,    1.4446,    0.0087,    0.8290,        18
     4   1.5937,    0.0096,    0.8100,    1.8954,    0.0101,    0.8000,        19
     5   2.0519,    0.0104,    0.7850,    2.2273,    0.0107,    0.7600,        20
     6   2.3747,    0.0108,    0.7450,    2.6229,    0.0106,    0.7000,        21
     7   2.8720,    0.0101,    0.6800,    3.0555,    0.0094,    0.6450,        22
     8   3.3138,    0.0077,    0.5900/                                          23
      DATA (CN( 3,J),DH( 3,J),ETA( 3,J),J=1,15)/                                 24
     1   0.3582,    0.0031,    0.8000,    0.5911,    0.0051,    0.8300,        25
     2   0.8555,    0.0071,    0.8600,    1.0764,    0.0087,    0.8630,        26
     3   1.2519,    0.0099,    0.8670,    1.4354,    0.0111,    0.8700,        27
     4   1.5201,    0.0122,    0.8720,    1.8409,    0.0134,    0.8720,        28
     5   2.0247,    0.0143,    0.8700,    2.2455,    0.0152,    0.8670,        29
     6   2.4302,    0.0157,    0.8600,    2.5956,    0.0162,    0.8500,        30
     7   2.7791,    0.0166,    0.8300,    3.0555,    0.0167,    0.8000,        31
     8   3.3138,    0.0164,    0.7600/                                          32
      DATA (CN( 4,J),DH( 4,J),ETA( 4,J),J=1,15)/                                 33
     1   0.3582,    0.0033,    0.7995,    0.4237,    0.0038,    0.8000,        34
     2   0.5810,    0.0061,    0.8400,    0.8837,    0.0078,    0.8600,        35
     3   1.1047,    0.0096,    0.8680,    1.2882,    0.0110,    0.8730,        36
     4   1.5090,    0.0126,    0.8800,    1.7482,    0.0141,    0.8830,        37
     5   2.0429,    0.0159,    0.8835,    2.2091,    0.0166,    0.8830,        38
     6   2.3747,    0.0174,    0.8800,    2.6047,    0.0183,    0.8740,        39
     7   2.8720,    0.0191,    0.8600,    3.1291,    0.0195,    0.8350,        40
     8   3.3138,    0.0197,    0.8200/                                          41
```

```
 DATA (CN( 5,J),DH( 5,J),ETA( 5,J),J=1,15)/                                    42
1   0.3582,   0.0036,   0.7750,   0.5065,   0.0049,   0.8000,                  43
2   0.7365,   0.0071,   0.8480,   0.9754,   0.0092,   0.8600,                  44
3   1.2882,   0.0119,   0.8750,   1.5647,   0.0141,   0.8900,                  45
4   1.7301,   0.0155,   0.8912,   1.9690,   0.0172,   0.8940,                  46
5   2.0983,   0.0181,   0.8955,   2.2637,   0.0192,   0.8970,                  47
6   2.4332,   0.0202,   0.8961,   2.6691,   0.0214,   0.8900,                  48
7   2.9456,   0.0226,   0.8790,   3.1846,   0.0235,   0.8671,                  49
8   3.3138,   0.0239,   0.8600/                                                50
 DATA (CN( 6,J),DH( 6,J),ETA( 6,J),J=1,15)/                                    51
1   0.3682,   0.0038,   0.7600,   0.6164,   0.0064,   0.8000,                  52
2   0.8372,   0.0087,   0.8450,   1.1047,   0.0113,   0.8600,                  53
3   1.2382,   0.0130,   0.8730,   1.5283,   0.0152,   0.8900,                  54
4   1.7482,   0.0171,   0.8950,   1.9509,   0.0187,   0.9000,                  55
5   2.2133,   0.0209,   0.9005,   2.4302,   0.0226,   0.9010,                  56
6   2.6510,   0.0244,   0.9004,   2.8619,   0.0259,   0.9000,                  57
7   3.1384,   0.0286,   0.8900,   3.2584,   0.0303,   0.8800,                  58
8   3.3138,   0.0319,   0.8735/                                                59
 DATA (CN( 7,J),DH( 7,J),ETA( 7,J),J=1,15)/                                    60
1   0.3582,   0.0044,   0.7310,   0.7728,   0.0089,   0.8000,                  61
2   1.0129,   0.0115,   0.8300,   1.2659,   0.0141,   0.8600,                  62
3   1.4729,   0.0162,   0.8750,   1.6785,   0.0181,   0.8900,                  63
4   1.8409,   0.0197,   0.8930,   2.0247,   0.0216,   0.8975,                  64
5   2.1901,   0.0235,   0.8999,   2.3000,   0.0250,   0.9000,                  65
6   2.3929,   0.0265,   0.8980,   2.5038,   0.0284,   0.8937,                  66
7   2.5583,   0.0296,   0.8900,   2.6137,   0.0314,   0.8799,                  67
8   2.6319,   0.0329,   0.8710/                                                68
 DATA (CN( 8,J),DH( 8,J),ETA( 8,J),J=1,15)/                                    69
1   0.3682,   0.0048,   0.7100,   0.6072,   0.0078,   0.7450,                  70
2   0.7919,   0.0102,   0.7680,   0.9754,   0.0124,   0.8000,                  71
3   1.2337,   0.0153,   0.8380,   1.4548,   0.0177,   0.8600,                  72
4   1.6383,   0.0201,   0.8712,   1.8409,   0.0226,   0.8780,                  73
5   1.9509,   0.0242,   0.8800,   2.0801,   0.0261,   0.8775,                  74
6   2.1537,   0.0274,   0.8760,   2.2091,   0.0285,   0.8722,                  75
7   2.2537,   0.0299,   0.8660,   2.3009,   0.0314,   0.8600,                  76
8   2.3051,   0.0321,   0.8480/                                                77
 DATA (CN( 9,J),DH( 9,J),ETA( 9,J),J=1,15)/                                    78
1   0.3582,   0.0054,   0.6780,   0.5518,   0.0080,   0.7000,                  79
2   0.6529,   0.0096,   0.7125,   0.8282,   0.0119,   0.7350,                  80
3   1.0129,   0.0141,   0.7690,   1.1691,   0.0160,   0.8000,                  81
4   1.2337,   0.0169,   0.8060,   1.3809,   0.0188,   0.8225,                  82
5   1.5283,   0.0209,   0.8395,   1.6201,   0.0223,   0.8450,                  83
6   1.7482,   0.0244,   0.8470,   1.8409,   0.0263,   0.8445,                  84
7   1.8954,   0.0279,   0.8330,   1.9147,   0.0289,   0.8235,                  85
8   1.9237,   0.0303,   0.8080/                                                86
 DATA (CN(10,J),DH(10,J),ETA(10,J),J=1,12)/                                    87
1   0.3582,   0.0061,   0.6380,   0.4782,   0.0078,   0.6550,                  88
2   0.5447,   0.0104,   0.6700,   0.7546,   0.0122,   0.6850,                  89
3   0.8555,   0.0139,   0.7000,   0.9754,   0.0157,   0.7110,                  90
4   1.1047,   0.0181,   0.7180,   1.2015,   0.0201,   0.7180,                  91
5   1.2701,   0.0217,   0.7170,   1.3073,   0.0230,   0.7140,                  92
6   1.3365,   0.0244,   0.7000,   1.3407,   0.0251,   0.6890/                  93
 DATA (CN(11,J),DH(11,J),ETA(11,J),J=1, 9)/                                    94
1   0.3582,   0.0069,   0.6000,   0.4418,   0.0086,   0.6000,                  95
2   0.5518,   0.0106,   0.6120,   0.6447,   0.0123,   0.6170,                  96
3   0.7365,   0.0141,   0.6210,   0.8282,   0.0159,   0.6258,                  97
4   0.8837,   0.0172,   0.6250,   0.9391,   0.0186,   0.6230,                  98
5   0.9715,   0.0201,   0.6009/                                                99
 END                                                                           100
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$IBFTC ABETTA  DECK
      SUBROJTINE ETAAB (FAR,EM6,P6,ETA,ETAADS,ETAASV,P6DS,P6DSAV,AM6DS,A       1
     1M6DSV,IDES,FAR7DS,FAR7SV)                                               2
      DIMENSION FART(25),ETABRT(25),EM6T(7),DELM6(7),P6T(14),DELP6(14)         3
      DIMENSION X(3),Y(3)                                                      4
      DATA FART/.0390,.0585,.0732,.0878,.0976,.1171,.1268,.1463,.1619,         5
     1.1834,.1951,.2195,.2439,.2927,.3415,.4146,.4634,.5366,.6341,.7317,       6
     2.8293,.9268,1.000,1.0634,1.7/                                            7
      DATA ETABRT/.9400,.9887,1.0193,1.0306,1.0227,.9672,.9377,.9207,          8
     1.9354,.9626,.9773,1.0193,1.0532,1.077,1.0781,1.077,1.0747,1.0668,        9
     21.0578,1.0510,1.0374,1.0192,1.00,.9626,.9151/                           10
      DATA EM6T/1.00,1.071,1.190,1.309,1.428,1.547,1.666/                      11
      DATA DELM6/0.,.013,.041,.073,.110,.147,.187/                             12
      DATA P6T/.220,.2267,.250,.300,.3333,.3767,.4167,.500,.5833,.6667,        13
     1.75,.8333,.9167,1.0/                                                    14
      DATA DELP6/-.142,-.125,-.10,-.075,-.062,-.05,-.041,-.027,-.019,          15
     1-.013,-.008,-.004,-.0021,0./                                            16
      IF (IDES.NE.1) GO TO 5                                                   17
      DO 1 K=1,25                                                              18
1     ETABRT(K)=ETABRT(K)*ETAADS/ETAASV                                        19
      DO 2 K=1,25                                                              20
2     FART(K)=FART(K)*FAR7DS/FAR7SV                                            21
      DO 3 K=1,7                                                               22
3     EM6T(K)=EM6T(K)*AM6DS/AM6DSV                                             23
      DO 4 M=1,14                                                              24
4     P6T(M)=P6T(M)*P6DS/P6DSAV                                                25
      ETAASV=ETAADS                                                            26
      P6DSAV=P6DS                                                              27
      FAR7SV=FAR7DS                                                            28
      AM6DSV=AM6DS                                                             29
      RETURN                                                                   30
5     CONTINUE                                                                 31
      N=0                                                                      32
      IF (FAR.GT.0.067) GO TO 8                                                33
      DO 6 J=1,25                                                              34
6     IF (FAR.GE.FART(J)) N=J-1                                                35
      IF (N.EQ.0) N=1                                                          36
      IF (N.GE.24) N=23                                                        37
      DO 7 I=1,3                                                               38
      NN=N-1+I                                                                 39
      X(I)=FART(NN)                                                            40
7     Y(I)=ETABRT(NN)                                                          41
      CALL PARABO (X,Y,FAR,ETA1)                                               42
      GO TO 9                                                                  43
8     ETA1=-2.*FAR+.1948                                                       44
9     M=0                                                                      45
      DO 10 J=1,7                                                              46
10    IF (EM6.GE.EM6T(J)) M=J-1                                                47
      IF (M.EQ.0) M=1                                                          48
      IF (M.GE.6) M=5                                                          49
      DO 11 I=1,3                                                              50
      MM=M-1+I                                                                 51
      X(I)=EM6T(MM)                                                            52
11    Y(I)=DELM6(MM)                                                           53
      CALL PARABO (X,Y,EM6,COR1)                                               54
      L=0                                                                      55
      DO 12 J=1,14                                                             56
12    IF (P6.GE.P6T(J)) L=J-1                                                  57
      IF (L.EQ.0) L=1                                                          58
      IF (L.GE.13) L=12                                                        59
      DO 13 I=1,3                                                              60
      LL=L-1+I                                                                 61
      X(I)=P6T(LL)                                                             62
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13     Y(I)=DELP6(LL)                                                    63
       CALL PARABO (X,Y,P6,COR2)                                         64
       ETA=ETA1*(1.-COR1)*(1.+COR2)                                      65
       RETURN                                                            66
       END                                                               67
```

```
$IBFTC INPUT   DECK
       SUBROUTINE INPUT(LIUNIT,LOUNIT,ID,D,IT)                            1
       DIMENSION  D(1), IT(1)                                             2
C                                        ' DEFINES ARGUMENTS AS ARRAYS     3
C         CONSTRUCTION OF THE TABLE    ITAB                              4
C                                                                         5
C     BIT  STANDARD  RETURN     RETURN     RETURN     RETURN     RETURN   6
C   NUMBER  RETURN     1          2          3          4          5      7
C     0-2               $          A-Z        0-9(       =          OTH    8
C     3-4    DETPC      RI OTH     NLSF                                   9
C     5-6    DER        TINL       OTH PS     CF                         10
C     7-8   0-9.+$)OTH ,'A-Z=      -(*/                                  11
C     9      ,.)A-Z     OTH                                              12
C     9-10  .,          A-Z)       0-9+'      =$                         13
C    10     OTH         $A-Z*)=/                                         14
C    10-11   0-9.,-OTH +'(         $A-Z*      )=/                        15
C    12     0-9 A-Z    OTH                                              16
C    12-13  A-Z        0-9        OTH                                   17
C    13-14   +-        OTH        0-9                                   18
C    15-16   +.        DE-        OTH                                   19
C    17-18   F         F          OTH                                   20
C    19-20   D         E          OTH                                   21
C    21      OTH       .                                                22
C    21-22   A-Z       OTH        .                                     23
C    23      '         OTH                                              24
C    24      $         OTH                                              25
C    25      =         OTH                                              26
C    26-27   (         A-Z        OTH                                   27
C    28-29   )         .          OTH                                   28
C    30      (         OTH                                              29
C    31      )         OTH                                              30
C      ERROR CODE DESIGNATIONS                                          31
C      ROUTINE   TYPE                                                   32
C      10 IXQTI  100 ILLEGAL CHARACTER                                  33
C      20 ITABLI 200 NAME TOO LONG                                      34
C      30 INMBRI 300 TABLE FULL OR BAD                                  35
C      40 INAMEI 400 SCALING ERROR                                      36
C      50 IARITI 500 NAME NOT IN TABLE                                  37
C      60 INAMEN 600 $DATA( ) INCOMPLETE                                38
C      70 INPUT  700 FORMULA ILL FORMED                                 39
C                800 FUNCTION UNDEFINED                                 40
C      MCNVRT = TYPE OF LEFT HAND VARIABLE                              41
C      KCNVRT = TYPE OF CURRENT VARIABLE                                42
C      ITYPE   MEANING                                                  43
C       1      REAL                                                     44
C       2      INTEGER                                                  45
C       3      DOUBLE PRECISION                                         46
C       4      TYPELESS OR NO CONVERSION                                47
C       5      SUBROUTINE                                               48
C       6      FUNCTION                                                 49
C         FORMAT OF TABLE                                               50
C      1ST WORD   012  3456              7-31                           51
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C                TYPE  NUMBER OF WORDS ADDRESS                                52
C      NEXT 1 TO 15 WORDS   THE NAME, 4 CHARACTERS TO THE WORD                 53
       DIMENSION IFT( 31), IPTAB( 21), ITAB( 65)                               54
       DIMENSION ANAME(15) ,IMAGE(80) ,IMAGE1(81),IPARAM(9)                    55
      .          ,KSTACK(27),NAME(15)  ,RVALUE(2) ,STACK(27)                   56
C                                                                              57
       COMMON                                                                  58
      ./ICOMNI/ VALUE     ,ICOMP     ,IFNTYP    ,IMAGE1    ,IRADIX    ,ISUB   59
      .         ,KCH      ,KCNVRT    ,KCOUNT    ,KDIF      ,KFLD1     ,KFLD2  60
      .         ,LCOMP    ,LCNVRT    ,LEVEL     ,LFRT      ,LOOK              61
      .         ,MCNVRT   ,MDIF      ,MODALL    ,MSTOR                        62
      .         ,NAME     ,NERROR    ,NONEW     ,NOTARG                       63
      .         ,SMCHR    ,TEST      ,ERMARK                                  64
      ./ICNSTI/ BLANK     ,BLANKS    ,DOLLAR    ,EOS                          65
      .         ,ICOMMA   ,IDOLAR    ,IFT       ,IPTAB     ,ITAB              66
      .         ,KAM10    ,KBPC      ,KBPW      ,KCPCD     ,KERTYP            67
      .         ,KZERO    ,NOPRNT    ,TAB1                                    68
      ./IPARAM/ ABORT     ,KIUNIT    ,KOUNIT    ,LIMALF    ,LOCK      ,LOCX   69
      .         ,NOLIST   ,NSTDIR    ,TRACE                                   70
      ./ISTACK/ STACK     ,ISTDIM    ,KSTACK    ,LEVLIM                       71
C                                                                              72
       INTEGER  BLANK     ,BLANKS    ,EOS       ,IDOLAR    ,TAB1      ,TRACE  73
      .,CONTYP  ,STORED                                                        74
       DOUBLE PRECISION STACK, VALUE                                           75
       LOGICAL ABORT                                                           76
C                                  ' STOP FOR ERROR                            77
       LOGICAL DOLLAR                                                          78
C                            ' TRUE IF A $T,$P, OR $C IS BEING PROCESSED       79
       LOGICAL ERMARK                                                          80
C                                  ' .TRUE. IF ANY ERROR HAS OCCURED           81
       LOGICAL LIMALF                                                          82
C                                  ' TERMINATE ALF CONSTANTS AT 15 WORDS.      83
       LOGICAL LOCK                                                            84
C                                  ' DO NOT STORE ANY INPUT DATA               85
       LOGICAL NOLIST                                                          86
C                                  ' DO NOT LIST INPUT CARDS                   87
       LOGICAL NONEW                                                           88
C                                  ' DO NOT READ A NEW CARD. SET IN INPUT      89
       LOGICAL MODALL                                                          90
C                                  ' .TRUE. RETURN ALL CHARACTERS              91
C                                    .FALSE. DELETE BLANKS AND SKIP FOR E      92
       LOGICAL SHORT                                                           93
C                                  ' DO NOT STORE ALPHABETIC AND RADIX CO      94
C                                     DIRECTLY INTO D ARRAY                    95
       LOGICAL SMCHR                                                           96
C                                  ' SAME CHARACTER IS TO BE USED OVER BY      97
       LOGICAL TEST                                                            98
C                                  ' STORE COMMA AT END OF CARD IF NEEDED      99
C      END          ************************************************          100
       EQUIVALENCE (STACK,ISTACK), (VALUE,KVALUE,RVALUE),(NAME,ANAME)          101
       EQUIVALENCE (ICOMNI,ISUB),(IMAGE,IMAGE1),(IPARAM,ABORT)                 102
        LOGICAL END2                                                           103
C                            ' .TRUE. IF A $END CARD HAS ALREADY BEEN FOUND    104
       KIUNIT=LIUNIT                                                           105
       KOUNIT=LOUNIT                                                           106
C      CALL DEBUGX                                                             107
       LIMALF = .TRUE.                                                         108
       DOLLAR = .FALSE.                                                        109
        NOLIST = .FALSE.                                                       110
       END2 = .FALSE.                                                          111
       MODALL = .FALSE.                                                        112
       ERMARK = .FALSE.                                                        113
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      LOCK = .FALSE.                                                    114
      KERTYP = 0                                                        115
      IFNTYP = -1                                                       116
      LOCX=1                                                            117
      L=LEVLIM+3                                                        118
      DO 16 I=1,L                                                       119
 16   KSTACK(I)=0                                                       120
      LEVEL=0                                                           121
      LFRT=0                                                            122
      NOTARG = ISTDIM                                                   123
      LCNVRT = 3                                                        124
C                                     ' DOUBLE PRECISION, STANDARD      125
      MCNVRT = 1                                                        126
      KDIF = 1                                                          127
      MDIF = 1                                                          128
 1    NONEW = .FALSE.                                                   129
      SMCHR = .TRUE.                                                    130
       CALL ICHAR2($9470,24)                                            131
C                                  ' ERROR IF $ IS NOT 1ST CHARACTER READ 132
      LDOLAR = KCOUNT                                                   133
C                                      ' CARD COLUMN OF LAST DOLLAR SIGN 134
       NONEW=.TRUE.                                                     135
C                                  ' $DATA MUST BE ON A SINGLE CARD      136
C              D    E  OTH                                              137
      CALL ICHARI($3,$9470,19)                                          138
C              (   A-Z OTH                                             139
 4    CALL ICHARI($4,$9470,26)                                          140
       CALL ISUBI                                                       141
      CALL ICHAR2($9470,31)                                             142
C                                     ' ERROR IF NO )                   143
       NONEW=.FALSE.                                                    144
      IT(1)=ISUB                                                        145
C     CALL DEBUG 2 (5HSETNO,IT(1))                                      145
C     CALL DEBUG 2(6HKERSIN,KERSIN)                                     147
      IF (ID.NE. IT(1)) GO TO 99                                        148
C                                    'RETURN BECAUSE WRONG DATA SET     149
      IF (IT(2).LT. 0)GO TO 9370                                        150
C                                         ' TABLE FULL OR BAD           151
      GO TO 19                                                          152
 3    IF (END2) GO TO 99                                                153
      END2 = .TRUE.                                                     154
      NONEW = .FALSE.                                                   155
 5    CALL ICHAR2($1,9)                                                 156
C                                ' PASS LETTERS AND ,.)                 157
      GO TO 5                                                           158
9470  KERTYP = 470                                                      159
      GO TO 999                                                         160
99    CONTINUE                                                          161
C     CALL DEBUG 2(6HSTATMT,99)                                         162
      KCH = IDOLAR                                                      163
      KCOUNT = LDOLAR                                                   164
C                        'NEXT CALL BEGINS PROCESSING AT THIS CARD COLUMN 165
      IF(ERMARK) IT(1) = -IABS(IT(1))                                   166
C                                       ' WARN PROGRAMER OF POSSIBLE ERRO 167
      IF(ERMARK.AND.ABORT)  GO TO789                                    168
      RETURN                                                            169
 789  WRITE(6,787)                                                      170
 787  FORMAT(44H ERROR HAS OCCURED AND ABORT IS .TRUE., STOP)           171
       STOP                                                             172
C     BEGIN TO INPUT THE DATA                                           173
C        STATEMENTS 19 AND 20 ARE THE SWITCHHOUSE                       174
C        CONTROL COMES HERE FOR NEW DIRECTION.                          175
C        LFRT = 0 INDICATES THAT THE PREVIOUS TASK WAS COMPLETED.       176
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```
 19   CONTINUE                                                          177
C     CALL DEBUG2(6HSTATMT,19)                                          178
       TEST=.FALSE.                                                     179
       GO TO 21                                                         180
 120  DOLLAR = .FALSE.                                                  181
20    CONTINUE                                                          182
C     CALL DEBUG 2(6HSTATMT,20)                                         183
       TEST=.TRUE.                                                      184
C        ENTRY ICHAR4 LOADS LCOMP WITH TAB NO 10 AND RETURNS ON TAB NO 7 185
C            OTH    ,'A-Z=  -(*/                                       186
 21    CALL ICHAR4($31,    $32,   7,10)                                 187
C NOW WE TEST LCOMP ON EACH OF THE 3 POSSIBLE RETURNS. THIS IS A 12 WAY 188
C             0-9.  +   $    )                                         189
       GO TO  (203,510, 64,430),LCOMP                                   190
C              ,    '  A-Z  =                                          191
 31    GO TO (460,202,530,450),LCOMP                                    192
C              -   (   *   /                                           193
 32    GO TO(520,420,440,441),LCOMP                                     194
64    IF(LERT.NE.0)     GO TO 9770                                     195
      LDOLAR = KCOUNT                                                  196
C                                  ' CARD COLUMN OF LAST DOLLAR SIGN   197
      DOLLAR = .TRUE.                                                  198
C     CALL DEBUG 2 (6HSTATMT,64)                                       199
       TEST=.FALSE.                                                    200
      CALL ICHAR4($9170,$9170,3,5)                                     201
C            DE  T   P   C                                            202
       GO TO(99,100,150,630),LCOMP                                     203
100   CALL ITABLI(IT)                                                  204
      IF (KERTYP) 999,120,999                                          205
C                                                                      206
C                                                                      207
C      $PARAMETER                                                      208
C              (    A-Z  OTH                                          209
150   CALL ICHARI($150,$9170,26)                                       210
  151 CALL ICHAR2($152,0)                                              211
C                                ' GET FIRST CHAR OF NAME  ..DON'T BRAN 212
 152  CALL INAMEN                                                      213
      CALL ILOOKI($153,IPTAB)                                          214
9570  KERTYP = 570                                                     215
      GO TO999                                                         216
 153  CALL ICHAR2($9170,29)                                            217
C                                    ' ERROR IF NO =                   218
      CALL ICHAR2($9170,10)                                            219
C                                    ' GET CHARACTER,SEPERATE PART OF  220
      CALL INMBRI                                                      221
       KCNVRT=IFLD(0,3,IPTAB(LOOK))                                    222
      CALL ICNVTI(3,KCNVRT)                                            223
C                                ' CONVERT FROM DP TO TYPE OF VARIABLE 224
       IPT=IFLD(7,25,IPTAB(LOOK))                                      225
      IPARAM(IPT) = KVALUE                                             225
C             )      ,   OTH                                          227
      CALL ICHARI($151,$9170,28)                                       228
C     IF(TRACE.GT.0) CALL DEBUGX                                       229
C                                    ' IF TRACE  TURNED ON PUT ON HEAD 230
      GO TO 120                                                        231
C                                ' GO TO SWITCH HOUSE TEST FOR INSERTIO 232
C                                                                      233
C                                                                      234
C  CONSTANTS = LOGICAL,NUMERIC,ALPHAMERIC,RADIX.                       235
 201  ASSIGN 220 TO CONTYP                                             236
C                                    ' RADIX                           237
      IFNTYP = -1                                                      238
```

```
      GO TO 210                                                          239
  202 ASSIGN 230 TO CONTYP                                               240
C                                        '   '                           241
      GO TO 210                                                          242
  203 ASSIGN 250 TO CONTYP                                               243
C                                        ' NUMERIC,LOGICAL               244
C                                                                        245
C                                                                        246
C      ALL CONSTANTS          210                                        247
  210 LOP = 0                                                            248
      SHORT =.TRUE.                                                      249
      MSTOR = 0                                                          250
C     CALL DEBUG2(6HST CON,210)                                          251
      IF(LEVEL.EQ.0)  LEVEL=3                                            252
      IF(KSTACK(  LEVEL).EQ.1)  GO TO 9770                               253
C                                              ' TWO CONSTANTS IN ROW E.G.  254
      GO TO CONTYP,(220,230,250)                                         255
C                                                                        256
C                                                                        257
C      RADIX CONSTANTS        220                                        258
C             (    A-Z  OTH                                              259
  220 CALL ICHAR2($9170,30)                                              260
      CALL ISUBI                                                         261
      NAME (2) = 0                                                       262
  221 CALL ICHAR2($2215,29)                                              263
C                                ' ERROR IF NO COMMA AFTER BASE NUMBER   264
      GO TO 9170                                                         265
 2215 CALL ICHAR2($9170,12)                                              266
C                                ' ERROR IF NO NUMBER                    267
  222 IRADIX = ISUB                                                      268
      SMCHR = .TRUE.                                                     269
  223 CALL ISUBI                                                         270
      MSTOR = MSTOR +1                                                   271
      NAME(MSTOR) = ISUB                                                 272
      IF (MSTOR.GE.15)  GO TO 225                                        273
C             )     ,    OTH                                            274
  224 CALL ICHARI($223,$9170,28)                                         275
      IRADIX = 10                                                        276
      GO TO 240                                                          277
  225 ASSIGN 224 TO NEXT                                                 278
      GO TO 241                                                          279
C                                                                        280
C                                                                        281
C      HOLLERITH CONSTANTS    230                                       282
230   MODALL = .TRUE.                                                    283
      TEST = .FALSE.                                                     284
      NAME(2) = BLANKS                                                   285
231   CALL INAMEN                                                        285
      IF(.NOT.MODALL)GO TO 240                                           287
C                                 'END OF CONSTANT                       288
      IF(LIMALF)   GO TO 265                                             289
C        LONG CONSTANT GOES TO 234                                       290
  234 ASSIGN 231 TO NEXT                                                 291
      GO TO 241                                                          292
C                                                                        293
C                                                                        294
C      STORE ALF + RADIX      240                                       295
  240 ASSIGN 260 TO NEXT                                                 296
      IF (MSTOR-2) 242,2405,241                                          297
 2405 IF (LERT.EQ.1)  GO TO 242                                          298
      CALL ICHAR2($2406,29)                                              299
      SMCHR = .TRUE.                                                     300
      GO TO 242                                                          301
```

```
 2406 SMCHR = .TRUE.                                                    302
 241  SHORT = .FALSE.                                                   303
      IF (LFRT.NE.0)  GO TO 265                                         304
C     CALL DEBUG2(6HST 241,0)                                           305
 242  KVALUE = NAME(1)                                                  306
      RVALUE(2) = ANAME(2)                                              307
      IF (NOTARG.GT.LEVEL) LCNVRT = 4                                   308
C     CALL DEBUG2(6HST 242,0)                                           309
C     CALL DEBUG2(6HSHORT ,SHORT)                                       310
C     CALL DEBUG2(6HLFRT  ,LFRT)                                        311
 243  IF (SHORT)  GO TO 255                                             312
      DO 245 I= 1,MSTOR                                                 313
      IF (LOCK) GO TO 245                                               314
      D(LOCX) = ANAME(I)                                                315
 245  LOCX = LOCX + 1                                                   316
 246  GO TO NEXT, (224,231,260)                                         317
C     SEE NEXT AND MEANING                                              318
C         260       * ALF OR ) AND RADIX                              319
C         224       MORE THAN 15 ELEMENTS IN RADIX FIELD              320
C         231       MORE THAN 15 ELEMENTS IN ALF FIELD                321
C                                                                       322
C                                                                       323
C      NUMERIC + LOGICAL      250                                       324
 250  TEST = .TRUE.                                                     325
      CALL INMBRI                                                       326
 255  CALL IARITI                                                       327
      LFRT = 1                                                          328
      IF (KERTYP) 999,20,999                                            329
C                                                                       330
C                                                                       331
C      RESET STACK BECAUSE IT WAS NOT USED                              332
 260  LEVEL = 0                                                         333
      TEST = .TRUE.                                                     334
       CALL ICHAR2($19,29)                                              335
C                                      * SKIP COMMA                     336
      KERTYP = 171                                                      337
       GO TO 999                                                        338
 265   KERTYP = 270                                                     339
       GO TO 999                                                        340
C                                                                       341
C     TEST EMPTY PARENTHESES                                            342
 400  IF ( (KSTACK(  LEVEL-1)+KSTACK(  LEVEL-2) ).NE.0) GO TO 997      343
C     CALL DEBUG 2(6HSTA (),400)                                        344
C     CALL STACKP                                                       345
C                  *                        PRINT STACK                346
 401  LEVEL=LEVEL-3                                                     347
C     EMPTY FUNCTION ARGUMENT IS NOT A CURRENT LEFT SIDE                348
      IF (KSTACK(  LEVEL).LT.6) GO TO 404                               349
 405  VALUE=0.                                                          350
      GO TO 403                                                         351
 404  RVALUE(1)  = D (LOCX)                                             352
      RVALUE(2) = D(LOCX+1)                                             353
      CALL ICNVTI(MCNVRT,3)                                             354
 403  CALL IARITI                                                       355
      GO TO 20                                                          355
C(((((((((((((((((                                                     357
 420  IF (LEVEL.EQ.0) LEVEL=3                                           358
C     CALL DEBUG 2(6HSTAT (,420)                                        359
 422  LOP=0                                                             360
      LFRT = 1                                                          361
      LEVEL=LEVEL+3                                                     362
C     CALL STACKP                                                       363
```

```
C                '                        PRINT STACK    .                    364
      IF (KSTACK(  LEVEL-3)-1) 20, 997, 20                                    365
C)))))))))))))))))                                                            365
 430  IF (LEVEL.LT.6) GO TO 997                                               367
C     CALL DEBUG 2(6HSTAT ),430)                                              368
C     CALL STACKP                                                             369
C                '                        PRINT STACK                        370
      LFRT = 1                                                                371
 431  IF (KSTACK(  LEVEL)-1) 400, 432, 997                                    372
 432  DO 433 I=1,3                                                            373
       VALUE=STACK(  LEVEL)                                                   374
       KSTACK(  LEVEL)=0                                                      375
       LEVEL=LEVEL-1                                                          376
 433   CALL IARITI                                                            377
      IF (KERTYP) 999, 20, 999                                                378
C******************(KOP=2)                                                   379
 440  KOP=2                                                                   380
C     CALL DEBUG 2(6HSTAT *,440)                                              381
      GO TO 445                                                               382
C//////////////////(KOP=3)                                                   383
441   KOP = 3                                                                 384
C                                                                             385
C     CALL DEBUG 2(6HSTAT /,441)                                              385
 445  IF (LOP.NE.0) GO TO 997                                                 387
C     CALL DEBUG 2(6HSTATMT,445)                                              388
C     CALL STACKP                                                             389
C                '                   PRINT STACK                           390
      LOP = 1                                                                 391
      LFRT = 1                                                                392
      IF (LEVEL.EQ.0) LEVEL=3                                                 393
      IF (KSTACK(  LEVEL).NE.1) GO TO 997                                     394
 444  VALUE=STACK(  LEVEL)                                                    395
      KSTACK(  LEVEL)=0                                                       395
      LEVEL=LEVEL-1                                                           397
      CALL IARITI                                                             398
      IF (KERTYP.NE.0) GO TO 999                                              399
 446  KSTACK(  LEVEL)=KOP                                                     400
      LEVEL=LEVEL+1                                                           401
C     CALL STACKP                                                             402
C                '                                  PRINT STACK              403
      GO TO 19                                                                404
C===============                                                              405
 450  IF (LEVEL.NE.0) GO TO 997                                               406
C     CALL DEBUG 2(6HSTAT =,450)                                              407
 451  LOP=0                                                                   408
      LOCX = LOOK                                                             409
      MCNVRT = KCNVRT                                                         410
      MDIF = KDIF                                                             411
      LCNVRT = 3                                                              412
C                                  ' DOUBLE PRECISION, STANDARD               413
      LEVEL=3                                                                 414
      LFRT=0                                                                  415
      KSTACK(  3)=0                                                           415
C     CALL DEBUG2(6HLOCX  ,LOCX)                                              417
C     CALL DEBUG2(6HMCNVRT,MCNVRT)                                            418
      GO TO 19                                                                419
C,,,,,,,,,,,,,,                                                               420
 460  CONTINUE                                                                421
C     CALL DEBUG 2(6HSTAT ,,460)                                              422
C     CALL STACKP                                                             423
C                '                        PRINT STACK                        424
      IF (LEVEL - 3) 461,463, 600                                             425
 461  IF (LEVEL.NE.0) GO TO 997                                               426
```

```
 462  LEVEL=3                                                                427
 463   IF(LFRT.EQ.0)GO TO 480                                                428
C                              * INCREMENT LOCX WITHOUT STORING              429
C         LFRT WILL BE ZERO AFTER $ EXPRESSION OR FOR CONSECUTIVE COMMAS     430
 470  IF (KSTACK(  3).NE.1) GO TO 997                                        431
  471 DO 475  I = 1,2                                                        432
       VALUE=STACK(  LEVEL)                                                 433
       KSTACK(  LEVEL)=0                                                    434
       LEVEL=LEVEL-1                                                        435
 475   CALL IARITI                                                          436
      IF (KERTYP.NE.0) GO TO 999                                            437
 476  KSTACK(  1)=0                                                         438
      CALL ICNVTI (LCNVRT,MCNVRT)                                           439
 474  IF(LOCK) GO TO 480                                                    440
      D(LOCX) = RVALUE(1)                                                   441
      IF (MCNVRT .EQ. 3) D(LOCX+1) = RVALUE(2)                              442
 480  LOP=0                                                                 443
C     CALL STACKP                                                          444
C                    *                  PRINT STACK                       445
      LFRT=0                                                                445
      LOCX = LOCX + MDIF                                                    447
      LEVEL=0                                                               448
      LCNVRT = 3                                                            449
C                                      * DOUBLE PRECISION, STANDARD         450
      GO TO 19                                                              451
C++++++++++++++++++(KOP=4)                                                  452
 510  KOP=4                                                                 453
C     CALL DEBUG 2(6HSTAT +,510)                                            454
      GO TO 521                                                             455
C------------------(KOP=5)                                                  456
 520  KOP=5                                                                 457
C     CALL DEBUG 2(6HSTAT -,520)                                            458
 521  IF (LOP.NE.0) GO TO 997                                               459
 522  LOP=1                                                                 460
      LFRT = 1                                                              461
      IF (LEVEL.EQ.0) LEVEL=3                                               462
 524  IF (KSTACK(  LEVEL)-1) 525, 526, 997                                  463
 525  STACK(  LEVEL)=0. DO                                                  464
C     CALL DEBUG 2(6HSTATMT,525)                                            465
 526  DO 528 I=1,2                                                          466
C     CALL DEBUG 2(6HSTATMT,526)                                            467
       VALUE=STACK(  LEVEL)                                                 468
       KSTACK(  LEVEL)=0                                                    469
       LEVEL=LEVEL-1                                                        470
 528   CALL IARITI                                                          471
      IF (KERTYP.NE.0) GO TO 999                                            472
 527  KSTACK(  LEVEL)=KOP                                                   473
      LEVEL=LEVEL+2                                                         474
      GO TO 19                                                              475
CABCDEFGHIJKLMNOPQRSTUVWXYZABCDEFGHIJKLMNOPQRSTUVWXYZABCDEFGHIJKLMNOPQRS    476
 530  LOP=0                                                                 477
C     CALL DEBUG 2(6HSTAT A,530)                                            478
      IF ( (LEVEL.NE.0).AND.(KSTACK(  LEVEL).EQ.1) ) GO TO 997              479
 535  TEST = .TRUE.                                                         480
      CALL INAMEI($999,D,IT)                                                481
      IF (I=NTYP) 531,621,640                                               482
 531  LFRT = 1                                                              483
      IF(LEVEL.NE.0)GO TO 540                                               484
 532  STACK(  3)=VALUE                                                      485
C     CALL DEBUG 2(6HSTATMT,532)                                            486
      KSTACK(  3)=1                                                         487
C     CALL STACKP                                                          488
```

```
C                    '                    PRINT STACK                                  489
      GO TO 20                                                                          490
 540  CONTINUE                                                                          491
C     CALL DEBUG 2(6HSTATMT,540)                                                        492
      CALL IARITI                                                                       493
      IF(KERTYP) 999,20,999                                                             494
C                                                                                       495
C        PROCESS SUBROUTINES AND FUNCTIONS                                              496
C                                                                                       497
C     COMMA SEPARATING FUNCTION ARGUMENTS                                               498
 600  IF (KSTACK(  LEVEL-3).LT.6) GO TO 997                                             499
C     CALL DEBUG 2(6HSTAT F,600)                                                        500
 601  IF (KSTACK(  LEVEL)-1) 602, 603, 997                                              501
 602  STACK(  LEVEL)=0.                                                                 502
 603  DO 610 I=1,2                                                                      503
      VALUE = STACK(  LEVEL)                                                            504
      KSTACK(  LEVEL)=0                                                                 505
       LEVEL=LEVEL-1                                                                    506
 610   CALL IARITI                                                                      507
      IF (KERTYP.NE.0) GO TO 999                                                        508
 611  KSTACK(  LEVEL)=KSTACK(  LEVEL-1)+1                                               509
      LEVEL=LEVEL+3                                                                     510
C     CALL STACKP                                                                       511
C                    '                         PRINT STACK                            512
      GO TO 19                                                                          513
C      $CALL                                                                            514
 630  DO 631 I = 1,4                                                                    515
C      SKIP 'ALL' IN $CALL                                                              516
C           OTH   OPERATORS                                                             517
      CALL ICHAR2($9170,12)                                                             518
 631  CONTINUE                                                                          519
      DOLLAR = .FALSE.                                                                  520
      TEST = .TRUE.                                                                     521
      CALL INAMEI ($999,D,IT)                                                           522
      IF (IFNTYP .NE. 1)   GO TO 640                                                    523
      KVALUE = -KVALUE                                                                  524
C                       ' INDICATE THAT NO RESULT IS TO BE STORED FOR SUB             525
C     FUNCTION NAME                                                                     526
621   CONTINUE                                                                          527
C                                         ' FUNCTIONS                                 528
C     CALL DEBUG2(6HST FNC,621)                                                         529
C     CALL DEBUG2(6HIFNTYP,IFNTYP)                                                      530
C     CALL DEBUG2(6HKVALUE,KVALUE)                                                      531
      IFNTYP = -1                                                                       532
      IF (LEVEL.EQ.0) LEVEL = 3                                                         533
      IF(NOTARG . GT. LEVEL) NOTARG = LEVEL                                             534
      LFRT = 1                                                                          535
      STACK(LEVEL)=KVALUE                                                               536
      KSTACK(  LEVEL)=6                                                                 537
      LEVEL = LEVEL + 3                                                                 538
C     CALL STACKP                                                                       539
C                    '                         PRINT STACK                            540
C            (      OTH                                                               541
      CALL ICHAR2($622,30)                                                              542
      GO TO 19                                                                          543
C                                       ' IF THERE ARE ARGUMENTS                        544
622   SMCHR = .TRUE.                                                                    545
      IF (KVALUE .LT. 0)  LEVEL = LEVEL -3                                              546
      GO TO 405                                                                         547
 640  IF (IFNTYP - 2)   9770,201,700                                                    548
C     LOCX       THE SUBROUTINE THAT STORES LOCX THE SUBSCRIPT OF  D ARR               549
 700  IF (IFNTYP .NE. 3)   GO TO 9770                                                   550
      IFNTYP = -1                                                                       551
```

```
      IF(LEVEL.NE.0) GO TO 9770                                          552
      LFRT = 0                                                           553
      CALL ICHAR2($9170,30)                                              554
C                                  ' ERROR IF NO ( AFTER LOCX             555
      ASSIGN 704 TO NEXT                                                 556
C             A-Z  OTH                                                   557
 702  CALL ICHAR2($9170,9)                                               558
      CALL INAMEI($999,D,IT)                                             559
      IF (IFNTYP .GT. -1) GO TO 9770                                     560
      GO TO NEXT,(704,708)                                               561
 704  LOOKX = LOOK                                                       562
C             OTH   ,                                                    563
      CALL ICHAR2($706,29)                                               564
C                                  ' ERROR IF NO COMMA                    565
      GO TO 9170                                                         566
 706  ASSIGN 708 TO NEXT                                                 567
      GO TO 702                                                          568
 708  KVALUE = LOCX - LOOKX + 1                                          569
      CALL ICNVTI(2,KCNVRT)                                              570
C                                   ' CONVERT FROM INT TO TYPE OF 2ND ARG 571
      IF(LOCK) GO TO 710                                                 572
      D(LOOK) = RVALUE(1)                                                573
 710  CALL ICHAR2($9170,31)                                              574
C                              ' ERROR IF NO )                          575
      TEST = .TRUE.                                                      576
C             OTH   ,                                                    577
      CALL ICHAR2($19,29)                                                578
C                                  ' SKIP THE COMMA THAT MUST FOLLOW      579
9170  KERTYP=170                                                         580
      GO TO 999                                                          581
9370  KERTYP=370                                                         582
      GO TO 999                                                          583
 997  CONTINUE                                                           584
9770  KERTYP = 770                                                       585
      GO TO 999                                                          586
 999  CALL IERORI                                                        587
      LFRT = 0                                                           588
      LOP = 0                                                            589
      NAME (1)=0                                                         590
      GO TO 19                                                           591
C                                       ' NOW GO TO SWITCH HOUSE ..  GOOD 592
      END                                                                593
```

```
$IBFTC BLOCK   DECK
      BLOCK DATA                                                          1
C      ICOMNI     BLOCK DATA PROGRAM                                       2
      DIMENSION IFT( 31), IPTAB( 21), ITAB( 65)                           3
      DIMENSION ANAME(15) ,IMAGE(80) ,IMAGE1(81),IPARAM(9)                4
     .         ,KSTACK(27),NAME(15)  ,RVALUE(2) ,STACK(27)                5
C                                                                         6
      COMMON                                                              7
     ./ICOMNI/ VALUE    ,ICOMP    ,IFNTYP   ,IMAGE1   ,IRADIX   ,ISUB    8
     .        ,KCH      ,KCNVRT   ,KCOUNT   ,KDIF     ,KFLD1   ,KFLD2   9
     .        ,LCOMP    ,LCNVRT   ,LEVEL    ,LFRT     ,LOOK              10
     .        ,MCNVRT   ,MDIF     ,MODALL   ,MSTOR                       11
     .        ,NAME     ,NERROR   ,NONEW    ,NOTARG                    12
     .        ,SMCHR    ,TEST     ,ERMARK                                13
     ./ICNSTI/ BLANK    ,BLANKS   ,DOLLAR   ,EOS                         14
```

```
     .         ,ICOMMA    ,IDOLAR    ,IFT       ,IPTAB     ,ITAB                  15
     .         ,KAM10     ,KBPC      ,KBPW      ,KCPCD     ,KERTYP                16
     .         ,KZERO     ,NOPRNT    ,TAB1                                        17
     ./IPARAM/ ABORT      ,KIUNIT    ,KOUNIT    ,LIMALF    ,LOCK      ,LOCX       18
     .         ,NOLIST    ,NSTDIR    ,TRACE                                       19
     ./ISTACK/ STACK      ,ISTDIM    ,KSTACK    ,LEVLIM                           20
C                                                                                 21
      INTEGER  BLANK     ,BLANKS    ,EOS       ,IDOLAR    ,TAB1      ,TRACE      22
      DOUBLE PRECISION STACK, VALUE                                               23
      LOGICAL ABORT,DOLLAR,ERMARK,LIMALF,LOCK,NOLIST,NONEW,MODALL,                24
     .NSTDIR,SMCHR,TEST                                                           25
      DATA NERROR,TRACE/0,0/                                                      26
      DATA ITAB/   65* 20572347824/                                               27
      DATA ITAB( 49)/-11890146992/                                                28
     ., ITAB( 44)/ 11923699376/, ITAB( 61)/ 29355228304/                          29
     ., ITAB( 29)/ 29053238816/, ITAB( 12)/ -3484760752/                          30
     ., ITAB( 28)/-11821997744/, ITAB( 17)/-11903778480/                          31
     ., ITAB( 33)/-12155961008/, ITAB( 45)/-12192136880/                          32
     ., ITAB( 50)/-12208914096/, ITAB( 13)/-12041137840/                          33
     ., ITAB( 60)/-11957255792/, ITAB( 11)/-11890146992/                          34
     ., ITAB(  1)/ 29063724720/, ITAB(  2)/ 29063724720/                          35
     ., ITAB(  3)/ 29063724720/, ITAB(  4)/ 29063724720/                          36
     ., ITAB(  5)/ 29063724720/, ITAB(  6)/ 29063724720/                          37
     ., ITAB(  7)/ 29063724720/, ITAB(  8)/ 29063724720/                          38
     ., ITAB(  9)/ 29063724720/, ITAB( 10)/ 29063724720/                          39
     ., ITAB( 18)/ 20572347824/, ITAB( 20)/ 18961735088/                          40
     ., ITAB( 21)/ 17350532528/, ITAB( 22)/ 17350565296/                          41
     ., ITAB( 23)/ 23256571312/, ITAB( 26)/ 20035476912/                          42
     ., ITAB( 36)/ 22182960560/, ITAB( 38)/ 22182960560/                          43
     ., ITAB( 40)/ 18424854176/, ITAB( 42)/ 19498606000/                          44
     ., ITAB( 51)/ 22719831472/, ITAB( 52)/ 17887731120/                          45
      DATA BLANK,BLANKS,EOS,ICOMMA,IDOLAR,KAM10,KBPC,KBPW,KCH,KCPCD,              46
     . KZERO,NOPRNT,TAB1,IMAGE1(2),IMAGE1(3)/                                     47
     .          48,-17997958192,          10,          59,          43,          48
     .           7,           6,          36,          43,          80,          49
     .           0, 11555507248,          64, 11555507248, 11555507248/          50
      DATA ABORT,IMAGE1(1),IMAGE1(81),IRADIX,ISTDIM,                              51
     . KCOUNT,KDIF,KSTACK,LEVLIM,NSTDIR,STACK/                                    52
     . .FALSE.,1HE,1H ,10,27,0,1,27*0,24,.TRUE.,27*0.D0/                          53
      DATA IFT/                                                                   54
     .           0,          31,-17716740112, 21051935792,-17716740128,          55
     . 23481748528,-17716740144, -3864988720,-17716740160,-19756682288,          56
     .-17716740176,-20009401392,-17716740192, 19113857200,-17716740208,          57
     . -8210767088,-17716740224, -8428915760,-17716740240, -8433110064,          58
     .-17716740256, 18568907824,-17716740272, 21907455024, -9126805536,          59
     . -9954237936, -9126805552, -3863968816, -9126805696, -3863883248,          60
     .           0/                                                              61
      DATA IPTAB/                                                                 62
     .           0,          21,  -536870928, 18565733616,  -536870976,          63
     . -3650164950,  -536870992, -3863882800,  -536871024, -6015524019,          64
     .  -535871040, -6221022825, 17716740128, -2580698739, 17716740144,          65
     . -2793302547, 17716740192, -3863968816, 17716740240,-21093496175,          66
     .           0/                                                              67
      END                                                                         68
```

```
$IBFTC IARITI  DECK
C     ARITHMETIC OPERATIONS FOR INPUT R. U. A. S. 2                               1
      SUBROUTINE IARITI                                                           2
```

```
C       CALLED FROM INPUT                                                       3
        DIMENSION IFT( 31), IPTAB( 21), ITAB( 65)                               4
        DIMENSION ANAME(15) ,IMAGE(80) ,IMAGE1(81),IPARAM(9)                    5
       .         ,KSTACK(27),NAME(15)  ,RVALUE(2) ,STACK(27)                    6
C                                                                               7
        COMMON                                                                  8
       ./ICOMNI/ VALUE     ,ICOMP     ,IFNTYP    ,IMAGE1    ,IRADIX    ,ISUB   9
       .         ,KCH      ,KCNVRT    ,KCOUNT    ,KDIF      ,KFLD1     ,KFLD2 10
       .         ,LCOMP    ,LCNVRT    ,LEVEL     ,LFRT      ,LOOK              11
       .         ,MCNVRT   ,MDIF      ,MODALL    ,MSTOR                        12
       .         ,NAME     ,NERROR    ,NONEW     ,NOTARG                       13
       .         ,SMCHR    ,TEST      ,ERMARK                                  14
       ./ICNSTI/ BLANK     ,BLANKS    ,DOLLAR    ,EOS                         15
       .         ,ICOMMA   ,IDOLAR    ,IFT       ,IPTAB     ,ITAB             16
       .         ,KAM10    ,KBPC      ,KBPW      ,KCPCD     ,KERTYP           17
       .         ,KZERO    ,NOPRNT    ,TAB1                                    18
       ./IPARAM/ ABORT     ,KIUNIT    ,KOUNIT    ,LIMALF    ,LOCK      ,LOCX  19
       .         ,NOLIST   ,NSTDIR    ,TRACE                                   20
       ./ISTACI/ STACK     ,ISTDIM    ,KSTACK    ,LEVLIM                       21
C                                                                               22
        INTEGER  BLANK     ,BLANKS    ,EOS       ,IDOLAR    ,TAB1      ,TRACE 23
        DOUBLE PRECISION STACK, VALUE                                           24
        LOGICAL ABORT,DOLLAR,ERMARK,LIMALF,LOCK,NOLIST,NONEW,MODALL,            25
       .NSTDIR,SMCHR,TEST                                                       26
        EQUIVALENCE (STACK,ISTACK), (VALUE,KVALUE,RVALUE),(NAME,ANAME)          27
        EQUIVALENCE (ICOMNI,ISUB),(IMAGE,IMAGE1),(IPARAM,ABORT)                 28
C       CALL DEBUGC(6HIARITI)                                                   29
C       CALL STACKP                                                             30
C                    *                        PRINT STACK                       31
C                                                                               32
        IF (KERTYP.NE.0) GO TO 100                                              33
        IF ( (LEVEL.LE.0).OR.(LEVEL.GT.LEVLIM) ) GO TO 120                      34
C       BRANCH ON KSTACK(  LEVEL)= -, 0, 1, 2, 3, 4, 5, 6, 7, 8 AND UP         35
 2      K=MAX0(1,KSTACK(  LEVEL)+2)                                             35
        IF(K.GE.8) GO TO 60                                                     37
C               -  0    1   2   3   4   5    =KSTACK(LEVEL)                     38
     3  GO TO (120,90, 120, 20, 30, 40, 50),K                                   39
 20     VALUE=STACK(  LEVEL)*VALUE                                              40
        GO TO 90                                                                41
 30     VALUE=STACK(  LEVEL)/VALUE                                              42
        GO TO 90                                                                43
 40     VALUE=STACK(  LEVEL)+VALUE                                              44
        GO TO 90                                                                45
 50     VALUE=STACK(  LEVEL)-VALUE                                              46
        GO TO 90                                                                47
 60     LEVEL1= LEVEL-K+9                                                       48
        DO 61 I=LEVEL1,LEVEL                                                    49
 61     KSTACK (  I)=0                                                          50
        LEVEL = LEVEL1-1                                                        51
C       CALL DEBUG 2(5HLEVEL,LEVEL)                                             52
C       CALL DEBUG 2(5HVALUE,VALUE)                                             53
         IF (LOCK)   GO TO 62                                                   54
        CALL IXQTI(VALUE,STACK(  LEVEL))                                        55
 62      CONTINUE                                                               56
C       CALL DEBUG 2(5HVALUE,VALUE)                                             57
        IF (LEVEL .LE. NOTARG) NOTARG = ISTDIM                                  58
        IF (STACK(LEVEL).LT.0.D0)  GO TO 110                                    59
        GO TO 90                                                                60
 90     STACK(  LEVEL)=VALUE                                                    61
        KSTACK(  LEVEL)=1                                                       62
 100    CONTINUE                                                                63
C       CALL STACKP                                                             64
```

```
C                    *                        PRINT STACK                                  65
C      CALL DEBUGR                                                                        66
       RETURN                                                                             67
 110    LFRT=0                                                                            68
C                                      * SPECIAL TREATMENT FOR SUBROUTINES               69
C       CALL DEBUG2(6HSTATMT,110)                                                        70
        KSTACK(LEVEL)=0                                                                  71
        LEVEL=0                                                                          72
C             OTH    ,                                                                   73
       CALL ICHAR2($100,29)                                                              74
       KERTYP = 150                                                                      75
       GO TO 100                                                                         76
 120   KERTYP=750                                                                        77
       GO TO 100                                                                         78
       END                                                                               79
```

```
$IBFTC ICHAR4  DECK
        SUBROUTINE ICHAR4(*,*,LIST1,LIST2)                                               1
       DIMENSION IFT( 31), IPTAB( 21), ITAB( 65)                                         2
       DIMENSION ANAME(15) ,IMAGE(80) ,IMAGE1(81),IPARAM(9)                              3
      .          ,KSTACK(27),NAME(15)  ,RVALUE(2) ,STACK(27)                           4
C                                                                                        5
       COMMON                                                                            6
      ./ICOMNI/ VALUE     ,ICOMP     ,IFNTYP    ,IMAGE1    ,IRADIX    ,ISUB           7
      .         ,KCH      ,KCNVRT    ,KCOUNT    ,KDIF      ,KFLD1     ,KFLD2          8
      .         ,LCOMP    ,LCNVRT    ,LEVEL     ,LFRT      ,LOOK                      9
      .         ,MCNVRT   ,MDIF      ,MODALL    ,MSTOR                               10
      .         ,NAME     ,NERROR    ,NONEW     ,NOTARG                              11
      .         ,SMCHR    ,TEST      ,ERMARK                                         12
      ./ICNSTI/ BLANK     ,BLANKS    ,DOLLAR    ,EOS                                 13
      .         ,ICOMMA   ,IDOLAR    ,IFT       ,IPTAB     ,ITAB                     14
      .         ,KAM10    ,KBPC      ,KBPW      ,KCPCD     ,KERTYP                   15
      .         ,KZERO    ,NOPRNT    ,TAB1                                           16
      ./IPARAM/ ABORT     ,KIUNIT    ,KOUNIT    ,LIMALF    ,LOCK      ,LOCX          17
      .         ,NOLIST   ,NSTDIR    ,TRACE                                          18
      ./ISTACI/ STACK     ,ISTDIM    ,KSTACK    ,LEVLIM                             19
C                                                                                       20
        INTEGER  BLANK     ,BLANKS    ,EOS       ,IDOLAR    ,TAB1      ,TRACE        21
      .,COMPR                                                                           22
        DOUBLE PRECISION STACK, VALUE, IDEBUA, DEBGNA(2)                                23
        DATA DEBGNA/6HICHAR ,5HITCHR/                                                   24
        LOGICAL ABORT,DOLLAR,ERMARK,LIMALF,LOCK,NOLIST,NONEW,MODALL,                    25
      .NSTDIR,SMCHR,TEST                                                                26
        EQUIVALENCE (STACK,ISTACK), (VALUE,KVALUE,RVALUE),(NAME,ANAME)                  27
        EQUIVALENCE (ICOMNI,ISUB),(IMAGE,IMAGE1),(IPARAM,ABORT)                         28
        LOGICAL GOTCD                                                                   29
C                    * TRUE IF NEW CARD WAS READ                                        30
       LOGICAL SMCHR                                                                    31
C                                     * RE-PROCESS THE SAME CHARACTER AS LAS            32
        KFLD2=LIST2                                                                     33
        IBITS=2                                                                         34
        ASSIGN 36 TO COMPR                                                              35
       IDEBUG = 4                                                                       36
       GO TO 10                                                                         37
        ENTRY ICHARI(*,*,LIST1)                                                         38
        IBITS = 2                                                                       39
       IDEBUG = 3                                                                       40
        GO TO 4                                                                         41
```

```
      ENTRY ICHAR2(*,LIST1)                                              42
      IBITS=1                                                            43
     IDEBUN = 2                                                          44
 4    KFLD2 = -1                                                         45
      ASSIGN 37 TO COMPR                                                 46
      IF(MODALL)GO TO 40                                                 47
 10   ASSIGN 20 TO IGETR                                                 48
  12  KFLD1=LIST1                                                        49
     IDEBUA = DEBGNA(1)                                                  50
      ASSIGN 110 TO NEXT                                                 51
      GOTCD=.FALSE.                                                      52
      IF(SMCHR)  GO TO 35                                                53
C                                  ' SKIP GETTING NEW CHARACTER          54
      GO TO 200                                                          55
C                                  ' GET CHARACTER RETURN TO 20          56
 20   IF(KCH.EQ.BLANK)GO TO 200                                          57
C                                        ' BYPASS BLANKS                 58
      IF (KCH.NE.EOS)  GO TO 30                                          59
C                                      ' EOS= END OF STATEMENT CHARACTER 60
      ASSIGN 200 TO INEWR                                                61
C                           ' PROVIDE TO GET FIRST CHARACTER FROM NEXT C 62
      GO TO 300                                                          63
 30   IF(TEST.AND.GOTCD)GO TO 100                                        64
 35   ITEMP = ITAB(KCH+1)                                                65
      ICOMP=IFLD(LIST1,IBITS,ITEMP)                                      66
     GO TO COMPR,(36,37)                                                 67
 36   LCOMP=IFLD(LIST2,2,ITEMP)+1                                        68
 37  CONTINUE                                                            69
     IF(TRACE .LT.4)  GO TO 38                                           70
C    CALL DEBUG2(IDEBUA,IDEBUN)                                          71
 38   SMCHR = .FALSE.                                                    72
     IF(ICOMP-1)   381,382,383                                           73
 381 RETURN                                                              74
 382 RETURN1                                                             75
 383 RETURN2                                                             76
 40   ASSIGN 35 TO IGETR                                                 77
      GO TO 12                                                           78
C   -   -   -   -   -   -    ITCHR    -   -   -   -   -   -   -        79
C             SPECIAL ROUTINE TO INSERT COMMA AT END OF CARD IF         80
C             THE NEXT CARD BEGINS WITH $ OR A LEFT MEMBER              81
C                   TO THIS ROUTINE, A LEFT MEMBER BEGINS WITH A-Z      82
C                    FOLLOWED BY ANY OF 0-9()A-Z FOLLOWED BY =          83
 100  IDEBUA = DEBGNA(2)                                                 84
      ITEMP = ITAB(KCH+1)                                                85
      ICOMP=IFLD(0,3,ITEMP)                                              86
     GO TO NEXT,(110,120)                                                87
C                           ' 110 FOR 1ST CHR ON NEW CARD, 120 FOR FOLL 88
 110  NONEW=.TRUE.                                                       89
      ASSIGN 120 TO NEXT                                                 90
C           $  A-Z 0-9() = OTH                                           91
      GO TO(130,200,140,140,140),ICOMP                                   92
C                                                                        93
C           $  A-Z 0-9() = OTH                                           94
 120  GO TO(140,200,200,130,140),ICOMP                                   95
 130  KCOUNT=0                                                           96
      KCH=ICOMMA                                                         97
      NONEW=.FALSE.                                                      98
      GOTCD = .FALSE.                                                    99
      GO TO 35                                                          100
C              ' COMMA IS CHARACTER RETURNED                            101
 140  KCOUNT=0                                                          102
      NONEW=.FALSE.                                                     103
      GOTCD = .FALSE.                                                   104
```

```
C       GO TO 200                                                       105
C                * FIRST NON-BLANK CHARACTER ON CARD IS RETURNED         106
C   -    -    -    -    -    -    -    -    -    -    -    -    -    -  107
C              ROUTINE TO GET NEXT CHARACTER                            108
C                                                                       109
 200    IF(KCOUNT.LT.KCPCD)GO TO 210                                    110
        ASSIGN 210 TO INEWR                                             111
        GO TO 300                                                       112
 210    KCOUNT=KCOUNT+1                                                 113
C                       * CARD COLUMN OF NEW CHARACTER                  114
        KCH=IFLD(0,KBPC,IMAGE(KCOUNT))                                  115
       GO TO IGETR,(20,35)                                              116
C                                       * 35 IS USED ONLY FOR MODALL .TRU 117
C   -    -    -    -    -    -    -    -    -    -    -    -    -    -  118
C              ROUTINE TO PRINT OLD CARD AND READ NEXT                  119
C               IF NONEW IS TRUE, STORE TAB1 IN KCH AND RETURN          120
 300    IF(NONEW)GO TO 310                                              121
        KCH=IMAGE(KCOUNT+1)                                             122
C                           * GET CARRIAGE CONTROL (IMAGE(81) IS A BLANK) 123
        IF((KCH.EQ.NOPRNT).OR.NOLIST)  GO TO 305                        124
        WRITE(KOUNIT,398)KCH,IMAGE                                      125
 398    FORMAT(1A1,5X,80A1)                                             126
 305    READ(KIUNIT,399)IMAGE                                           127
 399    FORMAT(80A1)                                                    128
        GOTCD=.TRUE.                                                    129
        KCOUNT=0                                                        130
       GO TO INEWR,(200,210)                                            131
 310    KCH=TAB1                                                        132
       GO TO 30                                                         133
C                                  * TAB1 IS RETURNED, INDICATES END OF C 134
        END                                                             135
```

```
$IBFTC ICNVTI  DECK
       SUBROUTINE ICNVTI(IFROM,ITO)                                      1
       DIMENSION IFT( 31), IPTAB( 21), ITAB( 65)                         2
       DIMENSION ANAME(15) ,IMAGE(80) ,IMAGE1(81),IPARAM(9)              3
      .          ,KSTACK(27),NAME(15)  ,RVALUE(2) ,STACK(27)             4
C                                                                        5
       COMMON                                                            6
      ./ICOMNI/ VALUE     ,ICOMP     ,IFNTYP    ,IMAGE1    ,IRADIX    ,ISUB    7
      .         ,KCH      ,KCNVRT    ,KCOUNT    ,KDIF      ,KFLD1     ,KFLD2   8
      .         ,LCOMP    ,LCNVRT    ,LEVEL     ,LFRT      ,LOOK               9
      .         ,MCNVRT   ,MDIF      ,MODALL    ,MSTOR                        10
      .         ,NAME     ,NERROR    ,NONEW     ,NOTARG                       11
      .         ,SMCHR    ,TEST      ,ERMARK                                  12
      ./ICNSTI/ BLANK     ,BLANKS    ,DOLLAR    ,EOS                          13
      .         ,ICOMMA   ,IDOLAR    ,IFT       ,IPTAB     ,ITAB              14
      .         ,KAM10    ,KBPC      ,KBPW      ,KCPCD     ,KERTYP            15
      .         ,KZERO    ,NOPRNT    ,TAB1                                    16
      ./IPARAM/ ABORT     ,KIUNIT    ,KOUNIT    ,LIMALF    ,LOCK      ,LOCX   17
      .         ,NOLIST   ,NSTDIR    ,TRACE                                   18
      ./ISTACI/ STACK     ,ISTDIM    ,KSTACK    ,LEVLIM                       19
C                                                                        20
       INTEGER  BLANK     ,BLANKS    ,EOS       ,IDOLAR    ,TAB1      ,TRACE  21
       DOUBLE PRECISION STACK, VALUE                                     22
       LOGICAL ABORT,DOLLAR,ERMARK,LIMALF,LOCK,NOLIST,NONEW,MODALL,      23
      .NSTDIR,SMCHR,TEST                                                 24
       EQUIVALENCE (STACK,ISTACK), (VALUE,IVALUE,RVALUE),(NAME,ANAME)    25
```

```
      EQUIVALENCE (ICOMNI,ISUB),(IMAGE,IMAGE1),(IPARAM,ABORT)                  26
      DIMENSION NTYPE(4)                                                       27
      DOUBLE PRECISION NTYPE                                                   28
      DATA NTYPE / 6HREAL  ,6HINT   ,6HDP    ,6HNOCONV/                       29
      IF((IFROM.LE.0).OR.(ITO.LE.0)) GO TO 100                                 30
      IF (IFROM - 4) 1,99,100                                                  31
1     IF (ITO - 4) 2,99,100                                                    32
2     ITOM2 = ITO - 2                                                          33
      IF (IFROM-2) 3,4,5                                                       34
3     IF (ITOM2) 99,10,20                                                      35
4     IF (ITOM2) 30,99,40                                                      36
5     IF (ITOM2) 50,60,99                                                      37
10    KVALUE = RVALUE(1)                                                       38
      GO TO 99                                                                 39
20    VALUE = RVALUE(1)                                                        40
      GO TO 99                                                                 41
30    RVALUE(1) = KVALUE                                                       42
      GO TO 99                                                                 43
40    VALUE = KVALUE                                                           44
      GO TO 99                                                                 45
50    RVALUE(1) = VALUE                                                        46
      GO TO 99                                                                 47
60    KVALUE = VALUE                                                           48
99    CONTINUE                                                                 49
C     CALL DEBUG3 (6HICNVTI,0.D0,3)                                            50
C     CALL DEBUG3(NTYPE(IFROM),NTYPE(ITO) ,3)                                  51
      RETURN                                                                   52
 100  WRITE(KOUNIT,101) IFROM,ITO                                              53
 101  FORMAT(35H ARGUMENTS OF ICNVTI BAD.  IFROM = ,I13,8H, ITO = ,I13,        54
     . 41H(1 TO 4 ALLOWABLE).  CHECK IPTAB IN COMNJ)                           55
      GO TO 99                                                                 56
      END                                                                      57
```

```
$IBFTC IERORI  DECK
      SUBROUTINE IERORI                                                         1
      DIMENSION IFT( 31), IPTAB( 21), ITAB( 65)                                 2
      DIMENSION ANAME(15) ,IMAGE(80) ,IMAGE1(81),IPARAM(9)                      3
     .          ,KSTACK(27),NAME(15)  ,RVALUE(2) ,STACK(27)                    4
C                                                                               5
      COMMON                                                                    6
     ./ICOMNI/ VALUE     ,ICOMP     ,IFNTYP    ,IMAGE1    ,IRADIX    ,ISUB     7
     .         ,KCH      ,KCNVRT    ,KCOUNT    ,KDIF      ,KFLD1     ,KFLD2    8
     .         ,LCOMP    ,LCNVRT    ,LEVEL     ,LFRT      ,LOOK                9
     .         ,MCNVRT   ,MDIF      ,MODALL    ,MSTOR                          10
     .         ,NAME     ,NERROR    ,NONEW     ,NOTARG                         11
     .         ,SMCHR    ,TEST      ,ERMARK                                    12
     ./ICNSTI/ BLANK     ,BLANKS    ,DOLLAR    ,EOS                            13
     .         ,ICOMMA   ,IDOLAR    ,IFT       ,IPTAB     ,ITAB                14
     .         ,KAM10    ,KBPC      ,KBPW      ,KCPCD     ,KERTYP              15
     .         ,KZERO    ,NOPRNT    ,TAB1                                      16
     ./IPARAM/ ABORT     ,KIUNIT    ,KOUNIT    ,LIMALF    ,LOCK      ,LOCX     17
     .         ,NOLIST   ,NSTDIR    ,TRACE                                     18
     ./ISTACI/ STACK     ,ISTDIM    ,KSTACK    ,LEVLIM                         19
C                                                                               20
      INTEGER  BLANK     ,BLANKS    ,EOS       ,IDOLAR    ,TAB1      ,TRACE    21
      DOUBLE PRECISION STACK, VALUE                                             22
      LOGICAL ABORT,DOLLAR,ERMARK,LIMALF,LOCK,NOLIST,NONEW,MODALL,              23
     .NSTDIR,SMCHR,TEST                                                         24
```

```
      EQUIVALENCE (STACK,ISTACK), (VALUE,KVALUE,RVALUE),(NAME,ANAME)
      EQUIVALENCE (ICOMNI,ISUB),(IMAGE,IMAGE1),(IPARAM,ABORT)
      INTEGER H(4,7)
      EQUIVALENCE (H(1,1),H1),(H(1,2),H2),(H(1,3),H3),(H(1,4),H4)
     .,(H(1,5),H5),(H(1,6),H6),(H(1,7),H7)
      DATA KA/1H*/
      DATA KB/1H /
      DATA KC/1H,/
      DATA KD/1H'/
      INTEGER MSGTYP(2,2), H1(4), H2(4), H3(4), H4(4), H5(4),H6(4),H7(4)
      DATA MSGTYP(1,1)/24H*DIAGNOSTIC**ERROR**          /
      DATA H1(1) /24HINAPPROPRIATE CHARACTER             /
      DATA H2(1) /24HNAME TOO LONG                       /
      DATA H3(1) /24HTABLE FULL OR DESTROYED             /
      DATA H4(1) /24H$D INCOMPLETE OR MISSING            /
      DATA H5(1) /24HNAME NOT IN TABLE                   /
      DATA H6(1) /24HFUNCTN OR SUB NOT ABOARD            /
      DATA H7(1) /24HFORMULA ILL-FORMED                  /
C     CALL DEBUGC(6HIERORI)
      NONEW = .FALSE.
      NERROR = NERROR + 1
C                                     ' COUNT DIAGONISTICS
      ERMARK = .TRUE.
C                                     ' WARN PROGRAMER OF POSSIBLE ERRO
       IOP = 0
C                                     ' COUNT OPERATORS  +-,=(*
       MODE = 1
      IF(NOTARG.LT.LEVEL) MODE = 2
      KC1=KB
      IF(KCOUNT.EQ.0) KC1=KC
      L = KCOUNT + 1
      MODALL = .FALSE.
      TEST = .TRUE.
      M =IABS(KERTYP)
      J = M/100
      K = 2
      IF(DOLLAR) MODE = 2
      IF(KERTYP.GT.0)  LOCK = .TRUE.
      IF(KERTYP.LT.0)  K=1
11    WRITE(KOUNIT,90)(MSGTYP(I,K),I=1,2),M,(H(I,J),I=1,4),KC1,
     .IMAGE,(KB,I=1,L),KA,(KB,I=L,81),NERROR,LOCK
 90   FORMAT(1H ,2A6,2H (,I3,2H) ,4A6,2X,81A1/45X,83A1,
     . /14X,11HERROR COUNT,I4,13H     LOCK = .,L1,1H.)
       IF(NERROR.GT.64)STOP
      IF(KERTYP.LT.0) GO TO 99
       SMCHR = .TRUE.
 30   CALL ICHAR4($31,$65,7,10)
C           0-9. +  $  )
      GO TO (30,65,39,80),LCOMP
C             ,  '  A-Z =
 31   GO TO (60,65,30,60),LCOMP
 39    SMCHR = .TRUE.
 40   L = KCOUNT + 1
      KC1 = KB
      IF(KCOUNT.EQ.0)KC1=KC
      WRITE(KOUNIT,91)KC1,IMAGE,(KB,I=1,L),KD,(KB,I=L,81)
 91   FORMAT(14X,43HSKIP AHEAD AND GUESS AT NEXT GOOD STATEMENT,
     . /14X,32HBEGIN PROCESSING AT SYMBOL         ,81A1/45X,83A1
     . /14X43HLOOK FOR DIAGONISTICS BUT DON''T STORE ANYTHING.//)
      IFNTYP = -1
       DO 1  I=1,ISTDIM
```

```
 1      KSTACK(I) = 0                                                          86
        LEVEL = 0                                                              87
        NOTARG = ISTDIM                                                        88
 99    CONTINUE                                                                89
       KERTYP = 0                                                              90
C      CALL DEBUGR                                                             91
       RETURN                                                                  92
C     ,=,=,=,=,=,=,=,=,=,=,=,=,=,=,=,=,=,=,=,=,=,=,=,=,=,=                    93
60     IF(MODE.EQ.1) GO TO 40                                                  94
C         ALL OPERATORS                                                        95
 65    IOP = IOP + 1                                                           96
       IF(IOP.LE.16)   GO TO 30                                                97
C        IF YOU FIND 16 OPERATORS BEFORE )   GIVE UP                           98
C                                                                              99
C     ))))))))))))))))))))                                                   100
  80    MODE = 1                                                             101
        DOLLAR = .FALSE.                                                     102
        GO TO 30                                                             103
C                                                                            104
C    MODE        ACTION                                                      105
C                                                                            106
C       1        SKIP TO NEXT $ OR = OR , (UNCONDITIONAL)                    107
C       2        SKIP TO NEXT $ (UNCONDITIONAL) OR TO = OR , AFTER )         108
       END                                                                   109
```

```
$IBFTC ILOOKI  DECK
       SUBROUTINE ILOOKI(*,IT)                                                 1
C      CALLED FROM                                                             2
C                  ITABLI                                                      3
C                  INAMEI                                                      4
       DIMENSION IT(1)                                                         5
       DIMENSION IFT( 31), IPTAB( 21), ITAB( 65)                               6
       DIMENSION ANAME(15) ,IMAGE(80) ,IMAGE1(81),IPARAM(9)                    7
      .          ,KSTACK(27),NAME(15)  ,RVALUE(2) ,STACK(27)                   8
C                                                                              9
       COMMON                                                                 10
      ./ICOMNI/ VALUE     ,ICOMP     ,IFNTYP    ,IMAGE1    ,IRADIX    ,ISUB   11
      .         ,KCH      ,KCNVRT    ,KCOUNT    ,KDIF      ,KFLD1     ,KFLD2  12
      .         ,LCOMP    ,LCNVRT    ,LEVEL     ,LFRT      ,LOOK              13
      .         ,MCNVRT   ,MDIF      ,MODALL    ,MSTOR                        14
      .         ,NAME     ,NERROR    ,NONEW     ,NOTARG                       15
      .         ,SMCHR    ,TEST      ,ERMARK                                  16
      ./ICNSTI/ BLANK     ,BLANKS    ,DOLLAR    ,EOS                         17
      .         ,ICOMMA   ,IDOLAR    ,IFT       ,IPTAB     ,ITAB             18
      .         ,KAM10    ,KBPC      ,KBPW      ,KCPCD     ,KERTYP           19
      .         ,KZERO    ,NOPRNT    ,TAB1                                    20
      ./IPARAM/ ABORT     ,KIUNIT    ,KOUNIT    ,LIMALF    ,LOCK      ,LOCX  21
      .         ,NOLIST   ,NSTDIR    ,TRACE                                   22
      ./ISTACI/ STACK     ,ISTDIM    ,KSTACK    ,LEVLIM                       23
C                                                                             24
       INTEGER  BLANK     ,BLANKS    ,EOS       ,IDOLAR    ,TAB1      ,TRACE 25
       DOUBLE PRECISION STACK, VALUE                                          26
       LOGICAL ABORT,DOLLAR,ERMARK,LIMALF,LOCK,NOLIST,NONEW,MODALL,           27
      .NSTDIR,SMCHR,TEST                                                      28
       EQUIVALENCE (STACK,ISTACK), (VALUE,KVALUE,RVALUE),(NAME,ANAME)         29
       EQUIVALENCE (ICOMNI,ISUB),(IMAGE,IMAGE1),(IPARAM,ABORT)                30
       LOOK=3                                                                 31
C                                    * FIRST USABLE POSITION                   32
```

```
1     IF(IT(LOOK)  .EQ.0) GO TO 7                                          33
C                                    * RETURN WITH NEXT AVAILABLE ENTR      34
      J=IFLD(3,4,IT(LOOK))                                                 35
C                                       * MAX POSSIBLE J IS 15             36
      IF (J .NE.MSTOR) GO TO 8                                             37
C                                    * 8 IF NAME IS WRONG LENGTH, TRY       38
      DO 4 K=1,J                                                           39
C                                    * CHECK NAME FOR MATCH                 40
      LOOKK = LOOK + K                                                     41
      IF (NAME(K).NE.IT(LOOKK))  GO TO 8                                   42
 4    CONTINUE                                                             43
C     CALL DEBUG2(6H*LOOKF,LOOK)                                           44
C                                  * ENTRY WAS FOUND                      45
      RETURN 1                                                             46
 7    CONTINUE                                                             47
C     CALL DEBUG2(6H*LOOKN,LOOK)                                           48
C                                  * NO ENTRY WAS FOUND                   49
      RETURN                                                               50
8     LOOK = LOOK+J+1                                                      51
                                                                           52
                                                                           53
C                                     * TRY NEXT ENTRY                    54
      GO TO 1                                                              55
      END                                                                  56
```

```
$IBFTC INAMEI  DECK
       SUBROUTINE INAMEI(*,D,IT)                                            1
C      CALLED FROM INPUT                                                    2
C     CALL DEBUGC(6HINAMEI)                                                 3
C     SUBROUTINE TO OBTAIN LOCATION, MODE, AND CONTENTS OF A NAMED CELL     4
C                                                                           5
      DIMENSION IFT( 31), IPTAB( 21), ITAB( 65)                            6
      DIMENSION ANAME(15) ,IMAGE(80) ,IMAGE1(81),IPARAM(9)                 7
     .          ,KSTACK(27),NAME(15)  ,RVALUE(2) ,STACK(27)                8
C                                                                           9
      COMMON                                                               10
     ./ICOMNI/ VALUE    ,ICOMP    ,IFNTYP   ,IMAGE1   ,IRADIX   ,ISUB     11
     .         ,KCH     ,KCNVRT   ,KCOUNT   ,KDIF     ,KFLD1   ,KFLD2    12
     .         ,LCOMP   ,LCNVRT   ,LEVEL    ,LFRT     ,LOOK               13
     .         ,MCNVRT  ,MDIF     ,MODALL   ,MSTOR                        14
     .         ,NAME    ,NERROR   ,NONEW    ,NOTARG                       15
     .         ,SMCHR   ,TEST     ,ERMARK                                 16
     ./ICNSTI/ BLANK    ,BLANKS   ,DOLLAR   ,EOS                          17
     .         ,ICOMMA  ,IDOLAR   ,IFT      ,IPTAB    ,ITAB               18
     .         ,KAM10   ,KBPC     ,KBPW     ,KCPCD    ,KERTYP             19
     .         ,KZERO   ,NOPRNT   ,TAB1                                   20
     ./IPARAM/ ABORT    ,KIUNIT   ,KOUNIT   ,LIMALF   ,LOCK     ,LOCX     21
     .         ,NOLIST  ,NSTDIR   ,TRACE                                  22
     ./ISTACI/ STACK    ,ISTDIM   ,KSTACK   ,LEVLIM                       23
C                                                                          24
      INTEGER  BLANK    ,BLANKS   ,EOS      ,IDOLAR   ,TAB1     ,TRACE    25
      DOUBLE PRECISION STACK, VALUE                                        26
      LOGICAL ABORT,DOLLAR,ERMARK,LIMALF,LOCK,NOLIST,NONEW,MODALL,         27
     .NSTDIR,SMCHR,TEST                                                    28
      EQUIVALENCE (STACK,ISTACK), (VALUE,KVALUE,RVALUE),(NAME,ANAME)       29
      EQUIVALENCE (ICOMNI,ISUB),(IMAGE,IMAGE1),(IPARAM,ABORT)              30
      DIMENSION IT(1)                                                      31
```

```
C                                       * TABLE OF NAMES PROVIDED BY USER
      DIMENSION D(1)
C                                       * USERS VARIABLES ARE IN D ARRAY
      ISUB = 1
C                                       * UNDERSTOOD SUBSCRIPT
      KDIF = 1
      CALL INAMEN
      CALL ILOOKI($1,IT)
      CALL ILOOKI($64,IFT)
 9540 KERTYP=540
C                                       * NAME NOT IN TABLE
      GO TO 99
  1   CONTINUE
C     CALL DEBUG2(6HSTATMT,1)
      ITL = IT(LOOK)
       KCNVRT=IFLD(0,3,ITL)
C     CALL DEBUG 2 (6HKCNVRT,KCNVRT)
C           R  I  D  T  S  F
      GO TO(12,12,10,12,62,61),KCNVRT
  10  KDIF = 2
C           (     OTH
  12  CALL ICHAR2($90,30)
C                                  * GO TO 90 FOR NO SUBSCRIPT
C           A-Z   0-9  OTH
       CALL ICHARI($82,$9140,12)
      CALL INAMEN
      CALL ILOOKI($83,IT)
      GO TO 9540
  82  SMCHR = .TRUE.
      CALL ISUBI
      GO TO 84
  83   ITYPE=IFLD(0,3,IT(LOOK))
       LOC=IFLD(7,25,IT(LOOK))
      RVALUE(1) = D(LOC)
      RVALUE(2) = D(LOC+1)
      CALL ICNVTI (ITYPE,2)
      ISUB = KVALUE
C           )     OTH
  84   CALL ICHAR2($9140,31)
C                               * ERROR IF NO )
      GO TO 91
  90  SMCHR = .TRUE.
  91   LOC=IFLD(7,25,ITL)
C     CALL DEBUG 2 (5HLOC 1,LOC)
      LOC = LOC + (ISUB-1)*KDIF
  50  RVALUE(1) = D(LOC)
      RVALUE(2) = D(LOC+1)
C     CALL DEBUG 3(5HIT(L),ITL,2)
      CALL ICNVTI (KCNVRT,3)
  52  LOOK = LOC
  98  CONTINUE
C     CALL DEBUG 3(5HVALUE,VALUE,4)
C     CALL DEBUG 2 (6HLOOK  ,LOOK)
C     CALL DEBUG 2 (5HLOC 2,LOC)
C     CALL DEBUG 2(6HKCNVRT,KCNVRT)
C     CALL DEBUGR
      RETURN
  61  IFNTYP = 0
C                                     * FUNCTION
      GO TO 63
  62  IFNTYP = 1
```

```
C                                     * SUBROUTINE                                93
 63    KVALJE=IFLD(7,25,ITL)                                                      94
       GO TO 98                                                                   95
 64    IFNTYP = 0                                                                 96
C                                     * LIBRARY FUNCTION OR SUBROUTINE           97
       KVALJE=IFLD(7,25,IFT(LOOK))                                                98
C                                     * PROGRAM NUMBER (USED BY IXQTI)           99
       MSTOR = 0                                                                 100
       KCNVRT=IFLD(0,3,IFT(LOOK))                                                101
C                                     * 5 FOR SUBROUTINES, 6 FOR FUNCTIONS      102
       IF(KCNVRT.EQ.5)IFNTYP=KVALUE                                              103
C                                     * PROVIDE FOR EXECUTION OF INPUT SUBRO     104
C      CALL DEBUG2(6HLIBF  ,KVALUE)                                              105
C     MEANING OF IFNTYP                                                          106
C       VALUE       NAME IS                                                     107
C     -1(NORMAL) AN ORDINARY VARIABLE                                           108
C      0          FUNCTION (USER OR FORTRAN MATH)                             109
C      1          USER SUBROUTINE                                             110
C      2          RADIX (INPUT FUNCTION)                                      111
C      3          LOCX (INPUT SUBROUTINE)                                     112
C        $CALL LOCX(Y,I) CAUSES I TO BE SET SO THAT Y(I)REFERS TO THE CUR      113
C        LEFT SIDE.                                                            114
       GO TO 98                                                                  115
 9140 KERTYP =140                                                              116
 99    CONTINUE                                                                  117
C      CALL DEBUG2(6HRETURN,1)                                                   118
C      CALL DEBUGR                                                               119
C                                        * REGESTER RETURN                      120
       RETURN 1                                                                  121
       END                                                                       122
```

```
$IBFTC INAMEN  DECK
       SUBROUTINE INAMEN                                                          1
C       CALLED FROM                                                               2
C                    INAMEI                                                       3
C                    ITABLI                                                       4
C                    INPUT                                                        5
C      CALL DEBUGC(6HINAMEN)                                                      6
C                                                                                 7
       DIMENSION IFT( 31), IPTAB( 21), ITAB( 65)                                  8
       DIMENSION ANAME(15) ,IMAGE(80) ,IMAGE1(81),IPARAM(9)                       9
      .          ,KSTACK(27),NAME(15)  ,RVALUE(2) ,STACK(27)                    10
C                                                                                11
       COMMON                                                                    12
      ./ICOMNI/ VALUE     ,ICOMP     ,IFNTYP    ,IMAGE1    ,IRADIX    ,ISUB     13
      .         ,KCH      ,KCNVRT    ,KCOUNT    ,KDIF      ,KFLD1     ,KFLD2    14
      .         ,LCOMP    ,LCNVRT    ,LEVEL     ,LFRT      ,LOOK                15
      .         ,MCNVRT   ,MDIF      ,MODALL    ,MSTOR                          16
      .         ,NAME     ,NERROR    ,NONEW     ,NOTARG                         17
      .         ,SMCHR    ,TEST      ,ERMARK                                    18
      ./ICNSTI/ BLANK     ,BLANKS    ,DOLLAR    ,EOS                            19
      .         ,ICOMMA   ,IDOLAR    ,IFT       ,IPTAB     ,ITAB                20
      .         ,KAM10    ,KBPC      ,KBPW      ,KCPCD     ,KERTYP              21
      .         ,KZERO    ,NOPRNT    ,TAB1                                      22
      ./IPARAM/ ABORT     ,KIUNIT    ,KOUNIT    ,LIMALF    ,LOCK      ,LOCX     23
      .         ,NOLIST   ,NSTDIR    ,TRACE                                     24
      ./ISTAKI/ STACK     ,ISTDIM    ,KSTACK    ,LEVLIM                         25
```

```
C                                                                       26
      INTEGER  BLANK    ,BLANKS   ,EOS      ,IDOLAR   ,TABI     ,TRACE  27
      DOUBLE PRECISION STACK, VALUE, DNAME                              28
      LOGICAL ABORT,DOLLAR,ERMARK,LIMALF,LOCK,NOLIST,NONEW,MODALL,      29
     .NSTOR,SMCHR,TEST                                                  30
      EQUIVALENCE (STACK,ISTACK), (VALUE,KVALUE,RVALUE),(NAME,ANAME)    31
      EQUIVALENCE (ICOMNI,ISUB),(IMAGE,IMAGE1),(IPARAM,ABORT)           32
      EQUIVALENCE(NAME,DNAME)                                           33
C     COLLECTS NAME (UP TO 15 WORDS) TERMINATED BY ANY SPECIAL CHAR     34
       ASSIGN 6 TO NEXT                                                 35
       IF(MODALL)ASSIGN 2 TO NEXT                                       36
       MSTOR = 0                                                        37
       J = KBPW                                                         38
      NAME(2) = BLANKS                                                  39
 1    GO TO NEXT,(2,6,7)                                                40
C              '    OTH                                                41
 2     CALL ICHAR2($8 ,23)                                              42
       TEST = .TRUE.                                                    43
       MODALL = .FALSE.                                                 44
       CALL ICHAR2($99,23)                                              45
C                                     ' PAIR OF APOSTROPHYS DOES NOT EN 45
      TEST = .FALSE.                                                    47
      MODALL = .TRUE.                                                   48
      GO TO 8                                                           49
 6     ASSIGN 7 TO NEXT                                                 50
      GO TO 8                                                           51
C         A-Z-0-9  OTH                                                  52
 7     CALL ICHAR2($99,12)                                              53
 8     IF(J.LT.KBPW) GO TO 9                                            54
       IF(MSTOR.EQ.15) GO TO 10                                         55
       MSTOR = MSTOR + 1                                                56
       NAME(MSTOR) = BLANKS                                             57
       J = 0                                                            58
 9     NAME(MSTOR)=IFLD4(KCH,J,KBPC,NAME(MSTOR))                        59
       J=J+KBPC                                                         60
       GO TO 1                                                          61
 10   IF(MODALL) GO TO 99                                              62
      KERTYP = -260                                                     63
      CALL IERORI                                                       64
 95    CALL ICHAR2($99,12)                                              65
C                                     ' SKIP REST OF NAME               66
       GO TO 95                                                         67
 99   CONTINUE                                                          68
      SMCHR = .TRUE.                                                    69
C     CALL DEBUG3(6HNAME  ,DNAME,3)                                     70
C     CALL DEBUG2(5HMSTOR,MSTOR)                                        71
C     CALL DEBUGR                                                       72
      RETURN                                                            73
      END                                                               74
```

```
$IBFTC INMBRI  DECK
C     SUBROUTINE TO TRANSLATE A NUMERIC FIELD                           1
      SUBROUTINE INMBRI                                                 2
C      CALLED FROM INPUT                                                3
C     INMBRI IS CALLED WITH FIRST DIGIT IN KCH                          4
C     CALL DEBUGC(6HINMBRI)                                             5
      DIMENSION IFT( 31), IPTAB( 21), ITAB( 65)                         6
      DIMENSION ANAME(15) ,IMAGE(80) ,IMAGE1(81),IPARAM(9)              7
     .         ,KSTACK(27),NAME(15)  ,RVALUE(2) ,STACK(27)             8
```

```
C                                                                       9
      COMMON                                                           10
     ./ICOMNI/ VALUE    ,ICOMP    ,IFNTYP   ,IMAGE1   ,IRADIX   ,ISUB  11
     .        ,KCH      ,KCNVRT   ,KCOUNT   ,KDIF     ,KFLD1    ,KFLD2 12
     .        ,LCOMP    ,LCNVRT   ,LEVEL    ,LFRT     ,LOOK             13
     .        ,MCNVRT   ,MDIF     ,MODALL   ,MSTOR                      14
     .        ,NAME     ,NERROR   ,NONEW    ,NOTARG                   15
     .        ,SMCHR    ,TEST     ,ERMARK                             16
     ./ICNSTI/ BLANK    ,BLANKS   ,DOLLAR   ,EOS                      17
     .        ,ICOMMA   ,IDOLAR   ,IFT      ,IPTAB    ,ITAB           18
     .        ,KAM10    ,<BPC     ,KBPW     ,KCPCD    ,KERTYP         19
     .        ,KZERO    ,NOPRNT   ,TAB1                               20
     ./IPARAM/ ABORT    ,KIUNIT   ,KOUNIT   ,LIMALF   ,LOCK     ,LOCX  21
     .        ,NOLIST   ,NSTDIR   ,TRACE                              22
     ./ISTACI/ STACK    ,ISTDIM   ,KSTACK   ,LEVLIM                   23
C                                                                      24
      INTEGER  BLANK    ,BLANKS   ,EOS      ,IDOLAR   ,TAB1     ,TRACE 25
      DOUBLE PRECISION STACK, VALUE, DNBR, H, FD(4)                    26
      LOGICAL ABORT,DOLLAR,ERMARK,LIMALF,LOCK,NOLIST,NONEW,MODALL,     27
     .NSTDIR,SMCHR,TEST                                                28
      EQUIVALENCE (STACK,ISTACK), (VALUE,KVALUE,RVALUE),(NAME,ANAME)   29
      EQUIVALENCE (ICOMNI,ISUB),(IMAGE,IMAGE1),(IPARAM,ABORT)          30
      LOGICAL LVALUE                                                   31
      EQUIVALENCE (KVALUE,LVALUE)                                      32
      LOGICAL SWITCH                                                   33
      DIMENSION LD(4)                                                  34
      DATA LD(1),LD(2),LD(3),LD(4)/8,4,2,1/                            35
      DATA FD(1),FD(2),FD(3),FD(4)/1.0D8,1.0D4,1.0D2,10.D0/            36
      DNBR=0                                                           37
C               ' THE NUMBER  COLLECTED SO FAR                         38
       ICSC=0                                                          39
C               'THE CHARACTERISTIC SCALE FACTOR                       40
      IPF = 1                                                          41
C                                  ' SIGN OF EXPONENT                  42
      IESE = 0                                                         43
C                                  ' THE EXPONENT                      44
      ASSIGN 1 TO NEXT                                                 45
      SWITCH = .FALSE.                                                 46
      SMCHR = .TRUE.                                                   47
       CALL ICHAR2($70,21)                                             48
C                           ' GO TO 70 FOR LOGICAL CONSTANTS           49
       SMCHR = .TRUE.                                                  50
C           +-    OTH 0-9                                              51
 1     CALL ICHAR4($2, $3,   13,15)                                    52
       GO TO 50                                                        53
3     DNBR = DNBR*10.D0+FLOAT(KCH-KZERO)                               54
      GO TO NEXT,(1,15)                                                55
 15   ICSC = ICSC - 1                                                  56
      GO TO 1                                                          57
C              . DE OTH                                                58
 2     GO TO(20,30,50),LCOMP                                           59
 19    SMCHR=.TRUE.                                                    60
C                                   'ENTER HERE FOR INITIAL DECIMAL POINT 61
 20   IF (SWITCH)  GO TO 9130                                          62
C     CALL DEBUG2(6HSTAT .,20)                                         63
      ASSIGN 15 TO NEXT                                                64
      SWITCH = .TRUE.                                                  65
      GO TO 1                                                          66
 37    IPF=-1                                                          67
       GO TO 36                                                        68
 30    CONTINUE                                                        69
C     CALL DEBUG 2(6HSTAT E,30)                                        70
```

```
C             +-    OTH 0-9                                                  71
       CALL ICHAR4($50,$35, 13,15)                                           72
C              +  -                                                         73
       GO TO(36,37),LCOMP                                                    74
 35    SMCHR=.TRUE.                                                          75
 36    CALL ISUBI                                                            76
C                                     ' TEST WILL BE TRUE                   77
 44   ICSC = ICSC+ISIGN(ISUB,IPF)                                            78
C                                        ' RESOLVE SCALE FACTORS             79
50    CONTINUE                                                              80
C     CALL DEBUG 2(6HSTAT  ,50)                                             81
C     CALL DEBUG3 (5HDNBR1,DNBR ,4)                                         82
      H = 1.D0                                                              83
      IESC=IABS(ICSC)                                                       84
      DO 63 I=1,4                                                           85
 61    IF (IESC.LT. LD(I)) GO TO 63                                         86
 62    IESC=IESC-LD(I)                                                      87
       H=H*FD(I)                                                            88
       GO TO 61                                                             89
 63    CONTINUE                                                             90
      IF (ICSC.LT.0) GO TO 65                                               91
 64   DNBR = DNBR*H                                                         92
      GO TO 98                                                              93
C              T    F  OTH                                                  94
 70    CALL ICHARI($73,$19,17)                                              95
       LVALJE=.TRUE.                                                        96
 71    IF(NJTARG.GT.LEVEL)LCNVRT=4                                          97
C                                     ' LOGICAL CONSTANTS NOT CONVERTED     98
       RVALJE(2)=0.                                                         99
C             A-Z   OTH   .                                                100
 72    CALL ICHARI($9130,$99,21)                                           101
C                                        'DISCARD REST OF WORD, MUST FIND  102
       GO TO 72                                                            103
 73    LVALJE=.FALSE.                                                      104
       GO TO 71                                                            105
 65   DNBR = DNBR/H                                                        106
98    VALUE = DNBR                                                         107
      SMCHR = .TRUE.                                                       108
 99   CONTINUE                                                             109
C     CALL DEBUG3(6HDNBR 2,DNBR,4)                                         110
C     CALL DEBUG3(5HVALUE,VALUE,4 )                                        111
C     CALL DEBUG2(6HICSC  ,ICSC)                                           112
C     CALL DEBUG2(6HIPF   ,IPF)                                            113
C     CALL DEBUG 2(6HIESC  ,IESC)                                          114
C     CALL DEBUGR                                                          115
      RETURN                                                               116
 9130 KERTYP = 130                                                         117
      GO TO 99                                                             118
      END                                                                  119
```

```
$IBFTC ITABLI  DECK
C     SUBROUTINE TO CONSTRUCT TABLE ENTRIES                                  1
      SUBROUTINE ITABLI(IT)                                                  2
C      CALLED FROM INPUT                                                     3
C     CALL DEBUGC(6HITABLI)                                                  4
```

```
C                                                                       5
      DIMENSION IFT( 31), IPTAB( 21), ITAB( 65)                         6
      DIMENSION ANAME(15) ,IMAGE(80) ,IMAGE1(81),IPARAM(9)              7
     .         ,KSTACK(27),NAME(15)  ,RVALUE(2) ,STACK(27)             8
C                                                                       9
      COMMON                                                           10
     ./ICOMNI/ VALUE    ,ICOMP    ,IFNTYP   ,IMAGE1   ,IRADIX   ,ISUB  11
     .         ,KCH     ,KCNVRT   ,KCOUNT   ,KDIF     ,KFLD1   ,KFLD2 12
     .         ,LCOMP   ,LCNVRT   ,LEVEL    ,LFRT     ,LOOK            13
     .         ,MCNVRT  ,MDIF     ,MODALL   ,MSTOR                     14
     .         ,NAME    ,NERROR   ,NONEW    ,NOTARG                    15
     .         ,SMCHR   ,TEST     ,ERMARK                              16
     ./ICNSTI/ BLANK    ,BLANKS   ,DOLLAR   ,EOS                       17
     .         ,ICOMMA  ,IDOLAR   ,IFT      ,IPTAB    ,ITAB            18
     .         ,KAM10   ,KBPC     ,KBPW     ,KCPCD    ,KERTYP          19
     .         ,KZERO   ,NOPRNT   ,TAB1                                20
     ./IPARAM/ ABORT    ,KIUNIT   ,KOUNIT   ,LIMALF   ,LOCK    ,LOCX   21
     .         ,NOLIST  ,NSTDIR   ,TRACE                               22
     ./ISTACI/ STACK    ,ISTDIM   ,KSTACK   ,LEVLIM                    23
C                                                                      24
      INTEGER  BLANK    ,BLANKS   ,EOS      ,IDOLAR   ,TAB1     ,TRACE 25
      DOUBLE PRECISION STACK, VALUE                                    26
      LOGICAL ABORT,DOLLAR,ERMARK,LIMALF,LOCK,NOLIST,NONEW,MODALL,     27
     .NSTDIR,SMCHR,TEST                                                28
      EQUIVALENCE (STACK,ISTACK), (VALUE,KVALUE,RVALUE),(NAME,ANAME)   29
      EQUIVALENCE (ICOMNI,ISUB),(IMAGE,IMAGE1),(IPARAM,ABORT)          30
      DIMENSION IT (1)                                                 31
C                                                                      32
      KDIF = 1                                                         33
      ISUBX = 1                                                        34
      ITYPE = 1                                                        35
C                                  ' ALWAYS INITIALIZE TO .REAL.       36
C             (   A-Z  OTH                                             37
 1    CALL ICHARI ($1,$9120,26)                                        38
C                                   ' SKIP 'ABLE' IN TABLE             39
 3    CONTINUE                                                         40
C     CALL DEBUG2(6HSTATMT,3)                                          41
      CALL ICHAR4($4,$9120,7,9)                                        42
C             .   )   0-9+  OTH                                        43
       GO TO (30 ,98 ,10 ,9120),LCOMP                                  44
C             ,  A-Z  OTH  OTH                                         45
 4     GO TO (3  ,20, 9120,9120),LCOMP                                 46
 9120 KERTYP= 120                                                      47
C                  '                     ILLEGAL CHARACTER            48
      GO TO 98                                                         49
 10   CONTINUE                                                         50
C     CALL DEBUG2(6HST 0-9 ,10)                                        51
      SMCHR = .TRUE.                                                   52
      CALL ISUBI                                                       53
      ISUBX = ISUB                                                     54
      CALL ICHAR2($9120,25)                                            55
C                                  'ERROR IF NO =                      56
      GO TO 3                                                          57
 30    CONTINUE                                                        58
C     CALL DEBUG 2(6HSTATMT,30)                                        59
 31   KDIF = 1                                                         60
C     SPLIT TYPES (INT,REAL,DP,NO CONVERSION,FUNCTION ,SUBROUTINE)     61
      CALL ICHAR4($32,$33,3,5)                                         62
      IF(LCOMP.GT.1) GO TO 9120                                        63
      KDIF = 2                                                         64
      GO TO 33                                                         65
```

```
 32    IF (LCOMP.EQ.3) GO TO 9120                                              55
       ITYPE = LCOMP                                                           67
       GO TO 34                                                                68
 33    ITYPE = LCOMP+2                                                         69
C              A-Z  OTH   .                                                    70
 34    CALL ICHARI($9120,$3,21)                                                71
       GO TO 34                                                                72
 20    CONTINUE                                                                73
C      CALL DEBUG2(6HSTATMT,20)                                                74
       CALL INAMEN                                                             75
 50    CONTINUE                                                                76
C      CALL DEBUG2(6HSTATMT,50)                                                77
        ITBUFF=IFLD4(ITYPE,0,3,ITBUFF)                                         78
        ITBUFF=IFLD4(MSTOR,3,4,ITBUFF)                                         79
        ITBUFF=IFLD4(ISUBX,7,25,ITBUFF)                                        80
C      CALL DEBUG2 (5HITYPE,ITYPE)                                             81
C      CALL DEBUG2 (5HMSTOR,MSTOR)                                             82
C      CALL DEBUG2 (5HISUBX,ISUBX)                                             83
C      CALL DEBUG4 (6HITBUFF,ITBUFF,2)                                         84
       ISUBX = ISUBX + KDIF                                                    85
       CALL ILOOKI($56,IT)                                                     86
       IF((IT(2).NE.0).AND.((LOOK+MSTOR +2).GT.IT(2)))   GO TO 9320            87
       IT(LOOK)=ITBUFF                                                         88
       DO 55 K=1,MSTOR                                                         89
        LOOK=LOOK+1                                                            90
  55    IT(LOOK)=NAME(K)                                                        91
C      CALL DEBUG2(6HSTATMT,55)                                                92
       LOOK=LOOK+1                                                             93
       IT(LOOK)=0                                                              94
       GO TO 3                                                                 95
 56    IT(LOOK)=ITBUFF                                                         96
C      CALL DEBUG2(6HSTATMT,56)                                                97
       GO TO 3                                                                 98
 98    CONTINUE                                                                99
C      CALL DEBUGR                                                            100
       RETURN                                                                 101
9320   KERTYP =-320                                                           102
       CALL IERORI                                                            103
       GO TO  3                                                               104
       END                                                                    105
```

```
$IBFTC ISUBI   DECK
       SUBROUTINE ISUBI                                                         1
C       ISUBI FINDS SUBSCRIPTS AND INTEGER CONSTANTS                            2
C       CALLED FROM                                                             3
C                    INAMEI                                                     4
C                    INMBRI                                                     5
C                    INPUT                                                      6
C                    ITABLI                                                     7
C          ISUB BEGINS PROCESSING WITH THE NEXT CHARACTER.                       8
C      CALL DEBUGC(5HISUBI)                                                      9
C      COLLECTS INTEGER OF BASE IRADIX TERMINATED BY A SPECIAL CHARACTER        10
       DIMENSION IFT( 31), IPTAB( 21), ITAB( 65)                               11
       DIMENSION ANAME(15) ,IMAGE(80) ,IMAGE1(81),IPARAM(9)                    12
      .          ,KSTACK(27),NAME(15)  ,RVALUE(2) ,STACK(27)                   13
C                                                                              14
       COMMON                                                                  15
      ./ICOMNI/ VALUE    ,ICOMP    ,IFNTYP   ,IMAGE1   ,IRADIX   ,ISUB        16
```

```
     .         ,KCH      ,KCNVRT   ,KCOUNT   ,KDIF     ,KFLD1    ,KFLD2        17
     .         ,LCOMP    ,LCNVRT   ,LEVEL    ,LFRT     ,LOOK                   18
     .         ,MCNVRT   ,MDIF     ,MODALL   ,MSTOR                            19
     .         ,NAME     ,NERROR   ,NONEW    ,NOTARG                         20
     .         ,SMCHR    ,TEST     ,ERMARK                                     21
     ./ICNSTI/ BLANK     ,BLANKS   ,DOLLAR   ,EOS                            22
     .         ,ICOMMA   ,IDOLAR   ,IFT      ,IPTAB    ,ITAB                 23
     .         ,KAM10    ,KBPC     ,KBPW     ,KCPCD    ,KERTYP               24
     .         ,KZERO    ,NOPRNT   ,TAB1                                       25
     ./IPARAM/ ABORT     ,KIUNIT   ,KOUNIT   ,LIMALF   ,LOCK     ,LOCX        25
     .         ,NOLIST   ,NSTDIR   ,TRACE                                      27
     ./ISTACK/ STACK     ,ISTDIM   ,KSTACK   ,LEVLIM                         28
C                                                                            29
      INTEGER  BLANK     ,BLANKS   ,EOS      ,IDOLAR   ,TAB1     ,TRACE      30
      DOUBLE PRECISION STACK, VALUE                                          31
      LOGICAL ABORT,DOLLAR,ERMARK,LIMALF,LOCK,NOLIST,NONEW,MODALL,           32
     .NSTDIR,SMCHR,TEST                                                      33
      EQUIVALENCE (STACK,ISTACK), (VALUE,KVALUE,RVALUE),(NAME,ANAME)         34
      EQUIVALENCE (ICOMNI,ISUB),(IMAGE,IMAGE1),(IPARAM,ABORT)                35
      ISUB = 0                                                               36
C             A-Z  0-9  OTH                                                  37
 80    CALL ICHARI($10,$99,12)                                               38
       IDIGIT=KCH-KAM10                                                      39
C                        ' VALUE OF LETTER USED AS DIGIT                     40
 30    IF(IDIGIT .GE. IRADIX)   GO TO 99                                     41
35     ISUB = ISUB * IRADIX + IDIGIT                                         42
C                                                 ' ACCUM TOTAL.   IRADIX    43
       GO TO 80                                                              44
99     SMCHR = .TRUE.                                                        45
C                                      ' ALLOW SAME CHARACTER TO BE READ     46
C      CALL DEBUG2(6H*ISUBI,ISUB)                                            47
C      CALL DEBUGR                                                           48
       RETURN                                                                49
 10    IDIGIT=KCH-KZERO                                                      50
C                        ' VALUE OF DIGIT                                    51
       GO TO 30                                                              52
       END                                                                   53
```

```
$IBFTC IXQTI   DECK
       SUBROUTINE IXQTI (ARGL,ARGS)                                          1
C       USER MAY PUT HIS OWN COMMON STATEMENTS IN THIS ROUTINE AND            2
C       USE THEM TO SUPPLY ARGUMENTS TO HIS CALLS IF HE DESIRES               3
       COMMON                                                                4
      ./IPARAM/ ABORT ,KIUNIT ,KOUNIT, LIMALF ,LOCK, LOCX, NOLIST, NSTDIR    5
      .,        TRACE                                                       6
       DOUBLE PRECISION ARGS(27), ARGL, ARG22                                7
       DIMENSION ARG2(2)                                                     8
       EQUIVALENCE (ARG2,ARG22)                                              9
C                                                                           10
       M = DABS(ARGS(1))                                                    11
       IF (M.LT.1 .OR. M.GT.16)  GO TO 99                                   12
       GO TO (1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16),M                     13
     1 ARGL = COS(ARGL)                                                     14
       GO TO 100                                                            15
     2 ARGL = EXP(ARGL)                                                     16
       GO TO 100                                                            17
     3 ARGL = ALOG(ARGL)                                                    18
       GO TO 100                                                            19
```

```
    4 ARGL = SIN(ARGL)                                                    20
      GO TO 100                                                           21
    5 ARGL = SQRT(ARGL)                                                   22
      GO TO 100                                                           23
    6 ARGL = ATAN2(ARGS(2),ARGL)                                          24
      GO TO 100                                                           25
C      PRINT FUNCTION                                                     26
    7 ARG22 = ARGS(2)                                                     27
      WRITE (KOUNIT,101) ARG2,ARGL                                        28
  101 FORMAT(1H 2A6,3H = ,D26.17)                                         29
      GO TO 100                                                           30
    8 ARGL = SNGL(ARGS(2))**IFIX(SNGL(ARGL+DSIGN(.5D0,ARGL)))             31
      GO TO 100                                                           32
    9 ARGL = ABS(SNGL(ARGS(2)))**SNGL(ARGL)                               33
      GO TO 100                                                           34
   10 ARGL = ABS(ARGL)                                                    35
      GO TO 100                                                           36
C      DISC(RIMINENT) FUNCTION                                            37
   11 IF (ARGL) 102,103,104                                               38
  102 ARGL = ARGS(2)                                                      39
      GO TO 100                                                           40
  103 ARGL = ARGS(3)                                                      41
      GO TO 100                                                           42
  104 ARGL = ARGS(4)                                                      43
      GO TO 100                                                           44
   12 CALL LOCKX(ARGL)                                                    45
      GO TO 100                                                           46
   13 CONTINUE                                                            47
      GO TO 100                                                           48
   14 CONTINUE                                                            49
      GO TO 100                                                           50
   15 CONTINUE                                                            51
   16 CONTINUE                                                            52
  100 CONTINUE                                                            53
C     CALL DEBUGR                                                         54
      RETURN                                                              55
   99 KERTYP =-610                                                        56
      CALL IERORI                                                         57
      GO TO 100                                                           58
      END                                                                 59
```

```
$IBFTC LOCKX   DECK
      SUBROUTINE LOCKX(J)                                                  1
      COMMON                                                               2
     ./IPARAM/ ABORT    ,KIUNIT   ,KOUNIT   ,LIMALF   ,LOCK     ,LOCX      3
     .        ,NOLIST   ,NSTDIR   ,TRACE                                  4
      LOGICAL J,LOCK                                                       5
      LOCK = J                                                             6
      RETURN                                                               7
      END                                                                  8
```

```
$IBFTC DEBUGX  DECK
      SUBROUTINE DEBUGX                                                      1
C                                        *INITALIZATION                       2
      DIMENSION ISUBN(20)                                                    3
C     TRACE  = 0 NO PRINTING                                                 4
C     TRACE  = 1      PRINT DEBUG 2+3 CALLS ONLY                             5
C     TRACE  = 2      PRINT DEBUG 2+3 CALLS ONLY                             6
C     TRACE  = 3      PRINT  DEBUG 2+3 AND STACK PRINT                       7
C     TRACE  = 4      PRINT DEBUG 2+3 AND STACK PRINT AND CALLS FROM CHAR    8
      DIMENSION IFT(27), IPTAB(21), ITAB(65)                                 9
      DIMENSION ANAME(15) ,IMAGE(80) ,IMAGE1(81),IPARAM(9)                  10
     .         ,KSTACK(27),NAME(15)  ,RVALUE(2) ,STACK(27)                  11
C                                                                           12
      COMMON                                                                13
     ./ICOMNI/ VALUE    ,ICOMP    ,IFNTYP   ,IMAGE1   ,IRADIX   ,ISUB      14
     .        ,KCH      ,KCNVRT   ,KCOUNT   ,KDIF     ,KFLD1    ,KFLD2     15
     .        ,LCOMP    ,LCNVRT   ,LEVEL    ,LFRT     ,LOOK                16
     .        ,MCNVRT   ,MDIF     ,MODALL   ,MSTOR                         17
     .        ,NAME     ,NERROR   ,NONEW    ,NOTARG                      18
     .        ,SMCHR    ,TEST     ,ERMARK                                  19
     ./ICNSTI/ BLANK    ,BLANKS   ,DOLLAR   ,EOS                           20
     .        ,ICOMMA   ,IDOLAR   ,IFT      ,IPTAB    ,ITAB                21
     .        ,KAM10    ,KBPC     ,KBPW     ,KCPCD    ,KERTYP              22
     .        ,KZERO    ,NOPRNT   ,TAB1                                    23
     ./IPARAM/ ABORT    ,KIUNIT   ,KOUNIT   ,LIMALF   ,LOCK     ,LOCX      24
     .        ,NOLIST   ,NSTDIR   ,TRACE                                   25
     ./ISTACI/ STACK    ,ISTDIM   ,KSTACK   ,LEVLIM                        26
C                                                                           27
      INTEGER  BLANK    ,BLANKS   ,EOS      ,IDOLAR   ,TAB1     ,TRACE     28
      DATA BADCAL/6HBADCAL/                                                 29
      DOUBLE PRECISION ALFARG, ISUBN, STACK, VALUE, DBLANK, DARG            30
      LOGICAL ABORT,DOLLAR,ERMARK,LIMALF,LOCK,NOLIST,NONEW,MODALL,          31
     .NSTDIR,SMCHR,TEST                                                     32
      EQUIVALENCE (STACK,ISTACK), (VALUE,KVALUE,RVALUE),(NAME,ANAME)        33
      EQUIVALENCE (ICOMNI,ISUB),(IMAGE,IMAGE1),(IPARAM,ABORT)               34
     .,(DBLANK,BLANK)                                                       35
      ISUBC = 0                                                             36
      DO 10 I = 1,10                                                        37
10    ISUBN(I) = DBLANK                                                     38
      IF(TRACE.EQ.0) GO TO 99                                               39
       WRITE (KOUNIT,410)                                                   40
      GO TO 99                                                              41
      ENTRY DEBUGC(ISUBNA)                                                  42
      DOUBLE PRECISION ISUBNA                                               43
C                              * NEW SUBROUTINE CALLED                      44
      IF (ISUBC.GT.10)  GO TO 98                                            45
      ALFARG = DBLANK                                                       46
      NUMARG = -1                                                           47
      ISUBC = ISUBC+1                                                       48
      ISUBN(ISUBC) = ISUBNA                                                 49
      IF(TRACE .GE.4) GO TO 400                                             50
      GO TO 99                                                              51
C                                                                           52
98    ALFARG = BADCAL                                                       53
C                                        *  CALLS MIGHT GET OUT OF RANGE     54
      NUMARG = ISUBC                                                        55
      GO TO 400                                                             56
C                                                                           57
      ENTRY DEBUGR                                                          58
C                                        * CALL AT RETURN                   59
      IF (ISUBC.LT.1)   GO TO 98                                            60
      ALFARG = DBLANK                                                       61
      NUMARG = -1                                                           62
```

```
      ISUBN(ISUBC) = DBLANK                                              63
      ISUBC = ISUBC - 1                                                  64
      IF(TRACE .GE.4) GO TO 400                                          65
      GO TO 99                                                           66
C                                                                        67
      ENTRY DEBUG2(ALFAR,NUMAR)                                          68
      DOUBLE PRECISION ALFAR                                             69
      NUMARG = NUMAR                                                     70
      ALFARG = ALFAR                                                     71
 20   IF (TRACE .LT.1) GO TO 99                                          72
 400  WRITE (KOUNIT,405) (ISUBN(I),I=1,4),ALFARG,NUMARG,                73
     .KCOUNT,SMCHR,KCH,KFLD1,ICOMP,KFLD2,LCOMP                          74
 99   RETURN                                                             75
C                                                                        76
      ENTRY DEBUG3(ALFAR,DNUMAR,ITYPE)                                   77
      DOUBLE PRECISION DNUMAR                                            78
      ENTRY DEBUG4(ALFAR,DNUMAR,ITYPE)                                   79
      DARG = DNUMAR                                                      80
      NUMARG=NUMAR                                                       81
      ALFARG = ALFAR                                                     82
      IF (TRACE  .LT.1) GO TO 99                                         83
      GO TO (30,40,50,60), ITYPE                                         84
30    WRITE (KOUNIT,406) (ISUBN(I),I=1,4),ALFARG,NUMARG,                 85
     .KCOUNT,SMCHR,KCH,KFLD1,ICOMP,KFLD2,LCOMP                          86
      GO TO 99                                                           87
40    WRITE (KOUNIT,407) (ISUBN(I),I=1,4),ALFARG,NUMARG,                 88
     .KCOUNT,SMCHR,KCH,KFLD1,ICOMP,KFLD2,LCOMP                          89
      GO TO 99                                                           90
50    WRITE (KOUNIT,408) (ISUBN(I),I=1,4),ALFARG,NUMARG,                 91
     .KCOUNT,SMCHR,KCH,KFLD1,ICOMP,KFLD2,LCOMP                          92
      GO TO 99                                                           93
60    WRITE (KOUNIT,409) (ISUBN(I),I=1,4),ALFARG,NUMARG,                 94
     .KCOUNT,SMCHR,KCH,KFLD1,ICOMP,KFLD2,LCOMP                          95
      GO TO 99                                                           96
405   FORMAT(1H ,29X,5(A6,1X),I24,                                       97
     .1H(,I3,L2,1H),A6,2H (,I3,I2,1H),2H (,I3,I2,1H))                   98
406   FORMAT(1H ,29X,5(A6,1X),E24.8,                                     99
     .1H(,I3,L2,1H),A6,2H (,I3,I2,1H),2H (,I3,I2,1H))                  100
407   FORMAT(1H ,29X,5(A6,1X),11X,O12,1X,                               101
     .1H(,I3,L2,1H),A6,2H (,I3,I2,1H),2H (,I3,I2,1H))                  102
408   FORMAT(1H ,29X,5(A6,1X),16X,A8,                                   103
     .1H(,I3,L2,1H),A6,2H (,I3,I2,1H),2H (,I3,I2,1H))                  104
409   FORMAT(1H ,29X,5(A6,1X),D24.18,                                   105
     .1H(,I3,L2,1H),A6,2H (,I3,I2,1H),2H (,I3,I2,1H))                  106
410   FORMAT(29X,11HDEBUG TRACE,52X,9HI--KCOUNT,5X,8HI--LIST1/          107
     .68X,9HD ARG  OR,15X,9HI I-SMCHR,5X,10HI I--ICOMP /               108
     .29X,18HSUBROUTINES CALLED,11X,7HALF ARG,7X,11HNUMERIC ARG,9X,    109
     .3HI I,1X,5HKCH-I,5X,16HI I      I--LIST2 /                       110
     .92X,34I I,5X,1HI,5X,18HI I      I I--LCOMP)                      111
      END                                                               112
```

```
$IBFTC STACKP  DECK
      SUBROUTINE STACKP                                                  1
      DIMENSION IFT(27), IPTAB(21), ITAB(65)                             2
      DIMENSION ANAME(15) ,IMAGE(80) ,IMAGE1(81),IPARAM(9)               3
     .          ,KSTACK(27),NAME(15)  ,RVALUE(2) ,STACK(27)             4
C                                                                        5
      COMMON                                                             6
```

```
     ./ICOMNI/ VALUE    ,ICOMP    ,IFNTYP   ,IMAGE1   ,IRADIX   ,ISUB          7
     .         ,KCH     ,KCNVRT   ,KCOUNT   ,KDIF     ,KFLD1    ,KFLD2        8
     .         ,LCOMP   ,LCNVRT   ,LEVEL    ,LFRT     ,LOOK                   9
     .         ,MCNVRT  ,MDIF     ,MODALL   ,MSTOR                          10
     .         ,NAME    ,NERROR   ,NONEW    ,NOTARG                         11
     .         ,SMCHR   ,TEST     ,ERMARK                                   12
     ./ICNSTI/ BLANK    ,BLANKS   ,DOLLAR   ,EOS                            13
     .         ,ICOMMA  ,IDOLAR   ,IFT      ,IPTAB    ,ITAB                 14
     .         ,KAM10   ,KBPC     ,KBPW     ,KCPCD    ,KERTYP               15
     .         ,KZERO   ,NOPRNT   ,TAB1                                     16
     ./IPARAM/ ABORT    ,KIUNIT   ,KOUNIT   ,LIMALF   ,LOCK     ,LOCX        17
     .         ,NOLIST  ,NSTDIR   ,TRACE                                    18
     ./ISTACI/ STACK    ,ISTDIM   ,KSTACK   ,LEVLIM                         19
C                                                                            20
      INTEGER  BLANK    ,BLANKS   ,EOS      ,IDOLAR   ,TAB1     ,TRACE      21
      DOUBLE PRECISION STACK, VALUE                                          22
      LOGICAL ABORT,DOLLAR,ERMARK,LIMALF,LOCK,NOLIST,NONEW,MODALL,           23
     .NSTDIR,SMCHR,TEST                                                      24
      EQUIVALENCE (STACK,ISTACK), (VALUE,KVALUE,RVALUE),(NAME,ANAME)         25
      EQUIVALENCE (ICOMNI,ISUB),(IMAGE,IMAGE1),(IPARAM,ABORT)                26
      IF(TRACE .LT. 3)  GO TO 99                                             27
      LEVELX = LEVEL + 3                                                     28
      WRITE(KOUNIT,85)LEVEL,VALUE,KVALUE,RVALUE,LOCX                         29
      WRITE(KOUNIT,89)(STACK(I),I=1,LEVELX)                                  30
      WRITE(KOUNIT,86)(KSTACK(I),I=1,LEVELX)                                 31
89    FORMAT(11D12.4)                                                        32
86    FORMAT(11I12)                                                          33
85    FORMAT(7H LEVEL=I3,7H VALUE=D25.17,8H KVALUE=I3,3H ,D,2(1X,D12),       34
     .6H LOCX=I6)                                                            35
 99   RETURN                                                                 36
      END                                                                    37
```

# APPENDIX B

# HUFF INPUT ROUTINE

The first version of the Huff Input Routine was reported in reference 5. The Huff Input Routine provides more versatility in reading input data into the computer than the NAMELIST feature in FORTRAN. The Huff Input Routine has the ability to make simple arithmetic manipulations (such as conversion of units) during loading and to load alphanumeric data. While not an indispensable feature, it has been found to be quite convenient. The Huff Input Routine also allows for the automatic printout of data cards at execution time.

The following section contains a general description of the Huff Input Routine and its usage.

## Usage

The programmer transfers control to the INPUT routine with a standard FORTRAN IV call

```
CALL INPUT (5,6,1,X,ITABLE)
```

Argument 1 is the system input tape number (5 on the Lewis System). Argument 2 is the system output tape number (6 on the Lewis System). Argument 3 is the identifying number of a data group. This value is compared with an identification number occurring on an input card ($DATA card). If the values agree, the data are processed until another $DATA or end-of-data ($END) card is encountered. If the values do not agree, no data are processed and control is returned to the calling program. Argument 4 is the array X, which serves as a reference point for the storing of input data. Since all data are stored relative to X, the programer must provide fixed relations between the location of X and other locations to be loaded (e.g., through the use of common blocks and/or equivalence statements). In this code, X is "WORD," the first name in the labeled common block "ALL." Common blocks ALL, DESIGN, FRONT, SIDE, BACK, DUMMY, and SPOOL 2 are in all routines; hence, they are loaded sequentially so that the location of all variables is known. Argument 5 is the array ITABLE, which contains the names of the variables used on the cards and their subscript location relative to X. Sufficient space must be provided in the calling program for storing the table of names. This is done by a DIMENSION statement. The dimension of ITABLE should be stored in ITABLE(2). ITABLE(3) must initially be zero.

## Types of Input Statements

$DATA statement. - The $DATA statement identifies a group of data with an identification number. It must be the first statement on a card. For example, $DATA(1) or $D(1) on the first card of a data group causes the value 1 to be compared with argument 3 in the calling sequence. If unequal, control is returned to the calling program. If equal, data are loaded until the next $DATA or $END statement is reached.

$TABLE statement. - The $TABLE statement makes a list of names needed for loading data. Consider for example that the real variable names VELOCITY, MASS, and RADIUS are to be assigned to memory locations X(1), X(2), and X(3), respectively. The card would be punched $TABLE (.REAL., 1 = VELOCITY, 2 = MASS, 3 = RADIUS). These variables will be treated as real in any subsequent loading of data. A limit of 15 computer words is placed on the length of a name. Since .REAL. is what designates the mode of the name, a name may begin with any alphabetic letter. For example, the statement $TABLE (.INTEGER., 20 = INDEX, SUBSCRIPT, I) will place these names in the table and any values subsequently loaded will be stored in X(20), X(21), and X(22), respectively, as integers. In a similar manner, $TABLE(.DOUBLE PRECISION., 10 = RADIUS DOUBLE, .LOGICAL., 12 = SWITCH 1, SWITCH 2) causes the name RADIUS DOUBLE to be stored in the table as a double-precision variable equivalent to X(10) and X(11), and the logical variables SWITCH 1 and SWITCH 2 will be equivalent to X(12) and X(13).

Note that $TABLE statements are loaded as Number = Name to avoid confusion with loading statements.

## Loading Statement

The loading statement loads data by taking the name of a variable previously appearing in a $TABLE statement and setting it equal to a value which may be of several forms.

Numeric values. - Standard FORTRAN language is used; for example, VELOCITY = 3.4, MASS = 32 (no decimal point is needed and MASS will have the REAL value 32), RADIUS = 4E21, and INDEX = 3. Data can be continued from one card to another; for example, SUBSCRIPT may appear at the end of one card and = 47 on the next card.

Subscripts may be used. Since 3 = RADIUS, RADIUS(2) = 6, 10, 12,, 14 will put real numbers in X(4), X(5), X(6), and X(8) and leave X(7) unchanged because of the double comma.

If new values are assigned to a variable before the next $D(1) card, the new value

will override the previous one. For example, RADIUS(2) = 8 will override the RADIUS(2) = 6 card.

Internally addressed values. - An internally addressed value is one that refers to the contents of memory by name. RADIUS(7) = RADIUS(3), RADIUS(INDEX) causes RADIUS(7) to assume the value of RADIUS(3) and RADIUS(8) to also assume the value of RADIUS(3) since INDEX = 3.

The statement RADIUS(7) = RADIUS(INDEX + 1) however is ILLEGAL.

Arithmetic expressions. - Provisions have been made to allow arithmetic operations to be performed on data at execution time. The operations + (addition), -(subtraction), *(multiplication), and /(division) and the functions, included among which are SQRT, EXP, SIN, COS, and PWR(X, Y) (= X**Y), may be used with name or numbers (or any expression that has a value) to compute the value of an arithmetic expression. Parentheses may be used to indicate the order of performing the operations. The computations are analyzed from left to right and any intermediate results are stored in up to 24 locations in the core (the stack) which is sufficient for fairly complex expressions. All numeric operations are carried out in double-precision floating-point FORTRAN arithmetic. As an example, RADIUS(2) = RADIUS(2)*SQRT(RADIUS(2)) or RADIUS(2) = PWR(RADIUS(2), 1.5) will set RADIUS(2) = $8^{3/2}$.

Alphanumeric expressions. - Alphanumeric data may be entered by placing the variable name on the "REAL" list and then setting the variable equal to the data by first enclosing in parentheses the length of the word to be read in. As an example,

```
Q = (A39) THIS IS AN EXAMPLE OF ALPHANUMERIC DATA
```

The (A39) gives the length of the data including imbedded blanks. Of course, since on the IBM 7094 there are six characters per word, Q must internally be dimensioned to at least 7.

## Printing Input Cards

Each input card processed will normally be written on the tape specified by the second argument of the calling sequence. An end-of-statement symbol read on the card will cause interpretation of the card to stop at that point and permit comments to be placed on the remainder of the card to be printed with the output. In order to avoid printing the card at all, the nonprint character is placed in the next column following the end-of-statement character. The developers of the routine selected the sign ≠ for both characters. This is punched as a colon on an IBM Model 29 Keypunch and corresponds to a 2-8 punch.

If the character following the end-of-statement symbol is other than a nonprint character, it is inserted as the printer control character in the first position of the output format before the card is written on output tape. If no end-of-statement character occurs on the card, a blank printer control character is used. Comment cards having the end-of-statement character as the first nonblank character will be printed and may be placed anywhere except in a continued alphabetic field.

In summary, the end-of-statement character has the effect of moving the end of the card forward to the column ahead of the end-of-statement character and the column following it is printer control.

If the control parameter NOLIST is true, printing is suppressed for all cards.

# APPENDIX C

# SYMBOLS

## General Symbols Internal to Program

Variables in program are formed by combining these symbols.

## Station Numbers

See figures 1 to 9 for each type of engine.

## Thermodynamic Properties

| | |
|---|---|
| AM | Mach number |
| FAR | fuel-air ratio, f/a |
| H | enthalpy, Btu/lbm |
| P | total pressure, atm |
| PS | static pressure, atm |
| S | entropy, Btu/$^{o}$R/lbm |
| T | total temperature, $^{o}$R |
| TS | static temperature, $^{o}$R |
| V | velocity, ft/sec |

## Component Symbols

| | |
|---|---|
| A, AFT | afterburner |
| B | burner |
| C | inner compressor |
| COM | combustor |
| D | fan duct |
| F | first or fan compressor |

| | |
|---|---|
| I | intermediate (middle) compressor |
| M | core nozzle |
| MAIN | all but wing |
| NOZ | nozzle |
| OB | overboard |
| T | total |
| THP | inner (high pressure) turbine |
| TIP | middle (intermediate pressure) turbine |
| TLP | outer (low pressure) turbine |
| WDUCT | wing (third stream) duct |
| WING, WNG | wing (third stream) |

## Engine Symbols

| | |
|---|---|
| BL | bleed, lbm/sec |
| CN | ratio of corrected speed to design corrected speed |
| DHT | turbine delta enthalpy, Btu/lbm |
| DHTC | turbine delta enthalpy (temperature corrected), $(H_{in} - H_{out})/T_{in}$, Btu/$^{o}$R/lbm |
| DP | pressure drop, $\Delta P/P$ |
| DT | temperature change, $^{o}$R |
| ETA | efficiency |
| ETAR | ram recovery, $P_2/P_1$ |
| HPEXT | horsepower extracted |
| PCBL | fractional bleed |
| PCN | percent of design shaft speed |
| PR | pressure ratio |
| TFF | turbine flow function, lbm $\sqrt{^{o}R}$/(psia)(sec) |
| WA | airflow, lbm/sec |
| WF | fuel flow, lbm/sec |

| | |
|---|---|
| WG | gas flow, lbm/sec |
| Z | ratio of pressure ratios |

## Miscellaneous Symbols

| | |
|---|---|
| A | area, ft |
| ALTP | altitude, ft |
| AM | Mach number of aircraft |
| BPRINT | bypass ratio (wing duct air/core air) |
| BYPASS | bypass ratio (fan duct air/air entering intermediate compressor) |
| C | when following component symbol signifies "corrected" |
| CF | correction factor, when used following component symbol |
| CS | ambient speed of sound, ft/sec |
| CV | nozzle velocity coefficient |
| DEL | delta degradation coefficient |
| DS | design value |
| DUM | dummy value |
| FCOVFN | ratio of core thrust to net thrust |
| FFOVFN | ratio of fan thrust to net thrust |
| FG | gross thrust, lbf |
| FGM | momentum thrust, lbf |
| FGP | pressure thrust, lbf |
| FMOVFN | ratio of fan plus core thrust to net thrust |
| FN | net thrust, lbf |
| FNOVFD | ratio of net thrust to design-point net thrust |
| FRD | ram drag, lbf |
| GU | initial or guessed values |
| ITRYS | number of loops through engine before quitting |
| LOOP | variable counter |
| LOOPER | number of loops through engine counter |

| | |
|---|---|
| SFC | specific fuel consumption, lbm/lbm/hr |
| TOLALL | tolerance on convergence |
| VA | velocity of aircraft, ft/sec |
| VJ | jet velocity, ft/sec |

## Input Symbols

| | |
|---|---|
| AFTFAN | logical control for an aft-fan engine |
| ALTP | altitude, ft |
| AM | Mach number of aircraft |
| AM6 | design afterburner entrance Mach number |
| AM23 | design duct-burner entrance Mach number |
| AM55 | design low-pressure-turbine exit Mach number |
| A6 | area of afterburner entrance (calculated from AM6), $ft^2$ |
| A8 | main nozzle throat area (can be changed at off-design), $ft^2$ |
| A28 | fan duct nozzle throat area (see A8), $ft^2$ |
| A38 | wing duct nozzle throat area (see A8), $ft^2$ |
| CNHPDS | design corrected speed - inner turbine |
| CNIPDS | design corrected speed - middle turbine |
| CNLPDS | design corrected speed - outer turbine |
| COLDDAY | factor for correcting corrected airflows for cold day, T2 = $-19^{o}$ F |
| CVDNOZ | nozzle thrust coefficient (DUCT) |
| CVDWNG | nozzle thrust coefficient (WING) |
| CVMNOZ | nozzle thrust coefficient (CORE) |
| DELFG | gross-thrust delta degradation multiplier |
| DELFN | net-thrust delta degradation multiplier |
| DELSFC | specific-fuel-consumption delta degradation multiplier |
| DPAFDS | afterburner design pressure drop, $\Delta P/P$ |
| DPCODS | combustor design pressure drop, $\Delta P/P$ |
| DPDUDS | duct design pressure drop, $\Delta P/P$ |

| | |
|---|---|
| DPWGDS | wing duct design pressure drop, $\Delta P/P$ |
| DTCODS | combustor design temperature increase (automatically set to T4 - T3), $^{O}R$ |
| DUMMYSPOOL | logical control for spool which does not change temperature or pressure of air |
| ETAA | afterburner efficiency (not required) |
| ETAADS | afterburner efficiency at design |
| ETABDS | combustor efficiency at design |
| ETACDS | inner-compressor adiabatic efficiency at design |
| ETAD | duct-burner combustor efficiency |
| ETAFDS | front (outer) compressor adiabatic efficiency at design |
| ETAIDS | intermediate (middle) compressor adiabatic efficiency at design |
| ETAR | inlet pressure recovery (ram recovery), P2/P1 |
| ETHPDS | high-pressure-(inner) turbine design adiabatic efficiency |
| ETIPDS | intermediate-pressure-(middle) turbine design adiabatic efficiency |
| ETLPDS | low-pressure-(outer) turbine design adiabatic efficiency |
| FIXFANTOMIDDLE | logical control for boosted fan |
| FIXMIDDLETOCOMP | logical control for supercharged compressor |
| HOTDAY | factor for correcting corrected airflows to hot day, T2 = $44^{O}$ F |
| HPEXT | horsepower extraction |
| IAFTBN | index on afterburning desired |
| IAMTP | index on ram or inlet operation desired |
| IDBURN | index on duct burning desired |
| IDCD | duct nozzle convergent-divergent when IDCD = 1 (design or off-design) |
| IDES | index for design point; must be set equal to 1 to design engine; zeroed automatically |
| IDUMP | index for dumping of error matrix |
| IGASMX | index for mixed-flow or non-mixed-flow turbofans |

| | |
|---|---|
| IMCD | main nozzle convergent-divergent when IMCD = 1 (design or off-design) |
| ITRYS | index for maximum number of iterations |
| MODE | independent variable designator for engine operation |
| NOZFLT | index for floating main or duct nozzle |
| PCBLC | ratio of compressor bleed to turbines to compressor airflow |
| PCBLDU | ratio of compressor bleed leaked into fan duct to total compressor bleed flow |
| PCBLF | ratio of bleed from outer compressor to fan airflow dumped overboard (i.e., leakage) |
| PCBLHP | fraction of PCBLC used for high-pressure (inner) turbine (cooling) |
| PCBLIDS | ratio of design value of air into wing to air into core; zero for two-stream engine |
| PCBLIP | fraction of PCBLC used for intermediate-pressure turbine (cooling) |
| PCBLLP | fraction of PCBLC used for low-pressure (outer) turbine (cooling) |
| PCBLOB | inner-compressor bleed compressor airflow (overboard for customer use) |
| PCNC | inner-compressor shaft speed as a percent of design shaft speed |
| PCNCDS | design inner-compressor shaft speed |
| PCNF | outer-compressor shaft speed as a percent of design |
| PCNFDS | design outer-compressor shaft speed as a percent of design shaft speed |
| PCNI | intermediate-compressor shaft speed as a percent of design |
| PCNIDS | design intermediate-compressor shaft speed as a percent of design shaft speed |
| POLARDAY | factor for correcting corrected airflow to polar day, T2 = $-75^{o}$ F |
| PRCDS | design inner-compressor pressure ratio |
| PRFDS | design outer-compressor pressure ratio |

| | |
|---|---|
| PS55 | static pressure at low-pressure-turbine exit |
| P2 | compressor-face total pressure (for nonstandard days only), atm |
| TFHPDS | design inner-turbine flow function |
| TFIPDS | design intermediate-turbine flow function |
| TFLPDS | design outer-turbine flow function |
| TOLALL | tolerance on error matrix |
| TROPICALDAY | factor for correcting corrected airflows for tropical day, T2 = 31$^{o}$ F |
| T2 | compressor-face total temperature (for nonstandard days only), T1 + T2 |
| T24 | duct-burner exit temperature, $^{o}$R |
| T4 | combustor exit temperature, $^{o}$R |
| T4DS | design combustor exit temperature, $^{o}$R |
| T7 | afterburner exit temperature, $^{o}$R |
| T7DS | design afterburner exit temperature, $^{o}$R |
| WAFCDS | design outer-compressor corrected airflow, lbm/sec |
| WAICDS | design intermediate-compressor corrected airflow, lbm/sec |
| WFA | fuel flow rate to afterburner (IAFTBN = 2 only), lbm/sec |
| WFB | fuel flow rate to main burner (MODE = 2 only), lbm/sec |
| WFBDS | design fuel flow rate to main burner (MODE = 2 only), lbm/sec |
| ZCDS, ZFDS, ZIDS | design ratio of inner compressor, fan compressor, and middle compressor pressure ratios, respectively; equals pressure ratio at design point on design speed line minus value of pressure ratio at lowest point on speed line divided by high (surge) value minus low value of pressure ratio on the design speed line |

## Output Symbol List[1]

| | |
|---|---|
| A | area, ft$^{2}$ |

[1]Some symbols, such as T4, are followed by station numbers; see appropriate figure for each engine in order to determine station numbers.

| | |
|---|---|
| ALTP | altitude, ft |
| AM | Mach number |
| BLC | bleed flow out of compressor, lbm/sec |
| BLF | bleed flow out of fan (dumped overboard), lbm/sec |
| BLHP | bleed flow into high-pressure turbine, lbm/sec |
| BLI | airflow into third stream, lbm/sec |
| BLIP | bleed flow into intermediate-pressure turbine, lbm/sec |
| BPRINT | ratio of airflow into wing duct to airflow into core |
| BYPASS | ratio of airflow into fan duct to airflow into intermediate compressor |
| CNC | corrected shaft speed - inner compressor |
| CNF | corrected shaft speed - fan |
| CNHP | corrected shaft speed - high-pressure turbine, $PCNC/\sqrt{T_{in}}$ |
| CNHPCF | corrected speed - high-pressure-turbine correction factor |
| CNI | corrected shaft speed - intermediate compressor |
| CNIP | corrected shaft speed - intermediate-pressure turbine, $PCNI/\sqrt{T_{in}}$ |
| CNIPCF | corrected speed - intermediate-pressure-turbine correction factor |
| CNLP | corrected speed - low-pressure turbine, $PCNF/\sqrt{T_{in}}$ |
| CNLPCF | corrected speed - low-pressure-turbine correction factor |
| CVDNOZ | velocity coefficient of fan nozzle |
| CVDWNG | velocity coefficient of wing nozzle |
| CVMNOZ | velocity coefficient of core nozzle |
| DHHPCF | high-pressure-turbine delta enthalpy correction factor |
| DHIPCF | intermediate-pressure-turbine delta enthalpy correction factor |
| DHLPCF | low-pressure-turbine delta enthalpy correction factor |
| DHTC | work done by high-pressure turbine, Btu/lbm |
| DHTCHP | enthalpy change temperature corrected - high-pressure turbine, $Btu/^{o}R/atm/lbm$ |
| DHTCIP | enthalpy change temperature corrected - intermediate-pressure turbine, $Btu/^{o}R/atm/lbm$ |

| | |
|---|---|
| DHTCLP | enthalpy change temperature corrected - low-pressure turbine, Btu/$^{o}$R/atm/lbm |
| DHTF | work done by low-pressure turbine, Btu/lbm |
| DHTI | work done by intermediate-pressure turbine, Btu/lbm |
| DPCOM | $(\Delta P/P)_{combustor}$ |
| DPDUC | $(\Delta P/P)_{fan\ duct}$ |
| DPWING | $(\Delta P/P)_{wing\ duct}$ |
| DTCOCF | temperature-rise-across-combustor correction factor |
| ETAB | combustor efficiency |
| ETABCF | combustor efficiency correction factor |
| ETAC | inner-compressor adiabatic efficiency |
| ETACCF | inner-compressor efficiency correction factor |
| ETAD | duct-burner efficiency |
| ETAF | fan adiabatic efficiency |
| ETAFCF | fan efficiency correction factor |
| ETAI | intermediate-compressor adiabatic efficiency |
| ETAICF | intermediate-compressor efficiency correction factor |
| ETATHP | high-pressure-turbine adiabatic efficiency |
| ETATIP | intermediate-pressure-turbine adiabatic efficiency |
| ETATLP | low-pressure-turbine adiabatic efficiency |
| ETHPCF | high-pressure-turbine efficiency correction factor |
| ETIPCF | intermediate-pressure-turbine efficiency correction factor |
| ETLPCF | low-pressure-turbine efficiency correction factor |
| FAR | fuel-air ratio, f/a |
| FCOVFN | ratio of core thrust to net thrust |
| FFOVFN | ratio of fan thrust to net thrust |
| FG | gross thrust, lbf |
| FGM | momentum thrust of all but wing, lbf |
| FGMWNG | momentum thrust of wing, lbf |
| FGP | pressure thrust of all but wing, lbf |

| | |
|---|---|
| FGPWNG | pressure thrust of wing, lbf |
| FMOVFN | ratio fan thrust plus core thrust to net thrust |
| FN | net thrust, lbf |
| FNMAIN | net thrust of all but wing, lbf |
| FNOVFD | ratio of net thrust to design-point net thrust |
| FNWING | net thrust of wing, lbf |
| FRD | ram drag, lbf |
| FWOVFN | ratio of net wing thrust to net thrust |
| HPEXT | horsepower extracted, hp |
| P | pressure, atm |
| PCBLC | fraction of compressor exit air bled for cooling or lost to cycle |
| PCBLDU | fraction of bleed air out of compressor which leaks into fan duct |
| PCBLF | fraction of fan exit airflow lost overboard |
| PCBLHP | fraction of compressor bleed air put into high-pressure turbine |
| PCBLI | fraction of intermediate-compressor air which goes into third stream |
| PCBLIP | fraction of compressor bleed air put into intermediate-pressure turbine |
| PCBLLP | fraction of compressor bleed air put into low-pressure turbine |
| PCNC | inner-compressor shaft speed as a percent of design |
| PCNF | fan-compressor shaft speed as a percent of design |
| PCNI | intermediate-compressor shaft speed as a percent of design |
| PRC | pressure ratio of inner compressor |
| PRCCF | pressure-ratio-of-inner-compressor correction factor |
| PRF | pressure ratio of fan |
| PRFCF | pressure-ratio-of-fan correction factor |
| PRI | pressure ratio of intermediate compressor |
| PRICF | pressure-ratio-of-intermediate-compressor correction factor |
| PS | static pressure, atm |
| SFC | specific fuel consumption, lbm/lbf/hr |
| T | temperature, $^{o}R$ |
| T2DS | design exit temperature of fan, $^{o}R$ |

| | |
|---|---|
| T21DS | design exit temperature of inner compressor, $^{o}R$ |
| T22DS | design exit temperature of intermediate compressor, $^{o}R$ |
| TFFHP | high-pressure-turbine flow function, $(lbm)(\sqrt{^{o}R})(in.^{2})/(sec)(lbf)$ |
| TFFIP | intermediate-pressure-turbine flow function, $(lbm)(\sqrt{^{o}R})(in.^{2})/(sec)(lbf)$ |
| TFFLP | low-pressure-turbine flow function, $(lbm)(\sqrt{^{o}R})(in.^{2})/(sec)(lbf)$ |
| TFHPCF | high-pressure-turbine flow function correction factor |
| TFIPCF | intermediate-pressure-turbine flow function correction factor |
| TFLPCF | low-pressure-turbine flow function correction factor |
| V | velocity, ft/sec |
| VA | velocity of aircraft, ft/sec |
| VJD | fan duct exhaust velocity, ft/sec |
| VJM | core exhaust velocity, ft/sec |
| VJW | wing duct exhaust velocity, ft/sec |
| WA | airflow, lbm/sec |
| WA3CDS | corrected airflow in combustor at design, lbm/sec |
| WAC | inner-compressor airflow, lbm/sec |
| WACC | inner-compressor corrected airflow, lbm/sec |
| WACCF | inner-compressor corrected airflow correction factor |
| WACI | intermediate-compressor corrected airflow, lbm/sec |
| WAD | fan duct airflow, lbm/sec |
| WAF | fan airflow, lbm/sec |
| WAFC | fan corrected airflow, lbm/sec |
| WAFCF | fan corrected airflow correction factor |
| WAI | intermediate-compressor airflow, lbm/sec |
| WAICF | intermediate-compressor corrected airflow correction factor |
| WFB | fuel flow rate to combustor, lbm/sec |
| WFD | fuel flow rate to duct burner, lbm/sec |
| WFT | total fuel flow rate, lbm/sec |
| WG | gas flow rate, lbm/sec |
| WGT | total gas flow rate, lbm/sec |

| | |
|---|---|
| ZC | ratio of inner-compressor pressure ratios |
| ZF | ratio of fan pressure ratios |
| ZI | ratio of intermediate-compressor pressure ratios |

# REFERENCES


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2. McKinney, John S.: Simulation of Turbofan Engine. Part II. User's Manual and Computer Program Listing. Rep. AFAPL-TR-67-125, pt. 2, Air Force Systems Command, Nov. 1967. (Available from DDC as AD-825198.)

3. Koenig, Robert W.; and Fishbach, Laurence H.: GENENG - A Program for Calculating Design and Off-Design Performance for Turbojet and Turbofan Engines. NASA TN D-6552, 1972.

4. Keenan, Joseph H.; and Kaye, Joseph: Gas Tables. John Wiley & Sons, Inc., 1948.

5. Turner, Don H.; and Huff, Vearl N.: An Input Routine Using Arithmetic Statements for the IBM 704 Digital Computer. NASA TN D-1092, 1961.

TABLE I. - VARIABLES AND ERRORS

| | Engine designation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i |
| | Number of spools | | | | | | | | |
| | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 |
| | Number of streams | | | | | | | | |
| | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 2 |
| | Turbofan | Boosted fan | Supercharged compressor | Turbofan | | Aft fan | Supercharged compressor | Aft fan | |
| Variable 1 | ZF | ZF | ZF | ZF | ZF | ZF | ZF | ZF | ZF |
| Variable 2 | PCNF | PCNF | PCNF | PCNF | PCNF | PCNF | PCNF | PCNF | PCNF |
| Variable 3 | ZC | ZC | ZC | ZC | ZC | ZC | ZC | ZC | ZC |
| Variable 4 | PCNC | PCNC | PCNI | PCNC | PCNC | PCNC | PCNI | PCNC | PCNC |
| Variable 5 | TFFHP | TFFHP | TFFIP | TFFHP | TFFHP | TFFHP | TFFIP | TFFHP | TFFHP |
| Variable 6 | TFFLP | TFFLP | TFFLP | TFFLP | TFFLP | TFFLP | TFFLP | TFFLP | TFFLP |
| Variable 7 | ZI | ZI | ZI | ZI | ------ | ZI | ZI | ------ | ZI |
| Variable 8 | PCNI | ------ | ---------- | PCNI | ------ | PCNI | ---------- | ------ | PCNI |
| Variable 9 | TFFIP | ------ | ---------- | TFFIP | ------ | TFFIP | ---------- | ------ | TFFIP |
| Error 1 | $\frac{\text{TFHCAL - TFFHP}}{\text{TFHCAL}}$ | (a) | $\frac{\text{TFICAL - TFFIP}}{\text{TFICAL}}$ | (a) | (a) | (a) | (b) | (a) | (a) |
| Error 2 | $\frac{\text{DHTCC - DHTCHP}}{\text{DHTCC}}$ | (a) | $\frac{\text{DHTIC - DHTCIP}}{\text{DHTIC}}$ | (a) | (a) | (a) | (b) | (a) | (a) |
| Error 3 | $\frac{\text{TFLCAL - TFFLP}}{\text{TFLCAL}}$ | (a) | (a) | (a) | (a) | (a) | (a) | (a) | (a) |
| Error 4 | $\frac{\text{DHTCF - DHTCLP}}{\text{DHTCF}}$ | (a) | (a) | (a) | (a) | (a) | (a) | (a) | (a) |
| Error 5 | $\frac{\text{P25R - P25}}{\text{P25R}}$ | (a) | (a) | (a) | (a) | (a) | (a) | (a) | (a) |
| Error 6 | $\frac{\text{P7R - P7}}{\text{P7R}}$ | (a) | (a) | (a) | (a) | (a) | (a) | (a) | (a) |
| Error 7 | $\frac{\text{P38R - P38}}{\text{P38R}}$ | (a) | (a) | $\frac{\text{WAC - WAI}}{\text{WAC}}$ | ------ | (a) | (a) | ------ | (c) |
| Error 8 | $\frac{\text{TFICAL - TFFIP}}{\text{TFICAL}}$ | ------ | ---------- | (a) | ------ | (a) | ---------- | ------ | (a) |
| Error 9 | $\frac{\text{DHTIC - DHTCIP}}{\text{DHTIC}}$ | ------ | ---------- | (a) | ------ | (a) | ---------- | ------ | (a) |
| Matrix size | 9 × 9 | 7 × 7 | 7 × 7 | 9 × 9 | 6 × 6 | 9 × 9 | 7 × 7 | 6 × 6 | 9 × 9 |

[a]Same as error for engine a.

[b]Same as error for engine c.

[c]Same as error for engine d.

TABLE II. - INPUTS REQUIRED FOR BASIC CYCLES

| Variable | Units or type | Definition | Engine designation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | a | b | c | d | e | f | g | h | i |
| | | | Number of spools | | | | | | | | |
| | | | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 |
| | | | Number of streams | | | | | | | | |
| | | | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 2 |
| | | | Turbo-fan | Boosted fan | Super-charged com-pressor | Turbofan | | Aft fan | Super-charged com-pressor | Aft fan | |
| PRFDS | ---------- | Fan pressure ratio | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| WAFCDS | lb/sec | Fan corrected airflow | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| ETAFDS | ---------- | Fan efficiency | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| ZFDS | ---------- | Design Z of fan | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| PCNFDS | ---------- | Corrected speed of fan | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| PRIDS | ---------- | Intermediate pressure ratio | ↓ | ↓ | ↓ | ↓ | No | ↓ | ↓ | No | ↓ |
| WAICDS | lb/sec | Intermediate corrected airflow | ↓ | ↓ | ↓ | ↓ | Yes | ↓ | ↓ | Yes | ↓ |
| ETAIDS | ---------- | Intermediate efficiency | ↓ | ↓ | ↓ | ↓ | No | ↓ | ↓ | No | ↓ |
| ZIDS | ---------- | Design Z of intermediate compressor | ↓ | ↓ | ↓ | ↓ | No | ↓ | ↓ | No | ↓ |
| PCNIDS | ---------- | Corrected speed of intermediate compressor | ↓ | No | ↓ | ↓ | No | ↓ | ↓ | No | ↓ |
| PRCDS | ---------- | Compressor pressure ratio | ↓ | Yes | ↓ | ↓ | Yes | ↓ | ↓ | Yes | ↓ |
| PCBLIDS | ---------- | Fraction of air into third duct | ↓ | ↓ | ↓ | Zero | Zero | ↓ | ↓ | Zero | Zero |
| ETACDS | ---------- | Compressor efficiency | ↓ | ↓ | ↓ | Yes | Yes | ↓ | ↓ | Yes | Yes |
| ZCDS | ---------- | Design Z of compressor | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| PCNCDS | ---------- | Corrected speed of compressor | ↓ | ↓ | No | ↓ | ↓ | ↓ | No | ↓ | ↓ |
| ETABDS | ---------- | Combustor efficiency | ↓ | ↓ | Yes | ↓ | ↓ | ↓ | Yes | ↓ | ↓ |
| DPCODS | ---------- | Combustor pressure drop, $\Delta P/P$ | ↓ | ↓ | Yes | ↓ | ↓ | ↓ | Yes | ↓ | ↓ |
| T4DS | $^{o}R$ | Turbine inlet temperature | ↓ | ↓ | Yes | ↓ | ↓ | ↓ | Yes | ↓ | ↓ |
| TFHPDS | $\frac{lb\sqrt{^{o}R}}{(sec)(psia)}$ | High-pressure-turbine flow function | ↓ | ↓ | No | ↓ | ↓ | ↓ | No | ↓ | ↓ |
| CNHPDS | ---------- | High-pressure-turbine corrected speed | ↓ | ↓ | No | ↓ | ↓ | ↓ | No | ↓ | ↓ |
| ETHPDS | ---------- | High-pressure-turbine efficiency | ↓ | ↓ | No | ↓ | ↓ | ↓ | No | ↓ | ↓ |
| TFIPDS | $\frac{lb\sqrt{^{o}R}}{(sec)(psia)}$ | Intermediate-turbine work function | ↓ | No | Yes | ↓ | No | ↓ | Yes | No | ↓ |
| CNIPDS | ---------- | Intermediate-pressure-turbine corrected speed | ↓ | No | ↓ | ↓ | No | ↓ | ↓ | No | ↓ |
| ETIPDS | ---------- | Intermediate-pressure-turbine efficiency | ↓ | No | ↓ | ↓ | No | ↓ | ↓ | No | ↓ |
| TFLPDS | $\frac{lb\sqrt{^{o}R}}{(sec)(psia)}$ | Low-pressure-turbine flow function | ↓ | Yes | ↓ | ↓ | Yes | ↓ | ↓ | Yes | ↓ |
| CNLPDS | ---------- | Intermediate-pressure-turbine corrected speed | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| ETLPDS | ---------- | Intermediate-pressure-turbine efficiency | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| DPDUDS | ---------- | Fan pressure drop, $\Delta P/P$ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| DPWGDS | ---------- | Wing duct pressure drop, $\Delta P/P$ | ↓ | ↓ | ↓ | No | No | ↓ | ↓ | No | No |
| DPAFDS | ---------- | Afterburner pressure drop, $\Delta P/P$ | ↓ | ↓ | ↓ | Yes | Yes | ↓ | ↓ | Yes | Yes |
| FIXFANTOMIDDLE | Logical | Boosted fans | .F. | .T. | .F. | .F. | .F. | .F. | .F. | .F. | .F. |
| FIXMIDDLETOCOMP | Logical | Supercharged compressors | ↓ | .F. | .T. | ↓ | .F. | .F. | .T. | .F. | .F. |
| DUMMYSPOOL | Logical | No intermediate spool | ↓ | .F. | .F. | ↓ | .T. | .F. | .F. | .T. | .F. |
| AFTFAN | Logical | Aft-fan engines | ↓ | .F. | .F. | ↓ | .F. | .T. | .T. | .T. | .T. |

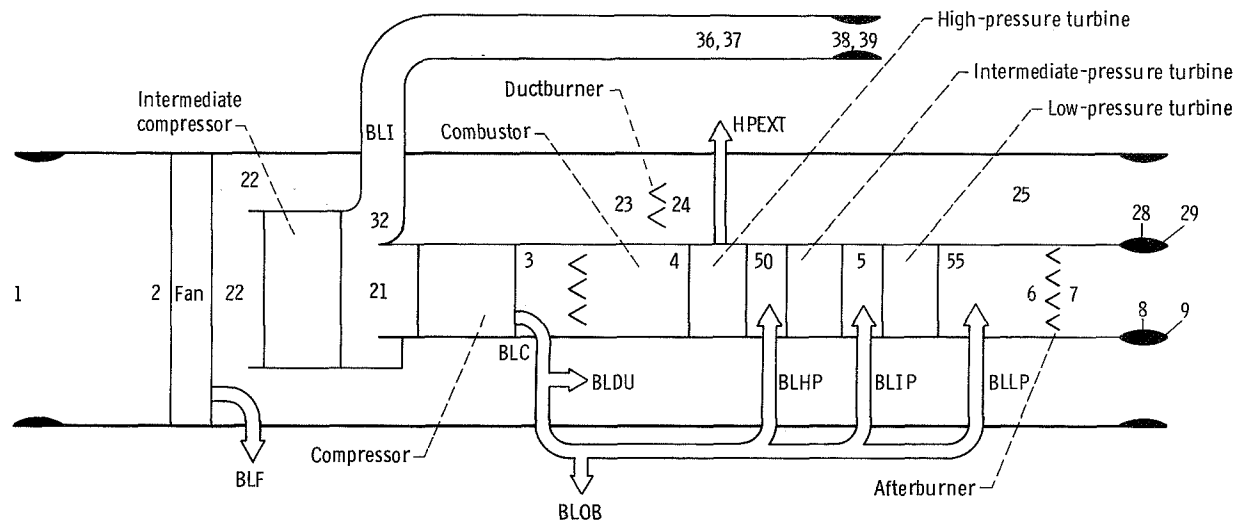



Figure 1. - Three-spool, three-stream turbofan engine (type a).

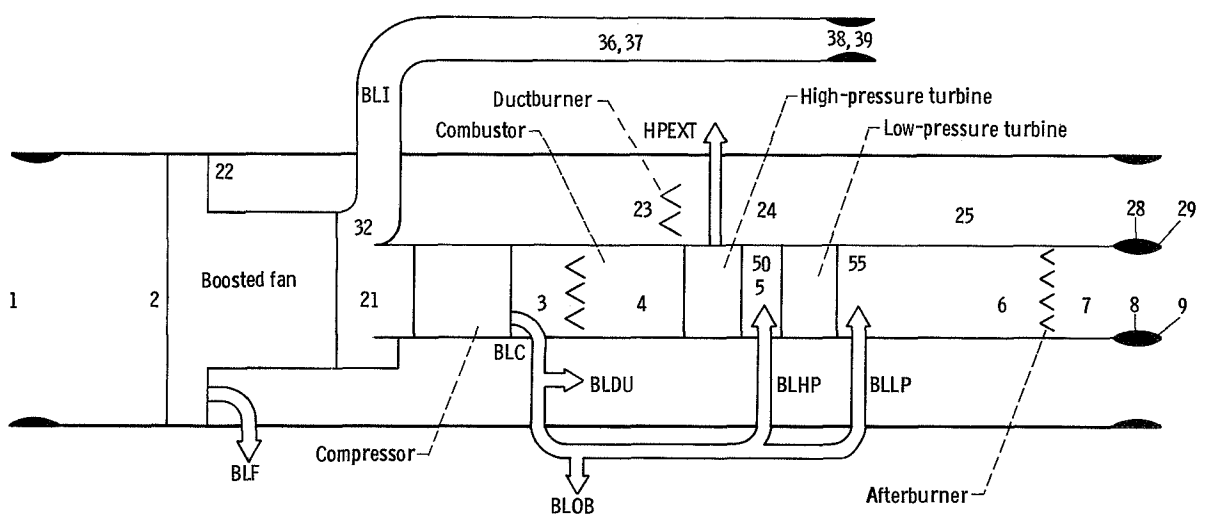



Figure 2. - Two-spool, three-stream boosted-fan engine (type b).

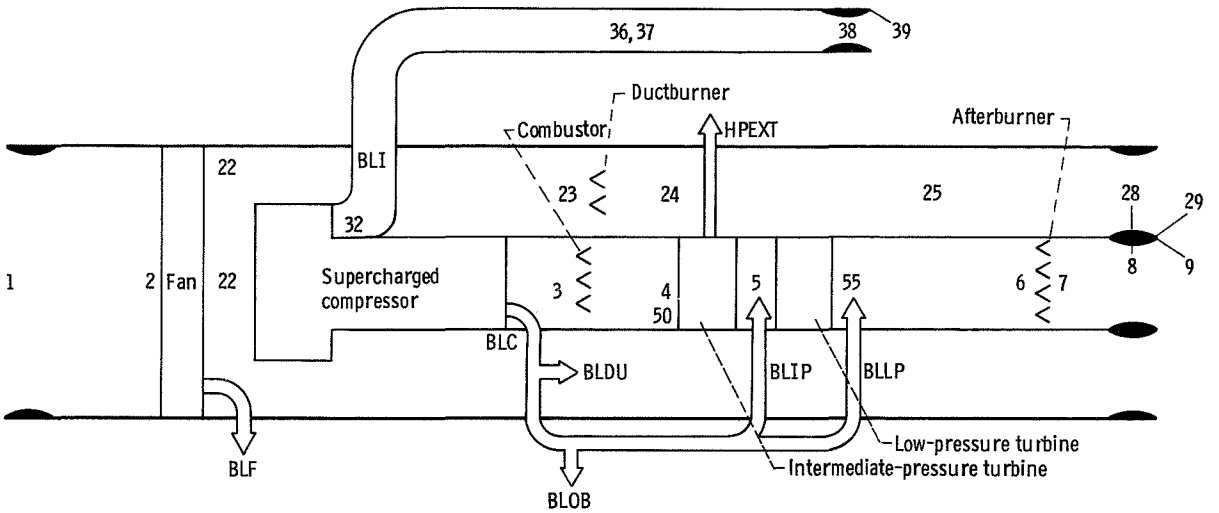



Figure 3. - Two-spool, three-stream, supercharged-compressor engine (type c).

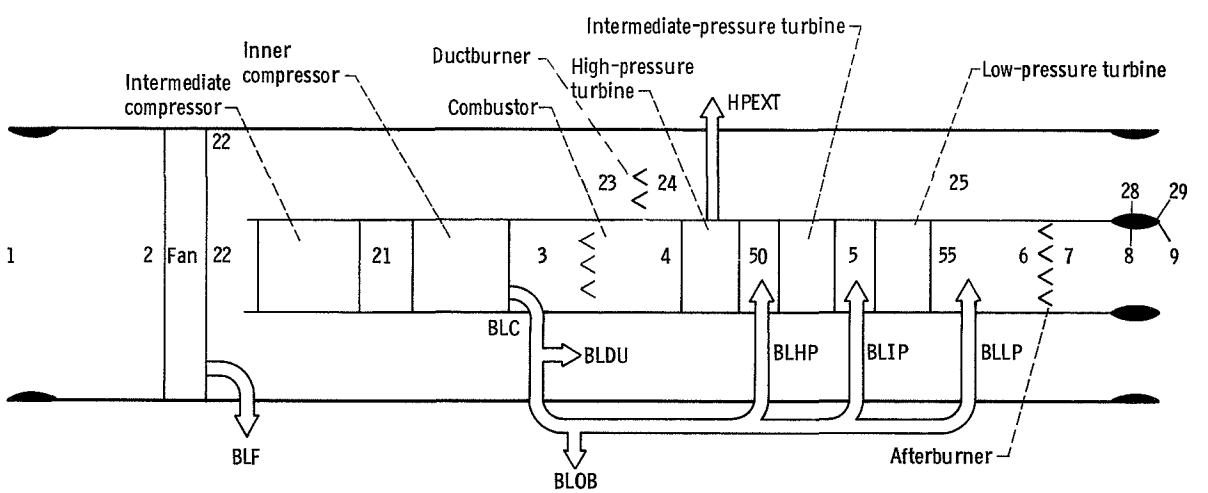



Figure 4. - Three-spool, two-stream engine (type d).

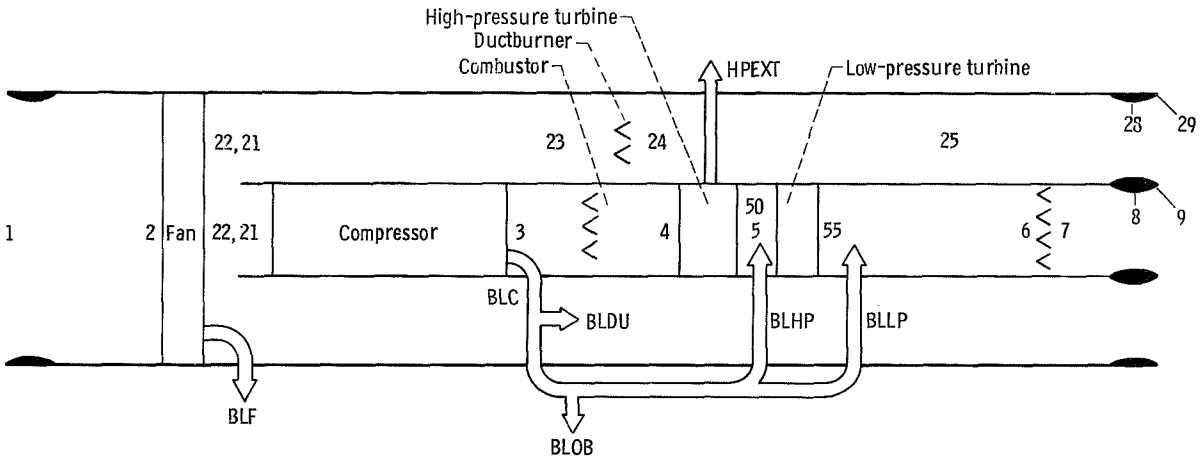



Figure 5. - Two-spool, two-stream turbofan engine (type e).

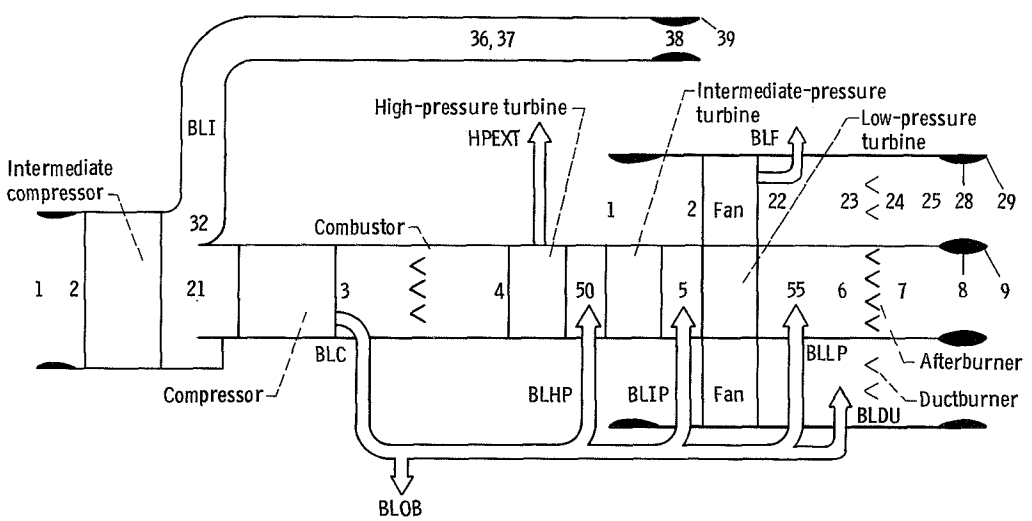



Figure 6. - Three-spool, three-stream, aft-fan engine (type f).

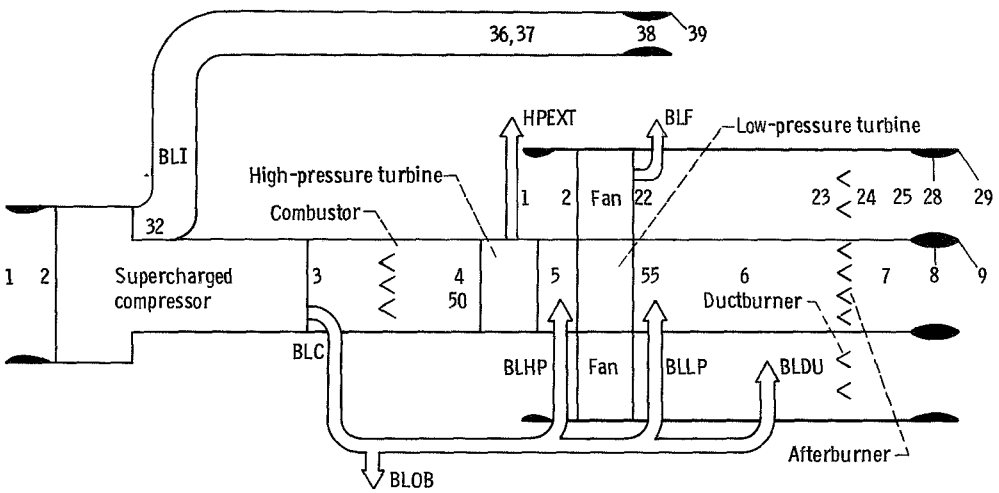



Figure 7. - Two-spool, three-stream, aft-fan engine (type g).

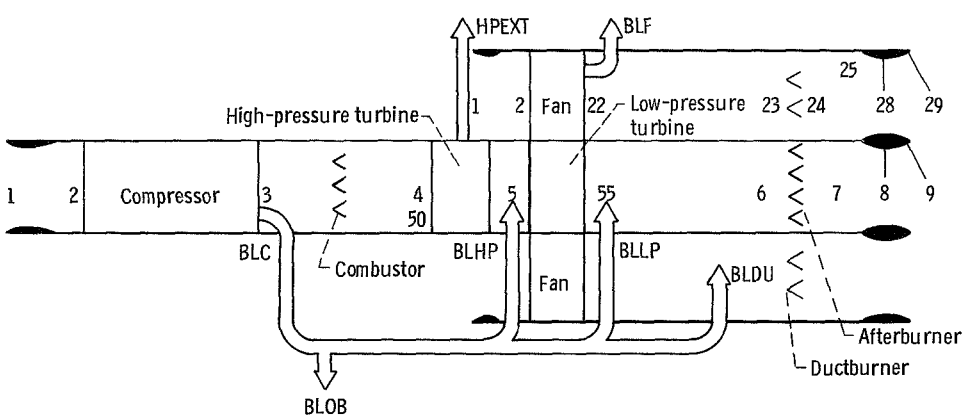



Figure 8. - Two-spool, two-stream aft-fan engine (type h).

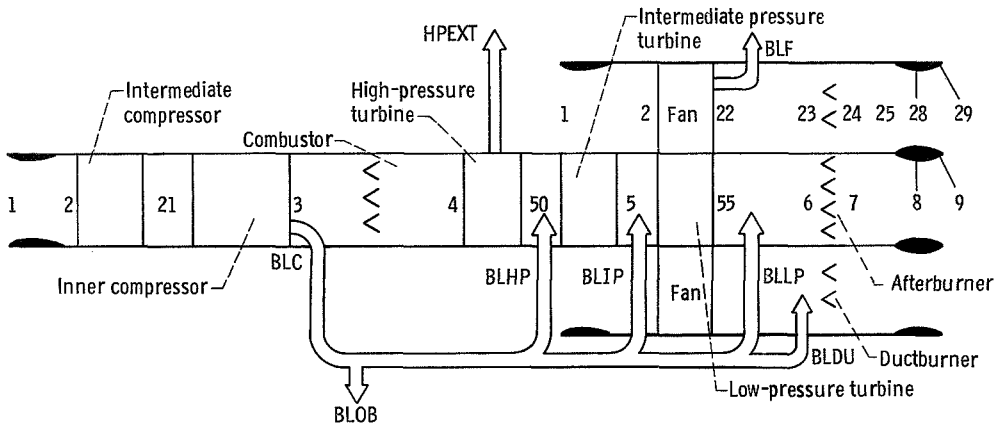



Figure 9. - Three-spool, two-stream aft-fan engine (type i).

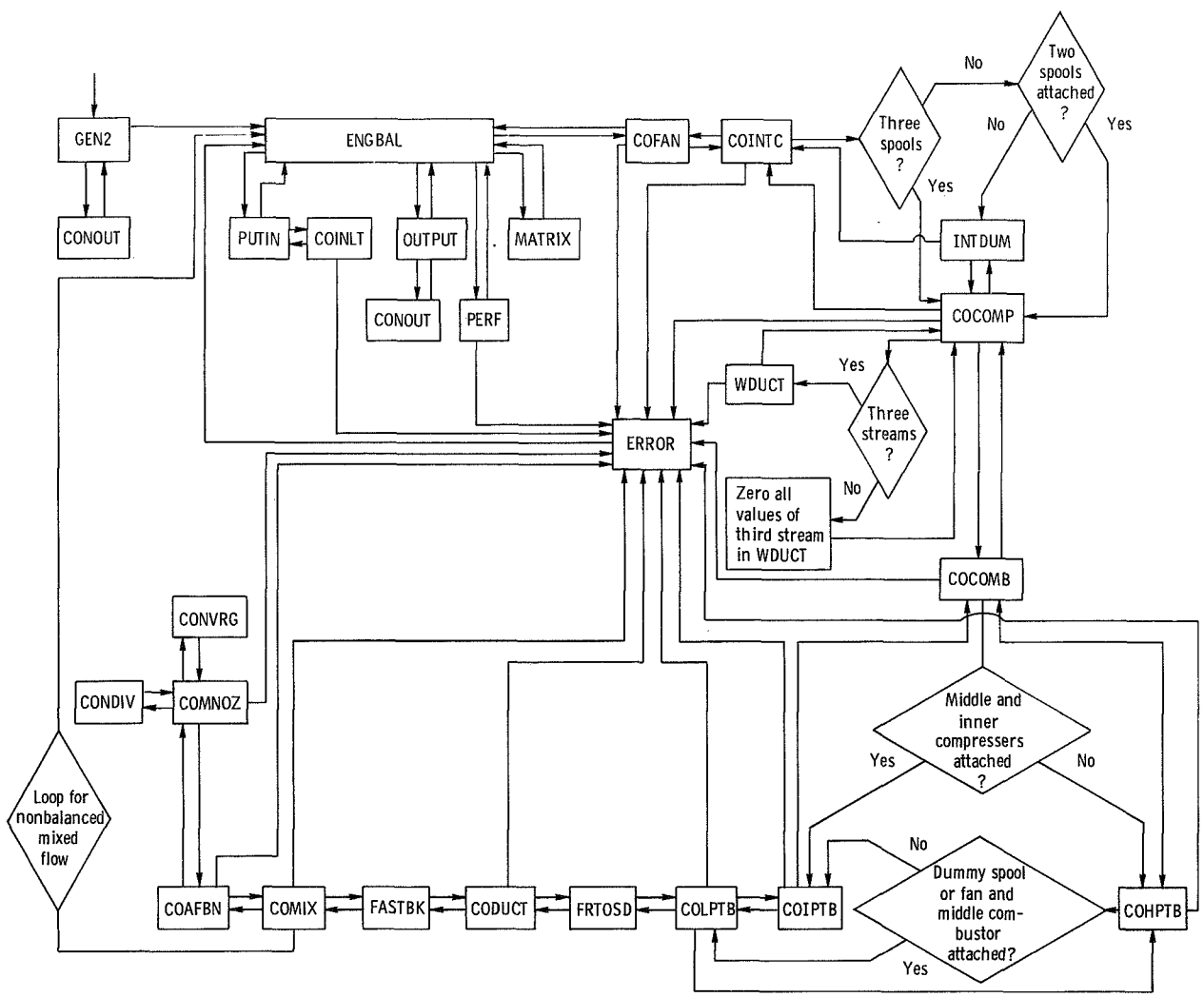



Figure 10. - Flow chart for GENENG II computer program.

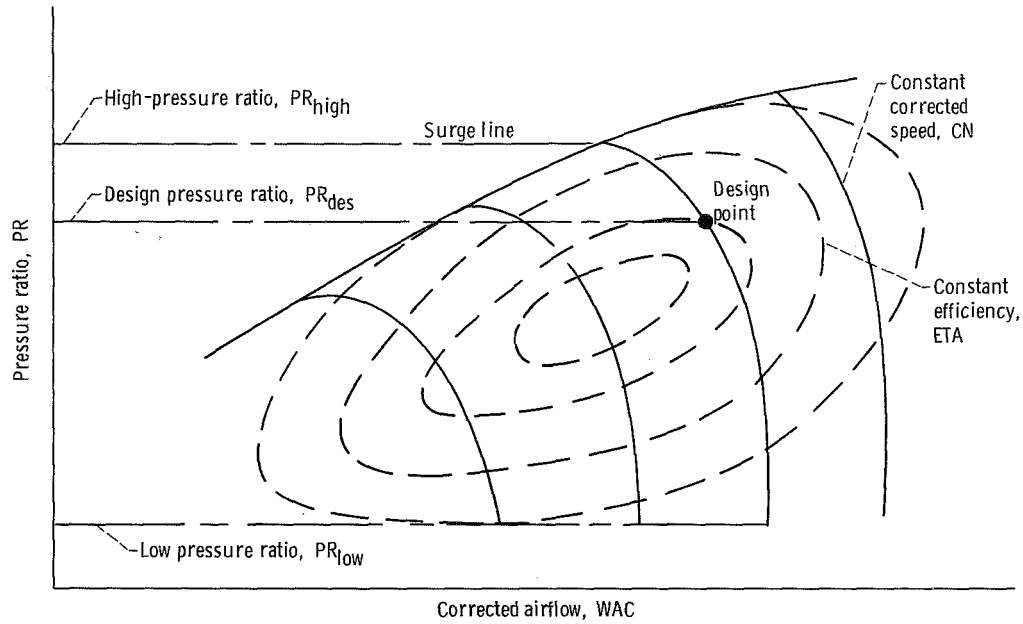



Figure 11. - Example of a specific fan-compressor map. $Z = (PR_x - PR_{low})/(PR_{high} - PR_{low})$.

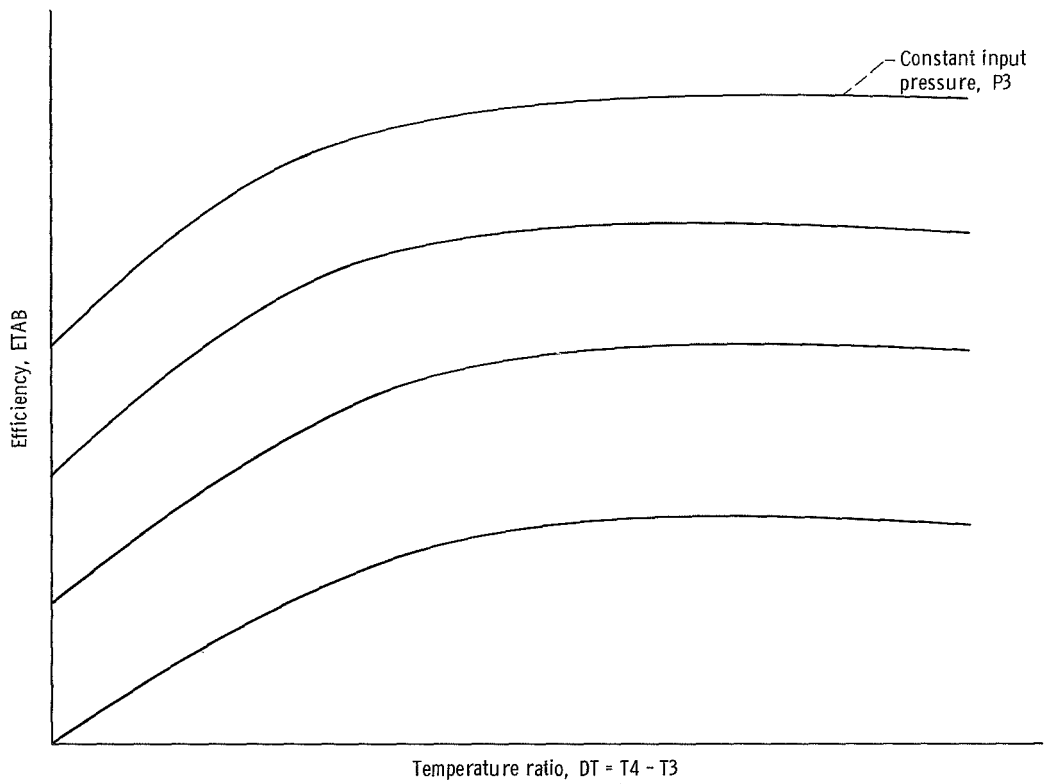



Figure 12. - Example of combustor map.

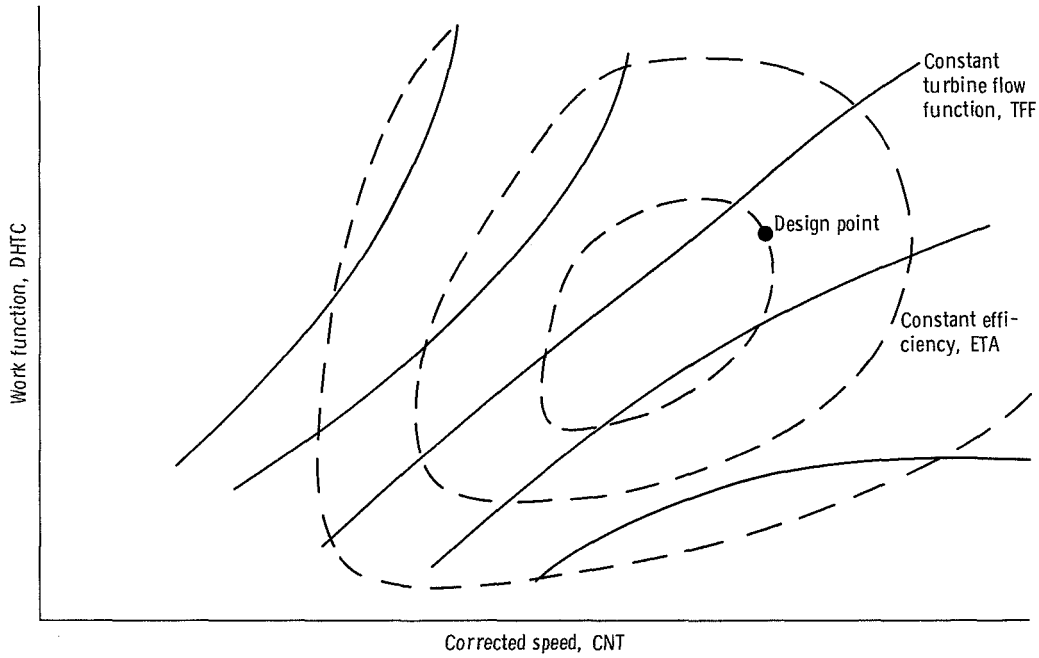
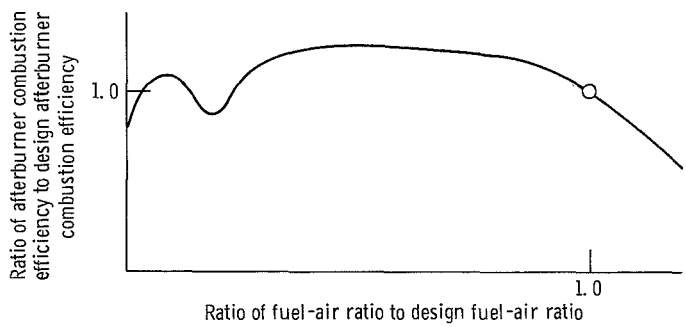
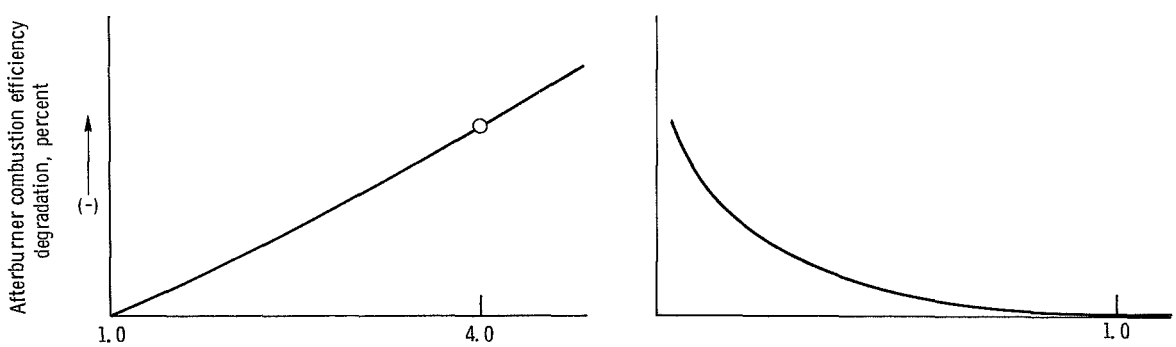



Figure 13. - Example of specific turbine map.




(a) Generalized afterburner combustion efficiency as function of fuel-air ratio.




(b) Efficiency correction factor against afterburner inlet Mach number.

(c) Efficiency correction factor against afterburner inlet total pressure.

Figure 14. - Example of a generalized afterburner combustion efficiency performance map.

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—NATIONAL AERONAUTICS AND SPACE ACT OF 1958

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